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Three Essays in Tax Policy, Macroeconomics, and Corporate Policies

by

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Contents

abstract

This thesis consists of three essays addressing the impact of tax policy changes on the macroeconomic aggregates and also on the real and financial decisions of firms of different sizes.

In the first chapter – "State-Dependent Macroeconomic Effects of Tax Changes: Estimates Based on Narrative Records in the U.S."- I provide evidence on the state-dependent macroeconomic effects of tax liability changes in the United States. I estimate a state-dependent model where the state of the economy is measured by the amount of slack in the economy. We consider narrative approach to identify tax shocks and local projection technique to calculate impulse responses. Our estimates show that linear responses are being about half-way between the large estimated responses during good times and the much smaller effects and not significantly different from zero during bad times. This suggests that, while the identified tax shocks based on narrative records are indeed unrelated to the state of the economy, the macroeconomics effects of the shocks are different depending on the state of the economy. Results are shown to be robust to many alternative specifications. We also find that the effects of tax changes depend on whether the tax changes are tax-cuts or tax-increases. Those tax cuts taken to stimulate long-run growth are more likely to increase growth and reduce deficits in good times than bad times, but instead, tax increases taken to deal with an inherited budget deficit have strong effect on deficit reduction during bad times.

Second chapter – "Tax Policy and Investment Behavior of Small and Large Firms" (joint with Morteza Zamanian) investigates the role of size in firms' responses to exogenous tax changes over the post-WWII period. Using the *US Census Bureau, Quarterly Financial Report (QFR)* data and employing a local projection method, we find that both small and large firms respond to exogenous corporate income tax cuts by boosting investment. However, large businesses relatively contribute higher share of aggregate changes of business investment. We also explore firms financing behavior in such occurrences. Perhaps the most controversial result of this paper is the responses of cash holding to tax policy changes. Despite the fact that small firms hold relatively more cash (cash to asset) than large firms, and then one would expect that small firms use their cash when investment opportunities arrive, instead, our finding show that large firms rely more heavily on cash to finance investment. In addition, while both firms increase their use of external financing, small firms rely more on debt to finance investment. In fact, cash reserves of large firms appear to be a strong substitute for debt in response to a corporate tax cut.

"Dynamics of Cash Holding: Evidence from U.S. Manufacturing Firms 1956-2014" (joint with Morteza Zamanian) is the last chapter of this dissertation which explores the long-run dynamics of corporate cash holding using a novel dataset of U.S. manufacturing firms. The results mirror previous empirical findings of increasing cash-to-asset ratio from the 1980s onwards. However, looking at a longer horizon we show that the trend of the cash ratio has been roughly U-shaped since 1955. To explain this fact, we review alternative theories of cash holding dynamics and show that cash flow volatility theory is the unique theory which can explain evolution of the cash ratio over the past six decades. In addition, using this dataset we show that the aggregate dynamics of cash holding is not driven by a particular size class of firms.

Chapter 1

State-Dependent Macroeconomic Effects of Tax Changes: Estimates Based on Narrative Records in the U.S.

This chapter provides evidence on the state-dependent macroeconomic effects of tax liability changes in the United States. We estimate a state-dependent model where the state of the economy is measured by the amount of slack in the economy. Our estimates show that linear responses are being about half-way between the large estimated responses during good times and the much smaller effects and not significantly different from zero during bad times. This suggests that, while the identified tax shocks based on narrative records are indeed unrelated to the state of the economy, the macroeconomics effects of the shocks are different depending on the state of the economy. In addition, we find that the effects of tax changes also depend on whether the tax changes are tax-cut or tax-increase. Tax cuts are more likely to increase growth and reduce deficits in good times than bad times, but instead, tax increases have strong effect on deficit reduction during bad times.

1.1 Introduction

The debate concerning the effects of fiscal policy shocks on macroeconomic aggregates is wide and the recent Great Recession (2007-2009) has raised again several fundamental issues in regard to the size and also the sign of fiscal multipliers. Numerous studies have attempted to estimate the dynamic macroeconomic effects of fiscal policy shocks and found a very large intervals for the size of fiscal multipliers.[1] The focus of these studies differs depending on their underlying arguments, so that the range of estimated multipliers are as wide within studies as it is across studies[2].

[1]The multiplier for a temporary increase in government spending lies between 0.5 and 2 (Ramey, 2012a) and larger for tax multiplier with range from 0.5 to 3 for an increase in taxes (Favero and Giavazzi (2012), Romer and Romer (2010), and Perotti (2012), among others.)

[2]A survey of this literature is in Ramey (2011).

The main challenge in measuring the aggregate effects of fiscal policy shocks is how to identify exogenous shifts in fiscal policy. One strand of the empirical literature considers exogenous shifts as unobservable and estimates the effects of fiscal policy shocks using a vector autoregressive (VAR) model by imposing short run restrictions (Blanchard and Perotti (2002), and Mountford and Uhlig (2009)). On the other hand, a very different identification strategy introduces a new dataset of observable exogenous tax changes identified via the narrative method (Ramey and Shapiro (1998), Romer and Romer (2010), and Cloyne (2013)). In the empirical literature, different results have been obtained for the fiscal multipliers between standard VAR methods and the narrative approach for identifying fiscal policy shocks. Ramey (2011) shows that timing is the key reason explaining this difference[3] and Favero and Giavazzi (2012) find that the different results found in the empirical literature is not explained by the different identification of the shocks[4], but by the different models used to estimate the macroeconomic effects of the policy changes. However, Alesina, Favero and Giavazzi (2013) point out some of the main advantages of using narrative approach, such as the possibility of distinguishing between different shifts in fiscal policy, permanent and temporary policy, also shocks identified via a narrative method are model independent and therefore are not affected by the possible omitted variables, and finally with the narrative approach we can distinguish between anticipated and unanticipated components of fiscal policy shocks, which is important to prevent the biases in the estimates of fiscal multipliers in the presence of fiscal foresight[5].

Moreover, over the past few years, a growing number of empirical studies have provided evidence that multipliers are different depending on the state of the economy. They find that the effect of government spending on output is state dependent and support the view that multipliers are larger and more effective when economy is in recession (e.g. Auerbach and Gorodnichenko (2012, 2013), Fazzari et al. (2013), Bachmann and Sims (2012), Baum et al. (2012), and Batini et al. (2012)). Although most studies agree that spending multipliers are larger when the economy is in recession than expansion[6], Owyang et al. (2013) and Ramey and Zubairy (2014) find no evidence that spending multipliers are greater during periods of high unemployment in the U.S.[7]. Caggiano et al. (2014) also do not find statistically larger fiscal spending multipliers in recessions than in expansions, except in extreme phases of the business cycle where they find larger spending multipliers in deep recessions than strong expansions. On the theoretical side, to our knowledge, there are only two papers which have addressed this issue and support state-dependent effects of fiscal policy shocks, although different multipliers have been obtained. One developed a search and matching

[3] She shows that the narrative identification of shocks Granger-cause the VAR shocks, this implies the importance of anticipation effects.

[4] They show that the exogenous tax shocks identified by the two alternative methods are quite different, the correlation between them is 0.22.

[5] Information set of econometrician is smaller than that of the private agents in the presence of fiscal foresight, i.e., agents are aware of future and basing their choices on more information than the econometrician possesses. This fact generates an equilibrium with a non-fundamental moving average representation. Leeper, Walker, and Yang (2013) show that under fiscal foresight, standard VAR techniques cannot correctly estimate the fiscal policy shock.

[6] Near zero during expansions but between 1.5 to 2 during recessions.

[7] In all states, multipliers are between 0.7 and 0.9.

model and shows public-employment multiplier is higher during recession than normal times[8] (Michaillat, 2014), while another one by using a New Keynesian model finds that effectiveness of fiscal policy is smaller in recessions than expansions (Galstyan and Wycherley, 2013).

This work seeks to shed light on this debate by analyzing the aggregate effects of tax changes across different states of the economy. We use a state-dependent model where the state of the economy is distinguished between periods of slack and non-slack in the economy. In particular, we use Jordà's (2005) local projection method to estimate state-dependent model and calculate impulse responses. Thus, our impulse responses are allowed to vary according to the amount of slack in the economy. We contribute to the empirical literature by highlighting the asymmetric effects of tax changes, tax-cut and tax-increase, which is important to analyze the dynamic macroeconomic effects of tax policy shocks.

Following the methodology developed by Auerbach and Gorodnichenko (2013) (AG-13) and Ramey and Zubairy (2014) (RZ) we estimate our linear and nonlinear models using Jordà's (2005) local projection technique to measure the impact of tax shocks on main macroeconomic aggregates in the U.S. from 1947 through 2007. This paper considers narrative measures of tax changes provided by Romer and Romer (2010) (RR) to identify exogenous tax shocks. We find large differences in the response of output and its components in slack and non-slack states. This implies that the effects of tax changes on the main macroeconomic aggregates are state dependent. In fact, the effectiveness of fiscal policy is considerably larger in good times than in bad times. Our estimates of the impact of tax changes on output using linear model are similar to many preexisting studies (e.g. RR, and Mertens and Ravn (2011, 2012)) that is large and persistent. However, the state-dependent responses are very different from them. We find that linear responses are being about halfway between the large estimated responses during good times and the much smaller effects during bad times. We carry out an extensive robustness analysis with respect to our measure of states, to the identification method, to the inclusion of a wide variety of control variables, and finally to our econometric framework and find little change in the baseline results. Moreover, we extend our findings in two ways. First we shed light on the large and state-dependent response of output to tax shocks by evaluating the behavior of the various components of output. We find that the non-linear responses of investment to tax changes could be the main transmission mechanism and explain why tax increases have a such strong and non-linear effects on output. Finally, we argue that the effects of tax changes do not depend only on the state of the economy, but also depend on whether tax changes are tax-cut or tax-increase. We find that, tax cuts are more likely to increase growth and reduce deficits in good times than bad times, but instead, tax increases are more successful in terms of output gains and deficit reduction, in bad times than good times.

The paper is organized as follows. The next section of the paper lays out the basic specification of our econometric methodology and also describes our measure of states. Section 3 reports our empirical results using linear and state-dependent models, first provides baseline results and then discusses a number of robustness checks. Section 4 develops possible explanations for our baseline results, and Section 5 concludes.

[8]It is 0.71 when the unemployment rate reaches 8% and 0.45 at a normal unemployment rate of 5.8%.

1.2 Econometric Framework and Measure of States

To allow for responses to vary according to the state of the economy, we first employ a state-dependent model where the states of the economy are allowed to vary according to the amount of slack in the economy. We then introduce unemployment rate as our indicator of slack, which is accepted as a key measure of underutilized resources.

1.2.1 Local Projection Method

Following the methodology developed by AG-13 and RZ, we use Jordà's (2005) local projection model to estimate our linear and state-dependent models and compute impulse responses of output to exogenous tax changes. The Jordà model is based on sequential regressions that can be estimated by simple regression techniques for each horizon h and for each variable and then constructing the impulse response function[9]. The linear model can be written as follows:

$$\Delta Y_{t+h} = \alpha_h + A_h(L)Y_{t-1} + B_h shock_t + \beta_{1,h}t + \beta_{2,h}t^2 + \epsilon_{t+h} \quad for \;\; h = 0, 1, 2, ... \tag{1.1}$$

where the *shock* is RR exogenous tax shocks[10], $\Delta Y_{t+h} \equiv Y_{t+h} - Y_{t-1}$ is the variable of interest, $A_h(L)$ is a polynomial in the lag operator. We estimate the series of regressions using quarterly data, where Y is the log of real per capita GDP. We use quadratic trend to deal with the movement of the baby boom generation through the labor market, which is the important source of the slow-moving demographics in the post-WWII period[11]. $A_h(L)$ is a polynomial of order 4, based on AICc[12]. The coefficient B_h gives the accumulated response of ΔY at time $t + h$ to the shock at time t. In fact, each step in the accumulated IRFs is obtained from a single equation.

Local projection technique compute impulse responses without specification and estimation of the underlying multivariate dynamic system. Thus, in contrast to the vector autoregression (VAR) model, where the impulse response coefficients are high-dimensional nonlinear functions of estimated parameters, local projection method directly estimates impulse response coefficients as a sequence of the B_h's estimated in a series of single regressions for each horizon. This means that the coefficients $A_h(L)$ only control dynamic effects of the baseline control variables and are not use directly to build IRFs. Thereupon, Jordà model is less sensitive to misspecification of the SVAR models because it does not constrain the shape of the impulse response function. Moreover, this method easily adapts to estimate a state-dependent model that are impractical or infeasible in a multivariate context. Thus, Jordà's method is a preferable alternative to VARs when calculating impulse responses is

[9] This technique has been used by Stock and Watson (2007) for forecasting the U.S. rate of price inflation.

[10] It should be noted that these shocks are as a percent of nominal GDP.

[11] Francis and Ramey (2009) show that the low-frequency movements in both hours and productivity growth during the 1970s and 1980s is due to the entry of the baby boom generation into the labor market.

[12] When the sample size (n) is small relative to the number of parameters (k) in the model (rule of thumb: $n/k < 40$), Burnham and Anderson (2002) strongly recommend using AICc, rather than AIC.

the object of interest.

We follow RZ and adapt Jordà's (2005) local projection model to estimate a state-dependent model as follows:

$$\begin{aligned} \Delta Y_{t+h} =& I_{t-1}\left\{\alpha_{S,h} + A_{S,h}(L)Y_{t-1} + B_{S,h} shock_t\right\} \\ &+ (1 - I_{t-1})\left\{\alpha_{N,h} + A_{N,h}(L)Y_{t-1} + B_{N,h} shock_t\right\} + \beta_{1,h}t + \beta_{2,h}t^2 + \epsilon_{t+h} \end{aligned} \tag{1.2}$$

where I is a dummy variable that indicates the state of the economy one period before the shock occurs, we use unemployment rate as our indicator of slack. We date the dummy variable by $(t-1)$ to avoid contemporaneous feedback from policy actions into whether the economy is in a slack state or a non-slack state. This implies that all of the coefficients of the model vary according to the state of the economy, the exception is the deterministic trend. The coefficients $B_{S,h}$ and $B_{N,h}$, respectively, give the high and low unemployment states accumulated responses of output (ΔY_{t+h}) to the shock at horizon h. The Newey-West corrected standard errors is employed to control the serial correlation in the error terms induced by the successive leading of the dependent variable.

Despite the above-mentioned advantages of Jordà's method, most of the estimated impulse responses using this method suffers from some weaknesses, such as: nonlinear version of local projection technique considers the possible interaction between states, but it could still be argued that this method does not incorporate the probability of switching from a particular state to another state after a fiscal policy shock. Also erratic estimates because of the loss of efficiency and oscillations at longer horizons[13]. However, as also mentioned by RZ, for our analysis the short-run responses are concerned, and we are not interested in the long-run results. For this reason and also following RR, we estimate our impulse response functions over 12 horizons, i.e., h=0,1,2,...,12.

1.2.2 Measurement of Slack States

In the present paper, we use unemployment rate as our indicator of slack. However, different measures of slack commonly used in the literature, slack as a stock variable or as a flow variable. AG-12 and AG-13 set a moving average of the output growth rate to measure the state of the business cycle, instead, RZ in their baseline specification define an economy to be in a slack state when the unemployment rate is above a fixed threshold.

As in RZ, in our baseline model, we consider 6.5 percent unemployment rate as a fixed threshold and define slack time when the unemployment rate exceeds this threshold. Using this definition of threshold results in about 25 percent of the observations being above the threshold[14]. Although our definition of the slack times is different from NBER business cycle dates, but the duration of slack times is close to NBER recessions with 21 percent of the time since 1946. Figure 1 shows the unemployment rate and RR exogenous legislated tax changes. As shown in the bottom panel, RR exogenous tax shocks are distributed across

[13] See Ramey (2012b) for a detailed discussion, where she compares impulse responses estimated using Jordà's method with a standard VAR and a dynamic simulation.

[14] It is around 35 percent in RZ historical sample from 1890 through 2012 for the U.S..

periods with a variety of unemployment rates. In fact, 25 percent of the the economy is being in slack times and 43 percent of the shocks occur when the unemployment rate is above the threshold. In the robustness analysis, we analyze sensitivity of the results to the different values of the fixed thresholds and also we consider, as two alternatives, time-varying thresholds based on Hodrick-Prescott filtered unemployment rate with a very high smoothing parameter of $\lambda = 1000000$ and also AG-12 moving average of GDP growth to measure the state of economy.

[Figure 1 about here.]

1.3 Empirical Results

We begin by presenting the baseline results of our analysis using local projection method and quarterly data for the U.S. over the sample from 1947 through 2007. Then, we perform extensive robustness checks with respect to our measure of states, to the identification method, to the inclusion of a variety of control variables, and to our econometric methodology.

1.3.1 Baseline Results

We first present the response of output to an exogenous tax increase using the linear model with no variations in the state of the economy. As shown in the first column of Figure 2, our linear estimate of the impact of tax changes on output is similar to many preexisting studies (e.g. RR, Mertens and Ravn (2011, 2012), and Cloyne (2013)) that is large. In particular, in the first three quarters after the tax change, the response is small and not statistically significant, but then steadily and rapidly rise for the next two years[15]. Our linear estimate show that an exogenous tax increase of 1 percent of GDP is associated with a 2.07 percent decline in output over the next two years. This implies that, an exogenous tax increase sets off a major contraction of the economy. The light and dark shaded areas represent, respectively, 90% and 68% confidence bands for the linear model and are based on Newey-West corrected standard errors.

[Figure 2 about here.]

However, as shown in the second and third columns of Figure 2, state-dependent responses look very different from the linear model. Dashed blue line shows output response in the bad time (states of slack), and dashed red line with circle shows output response in the good time (states of non-slack). These estimates show that an exogenous increase of 1 percent of GDP is associated with a 3.07 percent decline in GDP after eight quarters during good time, and opposite direction during bad time with a maximum effect of 1.74 percent increase in GDP after three quarters and becomes nearly zero after seven quarters. These findings imply that, exogenous tax increases have very large and persistent negative output effects in good time and positive smaller effects in bad time. The light and dark shaded areas represent, respectively, 90% and 68% confidence intervals for the impulse responses of the

[15] In our baseline estimates we calculate IRFs for 12 quarters as in RR, but 24 quarters in our VAR model.

bad time in the column II and for the good time in the column III. While, calculated impulse response for the good time is highly statistically significant, it is not significantly different from zero after quarter five during bad time. Since we are interested in the difference between responses across states, non-significant responses for the bad times are not a concern for us, and responses across states are quite different, however[16].

Although in Section 4 we discuss in detail about the possible explanations of our state-dependent responses, Auerbach and Gorodnichenko (2012) confirm our non-linear findings using different model, identification method and measures of slack in the U.S. over the post-WWII period. In fact, they employe a smooth transition VAR (STVAR) model, the Blanchard-Perotti identification scheme, and a transition function of the 7-quarter average of the output growth rate of normalized real GDP growth to measure the state of the economy. They estimate impulse responses to a \$1 increase in taxes and find positive tax multiplier during recessions and negative tax multiplier during recessions. As shown in Figure A1 of Auerbach and Gorodnichenko (2012) both output responses in recessions and expansions are highly statistically significant and persistent. Although their findings are quite similar to our baseline result regarding the sign of the output responses across states, not surprisingly, we find larger output responses in both bad and good times which is comparable to that difference between Blanchard-Perotti identification method and RR narrative method. Deák and Lenarčič (2012) also support our state-dependent findings by employing a regime-switching VAR model where the size of the fiscal multiplier is conditional on the state of public finance. They estimate responses to a negative revenue shock and show that the output responses are stronger during good times than during bad times on impact, and also tax multiplier becomes negative between quarters 4 and 17 during bad times. Since their model is symmetric with respect to the sing of the tax revenue shock, then the sign of their output responses to a positive revenue shocks are similar to our results.

Finally, as shown in Figure 3, linear responses are being about half-way between the large estimated responses during good times and the much smaller effects during bad times. The policy implication of our non-linear finding is that increasing liability taxes in periods of expansions sets off a major contraction of the economy whereas increasing them in times of recession would stimulates output.

[Figure 3 about here.]

1.3.2 Robustness

In this section we conduct various robustness checks with respect to our measure of states, to the inclusion of a variety of control variables, to the identification method, and to our econometric methodology.

Sensitivity to the Measures of Slack

Since there are different measures of slack, such as output gaps or the unemployment rate, and also different degrees of slack (deep vs. mild recessions), we verify the sensitivity of our

[16] Riera-Crichton et al. (2014) also use Jordà's method to estimate the state-dependent effects of government spending and although they find different multipliers across states, but it is not significant for the expansionary times.

benchmark results with respect to the different degrees and measures of slack in the economy. In the baseline version of our estimates, we simply consider 6.5 percent unemployment rate as our indicator of slack, and this results in about 25 percent of the the economy being in slack periods. We first choose different fixed thresholds and then allow for different time-varying thresholds and finally we perform a robustness check by using a transition function of the moving average of GDP growth to measure the state of the economy.

A. Sensitivity to the Fixed Threshold: we choose three different fixed thresholds to have a lower and higher degrees of slack in the economy. We pick threshold as 7%, 6% and 5.8% to have, respectively, 20% (higher degree of slack)[17], 30% and 40% (lower degree of slack) of the observations being above the threshold. Another point of using different thresholds is dealing with potential concern about the measurement errors induced by larger mean value of the shocks in good times than bad times. As shown in Table 1, both mean value and absolute mean value of the shocks are larger in good times than bad times when 25% of the observations being above the 6.5% threshold, and are nearly identical across states when 30% of the observations being above the 6% threshold. Figure 4 shows the sensitivity of GDP response to our three different fixed thresholds. Solid black line indicates GDP response in the linear model, and those lines over (below) this line are output responses in bad time (good time) with different degrees of slack in the economy. This robustness check clearly shows that our baseline results are not sensitive to variations in our threshold and mean of the shocks across states. However, output response is much sensitive to the amount of slack in bad time than good time, i.e., GDP response to a tax increase is positive when the economy spends about 20% and 30% of the time in bad time and becomes negative for the lower degree of slack, 30% and 40%. The policy implication of this result is clear: increasing tax in periods of higher degree of slack in the economy would stimulate output whereas increasing it in periods of higher and lower degree of non-slack (strong and weak expansions) have essentially no different effects and sets off a major contraction of the economy, though.

[Table 1 and Figure 4 about here.]

B. Sensitivity to the Time-Varying Threshold: we now verify the sensitivity of our benchmark results with respect to the time-varying thresholds. To this end, we consider a time-varying threshold, where we take deviations from different trends for Hodrick-Prescott filtered unemployment rate with a very high smoothing parameter of $\lambda = 1000000$. Using this definition of thresholds results in about 20%, 30% and 40% of the observations being above the thresholds[18]. Table 2 shows the mean and absolute mean values of tax shocks across states which are the same as those from the fixed threshold. Figure 5 shows the sensitivity of GDP response to our three different time-varying thresholds. Solid black line indicates GDP response in the linear model, and those lines over (below) this line are output responses in bad time (good time) with different degrees of slack in the economy. This robustness check also shows that our baseline results are not sensitive to variations in our

[17]Being 20% of the time in a recessionary regime is consistent with the NBER recessions.

[18]RZ also consider a time-varying threshold with about 40% of the observations being above the threshold in their robustness check.

time-varying threshold. However and in contrast to the different GDP responses with respect to variation in the fixed threshold, tax increase in periods of lower degree of non-slack in the economy (strong expansions) has a larger contractionary effect on output than weak expansions. Estimated output responses to a tax increase in different degrees of slack are similar to our baseline results.

[Table 2 and Figure 5 about here.]

C. An Alternative Indicator of States: finally we use AG-12 moving average of the output growth rate over typical measures of the output gap. This measure, that is highly correlated with NBER business cycle dates, indicates periods in which the economy is moving from its peak to its trough, and do not measure the slack states, though[19]. We use the same definition of this function as AG-12, which is given by $F(s_t) = \frac{exp(-\gamma s_t)}{1+exp(-\gamma s_t)}$, where $F(s)$ is the transition function, s is a seven-quarter moving average of the output growth rate as transition variable, and γ is a transition parameter. We set $\gamma = 2$, so that the economy spends about 21 percent of time in a recessionary regime[20], i.e., $Pr(F(s_t) > 0.8) = 0.21$. Top panel of Figure 6 shows the dynamics of F along with the NBER recessions.

As discussed earlier, Jordà's method easily adapts to estimate a state-dependent model, then we follow AG-13 and extend this methodology to a state-dependent model where the state of a the economy is measured by the smooth transition function. In fact, we replace the dummy variable I in equation (2) with the function $F(s)$ as follows:

$$\begin{aligned}\Delta Y_{t+h} =& F(s_{t-1}) \left\{\alpha_{R,h} + A_{R,h}(L)Y_{t-1} + B_{R,h} shock_t\right\} \\ &+ (1 - F(s_{t-1})) \left\{\alpha_{E,h} + A_{E,h}(L)Y_{t-1} + B_{E,h} shock_t\right\} + \beta_{1,h} t + \beta_{2,h} t^2 + \epsilon_{t+h}\end{aligned} \tag{1.3}$$

where the coefficients $B_{R,h}$ and $B_{E,h}$, respectively, give the recessionary and expansionary responses of ΔY to the shock at horizon h. As shown in the bottom panel of Figure 6, impulse responses estimated by using the new smooth transition threshold based on moving average of output growth are still similar to our baseline findings. Although, during the first few quarters there is no statistically significant difference in responses across states, but they become state-dependent after quarter three.

[Figure 6 about here.]

Controlling for Other Variables

Since the RR tax series are assumed to be truly exogenous, they are unlikely to be systematically correlated with other factors affecting output in the short or medium run, then there should be no need to control for other shocks[21]. However, correlation with other factors

[19] See Hall (2013) for a more detailed discussion.

[20] This is consistent with the duration of recessions in the US according to NBER business cycle dates.

[21] RR tax changes motivated by factors unrelated to the current or prospective state of the economy.

could be present just by accident in small samples. In order to rule out the possibility of such correlations, we experiment with augmenting our state-dependent model with two other policy shocks.

D. Monetary Policy Shock: is perhaps the most omitted variable to consider. We follow Mertens and Ravn (2012) and include two main measures of monetary policy in the model to address this issue. One is simply the federal funds rate, and our second series is inflation rate. As Figure 7 shows, controlling for monetary policy has little impact on the estimated effects of exogenous tax changes. The estimated responses of two measures of monetary policy are not state-dependent, though.

[Figure 7 about here.]

E. Government Spending Shock: is controlled in the same fashion as above by including three variables in the model: logarithm of the real per capita gross federal purchases of goods and services, logarithm of the real per capita federal government total receipts and also nominal federal deficit scaled by lagged nominal GDP. Again the effects of a tax increase on output is similar to the baseline result, and then including the government spending has little effect on the estimated responses, as shown in Figure 8. We find no sign of any significant change in government spending following tax shocks in the first six quarters across states, but in bad time (good time) and six quarters after a tax increase, government spending starts to increase (decrease). Perhaps somewhat surprising is that the behavior of federal total receipts and deficit, while the responses are not significantly different from zero in good time, a tax increase raises government revenue and reduces deficit.

[Figure 8 about here.]

An Alternative Identification of the Exogenous Tax Shock

Anticipated changes in fiscal policy affect the economy in advance of their implementation, while unanticipated policy changes affect only when they are implemented. Mertens and Ravn (2011, 2012) are the first attempts at providing empirical evidence on how distinction between anticipated and unanticipated tax policy changes are empirically appropriate. We follow the approach pioneered by Mertens and Ravn (2012) to distinguish between unanticipated and anticipated tax shocks. We now estimate the effects of unanticipated tax shock by using our linear and state-dependent model. Figure 9 shows our estimates of the impact of an exogenous unanticipated tax increase of 1 percent of GDP, linear response is similar to Mertens and Ravn (2012) impulse responses to an unanticipated tax increase. This implies that our estimation based on Jordà's linear mode are consistent with the linear VAR model used by Mertens and Ravn (2012). However, state-dependent impulse responses are quite different from the linear model and are similar to our earlier state-dependent baseline results.

[Figure 9 about here.]

VAR Specification

We now compare impulse responses estimated using Jordà's method to that a specific regime-switching VAR model. In particular, we use a regime-switching VAR model where the unemployment rate with a fixed threshold measures the state of the business cycle. Consider first the linear VAR model as follows:

$$\textbf{Linear}: \quad X_t = A + C(L)X_{t-1} + Dshock_t + E(L)shock_{t-1} + Bt + \epsilon_t \tag{1.4}$$

where X is a vector of endogenous variables, $C(L)$ is P-order lag polynomial, $E(L)$ is R-order lag polynomial for capturing the lag of tax shocks, and *shock* is the RR exogenous tax shocks, we set $X_t = [Y_t \quad C_t \quad I_t]$. We follow Mertens and Ravn (2012) and set $R = 12$. Note that under the condition that the lag polynomial E(L) does not contain unit roots, this model considers persistent but not permanent effects of tax shocks. First column of Figure 10 reports the impulse response functions to an exogenous tax increase of 1 percent of GDP, with 90% nonparametric, non-centered bootstrapped confidence intervals using 10,000 replications. We adapt the above linear VAR model to estimate a regime-switching VAR model as follows:

$$\begin{aligned}\textbf{Nonlinear}: \; X_t = \; & I_{t-1}\left\{A_R + C_R(L)X_{t-1} + D_R shock_t + E_R(L)shock_{t-1}\right\} \\ & + (1 - I_{t-1})\left\{A_E + C_E(L)X_{t-1} + D_E shock_t + E_E(L)shock_{t-1}\right\} + Bt + \epsilon_t\end{aligned} \tag{1.5}$$

where I is a dummy variable that takes one when the unemployment rate is above the threshold and indicates times of slack. We use the same estimation method and same method for computing impulse responses, and confidence intervals as the above linear VAR model. The estimated responses to a 1 percent tax increase using our extended regime-switching VAR model are remarkably similar to that of the previous results by using Jordà's method, as shown in Figure 10. This would imply that our results based on linear and state-dependent local projection technique are robust to our econometric methodology.

[Figure 10 about here.]

To summarize, we showed through extensive robustness analysis that our baseline results are robust to many alternative specifications. We find strong evidence that the responses are different across states: very large and significant response of output to a tax increase during times of non-slack in the economy. Thus, while our tax shocks, identified from narrative sources, are exogenous to the current or prospective state of the economy, the macroeconomics effects of the tax shocks are different depending on the state of the economy.

1.4 Extensions

In this section, we extend our findings in two ways to shed light on the large and state-dependent response of output to tax shocks. First, we examine how tax changes affect the components of GDP, such as consumption and investment and also two main components of investment, residential and nonresidential fixed investment. Finally, we ask whether tax changes are tax cuts or tax increases and evaluate the possibility that the main macroeconomic aggregates react asymmetrically to the sign of the tax changes.

1.4.1 The Components of Output and the Transmission Mechanism

Based on our baseline estimation we find that the effects of exogenous tax increases on output are different depending on the state of the economy. We need to study responses of other variables to understand the workings of exogenous tax shocks and shed light on how or why tax changes have such different effects across states. To that end, we examine the response of the various components of GDP, such as consumption and investment, to exogenous tax shocks and transmission mechanism of tax changes by highlighting the behavior of nonresidential and residential fixed investment to tax changes.

F. Output Components: we include logarithm of real per capita private sector consumption expenditure and logarithm of real aggregate per capita gross private sector investment. The results are presented in Figures 11 and 12. Two main components of GDP, private consumption and investment, also have the similar behavior as output[22]. According to our linear estimates, a 1 percent tax increase is associated with, respectively, a 1.8 and 7.6 percent peak decline in private consumption and investment. However, as shown in the second and third columns of Figure 11, state-dependent responses look very different from the linear model and are very similar to output response across states. Panel A of Figure 12 compares linear and non-linear responses and shows that linear responses are being about half-way between the large estimated responses during good times and the much smaller effects during bad times. Panel B of Figure 12 compares the estimated responses of output, and its components. First column shows that the behavior of investment to a tax increase based on linear model is exactly what one would expect: much larger than GDP and consumption responses, and are similar to many preexisting studies (e.g. Blanchard and Perotti (2002), RR, Mertens and Ravn (2011, 2012), and Cloyne (2013)) who employed linear model. This implies that the investment behavior is the main transmission mechanism of fiscal policy shocks on output[23]. Our estimated state-dependent responses of the GDP components are presented in the second and third columns. The key results are that both components have the same responses as output response to a tax increase across states, that rise over the first year during bad time and fall in good time, also the rise and fall in investment are much larger than the rise and fall in consumption. The non-linear and large responses of investment to a tax shock are particularly surprising in light of our baseline findings for different output responses across states. These findings also suggest that the important part of the output state-dependent responses appears to be due to the procyclical and non-linear behavior of investment.

[22] Also the responses of exports and imports to a tax increase are exactly what one would expect: exports rise and imports fall.

[23] See section VI, part C, of RR for a discussion.

[Figures 11 and 12 about here.]

G. Transmission Mechanism: Investment accounts for approximately 17% of GDP and is the most volatile component of GDP. The level of fixed investment by businesses also indicates something about the level of confidence that business owners or managers have about the ability to earn more income from sales in the next few years. The reasoning is that they would be unlikely to tie up additional capital in fixed assets for several years or more, unless they thought it would be a commercially viable proposition in the longer term. If there is too much uncertainty about whether their fixed investment will pay off, they are unlikely to engage in it.

In addition, our findings so far show that investment responses to tax shocks are much larger than other GDP component and suggest that the main transmission mechanism of tax changes on output could be investment responses. According to economic theory, investment is a key factor influencing economic growth and determined by interest rates, business confidence, taxes, and capacity utilization. As discussed in RR, a tax increase lowers interest rates and then conventional interest rate effect is not key to explain the fact that investment declines strongly in response to a tax increase. Business confidence plays a large role, perhaps the most significant role, in determining investment decisions. In fact, tax changes are one of the main drivers of the business confidence. Baker et al. (2013) develop a new index of economic policy uncertainty (EPU) and show that monetary and fiscal policies, specially tax policy, are the main driving factors of the EPU in the United States. Also, several papers have analyzed the effects of tax changes on investment and show that investment responses depend strongly on cash flow and overall economic conditions (e.g. Abel and Blanchard (1986), Fazzari et al. (1988), and Oliner et al. (1995), among others.).

Thus, in order to evaluate investment behavior more precisely, we examine how tax increases affect two main components of investment, residential and nonresidential fixed investment. We include logarithm of real per capita private fixed, residential, and nonresidential investments and estimate our linear and state-dependent models. The results are presented in Figures 13 and 14. Panel A of Figure 14 compares linear and non-linear responses and shows that the response of nonresidential fixed investment to a tax increase is quite similar to output response which is positive in bad time and negative in good time. As shown in Figure 13, estimated response of residential fixed investment to a tax shock is not statistically different across states, but very significant difference for nonresidential fixed investment. Also Panel B of Figure 14 compares the responses of total investment and its two main components. Perhaps surprisingly, the responses of total and nonresidential fixed investment during bad time that are very similar, positive over the first year, and comparable to the output response, but residential fixed investment responds differently. This implies that the state-dependent response of output is due to the fact that the response of nonresidential fixed investment to tax changes are different across states. Finally, correlation between time trends of GDP and nonresidential fixed investment in good and bad times are, respectively, 0.99 and 0.98, but for the residential fixed investment it is, 0.94 in good time and 0.69 in bad time. This reflects the fact that nonresidential fixed investment is highly procyclical in bad time, while residential fixed investment is much less procyclical in bad time. As discussed earlier, the important part of the output state-dependent responses appears to be due to the procyclicality of investment, but more precisely, it is due to the higher procyclicality of nonresidential fixed investment in bad time, and procyclicality of the both residential and nonresidential fixed investments in good time.

[Figures 13 and 14 about here.]

1.4.2 Tax Policy Asymmetries

We now evaluate potential asymmetric effects of tax changes depending on whether tax changes are tax cut or tax increase. We first examine whether tax changes in good and bad times are tax cuts or tax increases. From a theoretical perspective, fiscal policy is either countercyclical, i.e., tax rate (government spending) raises (falls) in good times and cuts (increases) in bad times, or acyclical based on Barro's tax-smoothing proposition. As shown in Table 3 and Figure 15, however, this is not true for the RR exogenous legislated tax changes, because of the particular motivation of these tax policy changes. In fact, 65% of the tax cuts have been taken in good times, and 50% of the tax increases have been taken in bad times, both acting procyclically. Finally, we evaluate the macroeconomic effects of tax changes may depend on whether tax shocks are tax-cut or tax-increase. Riera-Crichton et al. (2014) show that in most industrial countries only 56% of the government spending acts countercyclical and for the 44% of the time, government spending is either going down in bad times or going up in good times, acting procyclically. They argue that the sign of the government spending matters for the size of the multiplier across states and ignoring the distinction of government spending going up or down, the resulting multiplier would be biased downward. In addition, using tax rates for 62 countries for 1960-2009, Vegh and Vuletin (2013) find that tax policy is acyclical in industrial countries but mostly procyclical in developing countries. In this paper, we contribute to the empirical literature by taking into account the asymmetric effects of tax changes.

[Table 3 and Figure 15 about here.]

Moreover, by highlighting the constructions of the RR exogenous legislated tax changes, we develop another possible explanation for our state-dependent responses. RR use the narrative record of Presidential speeches and Congressional reports, to identify tax shocks. This analysis allows them to separate legislated changes into endogenous and exogenous tax policy changes: an endogenous policy decision is one that are taken for reasons related to prospective economic conditions and those exogenous tax changes are taken for more exogenous reasons and not taken to offset other macroeconomic shocks. In addition, RR classify exogenous changes into two categories: those ideological tax changes taken to achieve a long-run goal[24] and those tax changes taken to deal with an inherited budget deficit, as opposed to deficits caused by current spending[25]. Figure 15 shows RR exogenous tax cuts and tax increases, separately. Among the exogenous tax changes, long-run economic actions

[24]This category of exogenous tax change might be a tax cut motivated by a belief that lower marginal tax rates will raise output in the long run, an example of such a tax cut is the 1964 Kennedy-Johnson tax cut.

[25]An inherited budget deficit reflects past economic activities and decisions, not current conditions or budgetary decisions, an example is the 1993 Clinton tax increase.

are clearly the larger tax changes and the mean of the RR exogenous tax changes are -0.027 percent of GDP. Furthermore, vast majority of tax actions for long-run growth are tax cuts and all of the deficit-driven changes are tax increases. As a result, this suggests that our baseline impulse responses can be dominated by those tax cuts taken for long-run growth reasons. To avoid this bias, we distinguish between RR exogenous tax-cut and exogenous tax-increase and estimate our linear ans state-dependent model based on Jordà's method, they look as follows, respectively:

$$\Delta Y_{t+h} = \alpha_h + A_h(L)Y^*_{t-1} + B_h\boldsymbol{RR}^-_t + C_h\boldsymbol{RR}^+_t + \beta_{1,h}t + \beta_{2,h}t^2 + \epsilon_{t+h} \quad for \;\; h = 0, 1, 2, ... \tag{1.6}$$

$$\begin{aligned}\Delta Y_{t+h} =& I_{t-1}\left\{\alpha_{A,h} + A_{A,h}(L)Y^*_{t-1} + B_{A,h}\boldsymbol{RR}^-_t + C_{A,h}\boldsymbol{RR}^+_t\right\} \\ &+ (1 - I_{t-1})\left\{\alpha_{B,h} + A_{B,h}(L)Y^*_{t-1} + B_{B,h}\boldsymbol{RR}^-_t + C_{B,h}\boldsymbol{RR}^+_t\right\} + \beta_{1,h}t + \beta_{2,h}t^2 + \epsilon_{t+h}\end{aligned} \tag{1.7}$$

where $\boldsymbol{RR}^-$ indicates RR tax-cut, and $\boldsymbol{RR}^+$ indicates RR tax-increase. Thus, the coefficients $B_{A,h}$ and $B_{B,h}$, respectively, give the high and low unemployment state responses of ΔY to RR exogenous tax cut at horizon h. Analogously, the coefficients $C_{A,h}$ and $C_{B,h}$ give the high and low unemployment state responses of ΔY to RR exogenous tax increase at horizon h, respectively. Y^* equals Y and zero for those quarters including RR tax increases, when we estimate responses to the RR tax-cut[26]. Similarly, when we estimate responses to the RR tax-increase, Y^* equals Y and zero for the quarters including RR tax cuts.

Riera-Crichton et al. (2014) also use the same methodology to estimate the state-dependent effects of government spending and taking into account whether government spending is going up or down. Using state-dependent Jordà's method, they show that distinguishing between times in which government spending increases and times in which government spending decreases has crucial effect on the size of fiscal multipliers. In fact, the true long-run multiplier for recession and government spending going up is 2.3 compared to 1.3 when just distinguishing between recession and expansion.

Tax Cut

As shown in Figure 15, the largest RR exogenous tax cuts are distributed across periods with a variety of unemployment rates, so that 35% of the tax cut occur when the unemployment rate is above the threshold. We estimate impulse responses of a tax increase of 1 percent of GDP based on RR exogenous tax-cut, i.e., responses are derived from the estimated B_h in the linear model, equation 6, and $B_{A,h}$ and $B_{B,h}$ in the state-dependent model, equation

[26]Since many of the observations in the series of RR exogenous tax changes are zero, Y^* takes zero only for those quarters including RR tax increases.

7[27]. Top panels of Figures 16 and 17 show estimated responses of GDP to an exogenous tax increase of 1% of GDP while we consider RR tax cuts, $\boldsymbol{RR^-}$. Our results regarding the difference in responses between slack and non-slack states are quite similar to our baseline responses, where we used series of all RR exogenous tax changes. However, as shown in Figure 18, output responses to the RR tax cuts are higher than responses to the RR all tax changes. This is exactly what one would expect, because responses to the RR all tax changes are an average of the responses for tax cuts and tax increases. Therefore, ignoring whether tax changes are tax cuts or tax increase may yield biased estimates of the responses. In particular, a tax cut of 1 percent of GDP in linear model is associated with a 2.07 percent increase in output after two years by using RR all tax changes, but near 3.5 percent for RR tax cuts and almost same differences in good and bad times. Note that our analysis so far has considered output responses for an exogenous tax increase but those responses presented in Figure 18 are the impact of an exogenous tax cut.

[Figures 16, 17, and 18 about here.]

As described above, the vast majority of the tax cuts are taken to achieve some long-run goal such as higher normal growth[28]. Our state-dependent estimates show that, tax cuts have very large and persistent positive output effects during good times and slightly negative effect during bad times. In fact, as presented in Figure 19, tax cuts are more likely to increase growth in good times than bad times.

[Figure 19 about here.]

We also examine the hypothesis that decreases in taxes reduce future government spending, which is often referred to as the "starve the beast" hypothesis[29]. This idea argues that the most effective way to control federal government spending is to reduce the federal tax revenues[30]. Romer and Romer (2009) investigate this hypothesis using narrative sources of legislated tax changes and find no evidence that tax cuts restrain government spending in the U.S., instead, they show that tax cuts increase spending. We investigate the hypothesis that tax cuts curtail government spending using Jordà's (2005) local projection method. We address this issue by including total government spending to our linear and state-dependent model, where the tax shocks are only RR exogenous tax-cut ($\boldsymbol{RR^-}$).

As shown in Figure 20, estimated response of government spending to an exogenous tax cut of 1 percent of GDP does not support the starve-the-beast hypothesis. The calculated impulse response using linear model is very similar to the baseline specification of Romer and Romer (2009), so that the cumulative effect is near zero in the first quarters of the tax

[27]It should be noted that in both cases of RR tax cuts and RR and tax increases, we estimate responses to an exogenous tax increase of 1% of GDP.

[28]Our definition of states covers the most significant tax cuts taken to stimulate long-run growth, the 1948 tax cut passed over Truman's veto and 2003 Bush tax cut are considered during times of slack in the economy and the 1964 Kennedy-Johnson tax cut and the 2001 Bush tax cut are considered during non-slack state.

[29]Friedman (2003) summarizes this idea as follows: "How can we ever cut government down to size? I believe there is one and only one way: the way parents control spendthrift children, cutting their allowance. For governments, this means cutting taxes."

[30]The 1981 Reagan tax cut and the 2001 Bush tax cut are consistent with this approach.

cut and becomes positive after quarter three at every horizon, this suggests fiscal illusion or shared fiscal irresponsibility. Estimating state-dependent impulse responses, we find no evidence that tax cuts restrain government spending over the next two years after tax cut in bad times, but responses become different across states after quarter two. In fact, there is some evidence of reducing government spending over the next five quarters after tax cuts in good times, though it is not significantly different from zero, and then becomes significantly positive after quarter six at every horizon.

[Figure 20 about here.]

Tax Increase

We now consider those RR exogenous tax increases, which the majority of them was taken to reduce an inherited budget deficit. As shown in Table 3 and Figure 15, such a deficit driven tax changes are distributed across states with 50% of them taken during times of slack[31]. Bottom panels of Figures 16 and 17 show the estimated responses to an exogenous tax increase of 1 percent of GDP, these are derived from the estimated C_h in equation 6, and $C_{A,h}$ and $C_{B,h}$ in equation 7. In the linear case, the point estimates for the effect of a tax increase of one percent of GDP on GDP are positive, but small and not significant, also falls slowly after quarter four and then reaching a maximum effect of 0.4 percent after eight quarters. Interestingly, calculated responses to an exogenous tax increase of 1 percent of GDP by considering only RR exogenous tax-increase look quite different than the earlier results with RR exogenous tax-cut. We find little evidence that the responses are different across states. One of the possible explanations for this apparent asymmetries could be the motivation of the tax policy changes.

Since inherited deficit reflects past economic conditions and budgetary decisions, as opposed to deficits caused by current spending, then raising taxes for deficit reduction is not motivated to stimulate long-run growth. We now perform an estimation to test whether deficit-driven tax changes have different effects on deficit depending on the state of the economy. For this reason, we re-estimate our state-dependent model based on RR tax increases augmented to include the total nominal deficit divided by one quarter lag of nominal GDP. The results are presented in Figure 21. To make the comparison, we also consider responses of output and investment with deficit for both tax cuts and tax increases across states. This graph shows that responses are symmetric in good time to tax changes, that is positive for tax cut and negative for tax increase, but asymmetric in bad time. Panel A shows that expansionary tax policy (contractionary tax policy) is very expansionary (contractionary) during good time. Conditional on being in bad time, tax increase significantly raises output and investment over the next two years, and strongly reduces deficit, as shown in Panel B. In contrast, tax cut reduces output and investment over the first year, and persistently raises deficit.

[Figure 21 about here.]

[31] The most significant deficit-driven tax increases are the Tax Equity and Fiscal Responsibility Tax Act of 1982 and the Clinton tax increase in the Omnibus Budget Reconciliation Act of 1993.

To summarize, we find that the macroeconomic effects of tax changes do not depend only on the state of the economy, but also depend on the sign of tax changes. This paper shows that tax cuts are more likely to increase growth and reduce deficits in good times than bad times. In contrast, tax increases are more successful, in terms of output gains and deficit reduction, in bad times than good times. Finally, our findings suggest that tax cuts are more efficient in good times, but instead tax increases are more successful during bad times.

1.5 Conclusion

A growing number of studies have been recently devoted to the size of fiscal multipliers when the economy is in recession. There is considerable disagreement about the size of government spending multipliers across different states of the economy. Although, most of the studies show that spending multipliers are larger when the economy is in recession than expansion, but a few studies find no differences across states. This paper contributes new evidence to this debate. We investigate the dynamic macroeconomic effects of tax liability changes across states in the United States. We use a state-dependent model where the state of the economy is distinguished between periods of slack and non-slack in the economy. The amount of slack in the economy is measured by the unemployment rate.

Our estimates of the impact of tax changes on the macroeconomic aggregates using linear model are similar to many preexisting studies, but the state-dependent responses are very different from them. We find that linear responses are being about half-way between the large estimated responses during good times and the much smaller effects during bad times. This implies that the effects of tax changes on the main macroeconomic aggregates are state dependent, which the effectiveness of fiscal policy is considerably larger in good times than in bad times. Moreover, we showed through extensive robustness analysis that these results are robust to many alternative specifications.

Our results indicate that, the important part of the output state-dependent responses appears to be due to the procyclicality of investment, and more precisely, it is due to the higher procyclicality of nonresidential fixed investment in bad time, and procyclicality of the both residential and nonresidential fixed investments in good time.

We also contribute to the empirical literature by highlighting the asymmetric effects of tax changes, tax-cut and tax-increase, which is important to analyze the dynamic macroeconomic effects of tax policy shocks across states. We estimate our state-dependent model by distinguishing between RR exogenous tax-cut and RR exogenous tax-increase. We find that the impact of tax changes do not depend only on the state of the economy, but also depend on whether the tax changes are tax-cut or tax-increase. We show those tax cuts taken to stimulate long-run growth are more likely to increase growth and reduce deficits in good times than bad times, but instead, those tax increases taken to deal with an inherited budget deficit are more successful in terms of output gains and deficit reduction, in bad times than good times. Finally, we examine the hypothesis that decreases in taxes reduce future government spending and find no evidence supporting this hypothesis.

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1.6 Appendix: Tables and Figures

Table 1.1: Fixed Threshold

OBS-B	Tax-B	Tax-G	Mean-B	Mean-G	ABV-Mean-B	ABV-Mean-G
20	34	66	-0.005	-0.015	0.026	0.044
25	43	57	-0.004	-0.016	0.028	0.042
30	52	48	-0.007	-0.013	0.038	0.032
40	66	34	-0.012	-0.008	0.047	0.023

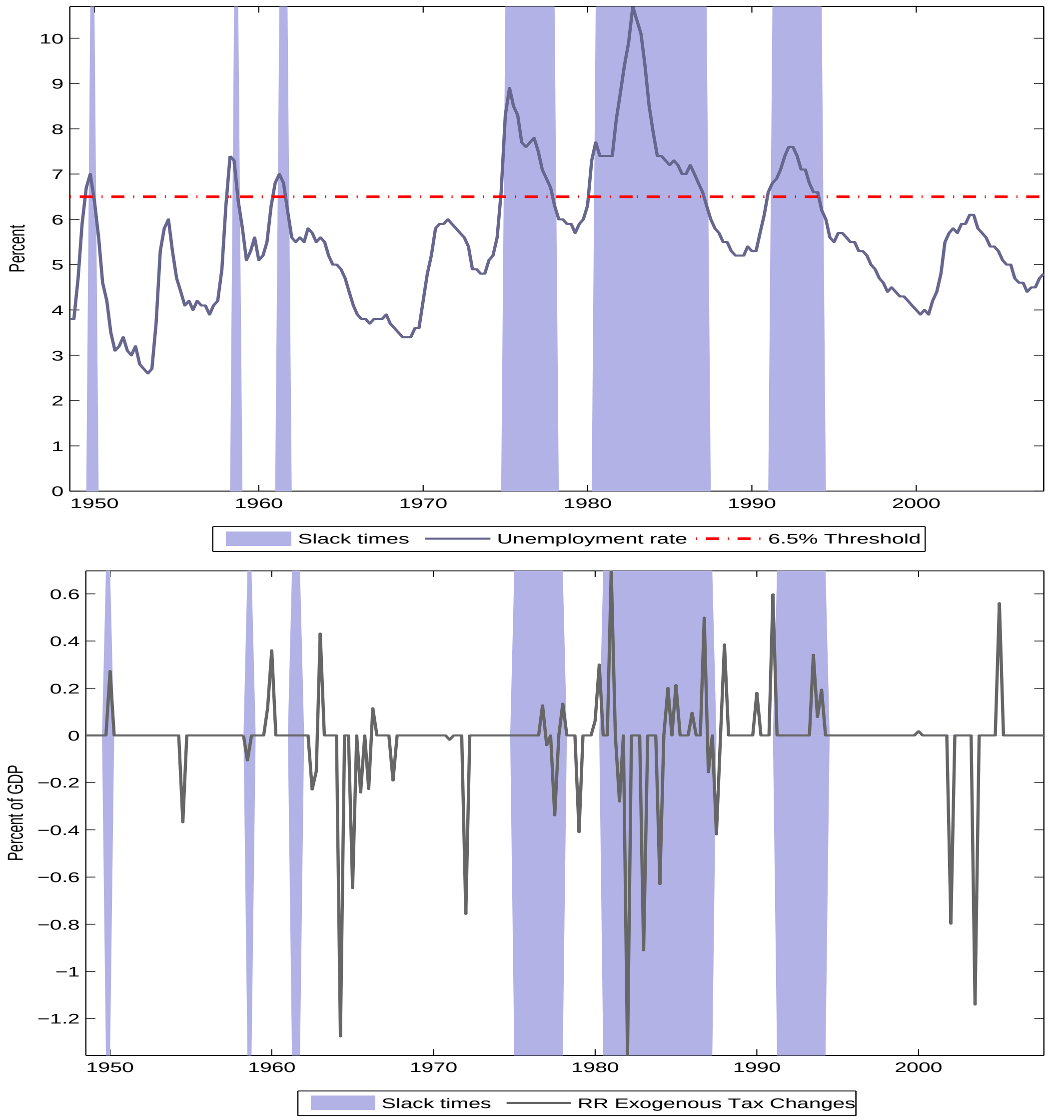
Table 1.2: Time-Varying Threshold

OBS-B	Tax-B	Tax-G	Mean-B	Mean-G	ABV-Mean-B	ABV-Mean-G
20	27	73	-0.014	-0.006	0.026	0.044
25	34	66	-0.015	-0.005	0.029	0.042
30	39	61	-0.012	-0.008	0.031	0.039
40	59	41	-0.005	-0.015	0.042	0.029

Table 1.3: Fixed Threshold and Tax Policy Asymmetries

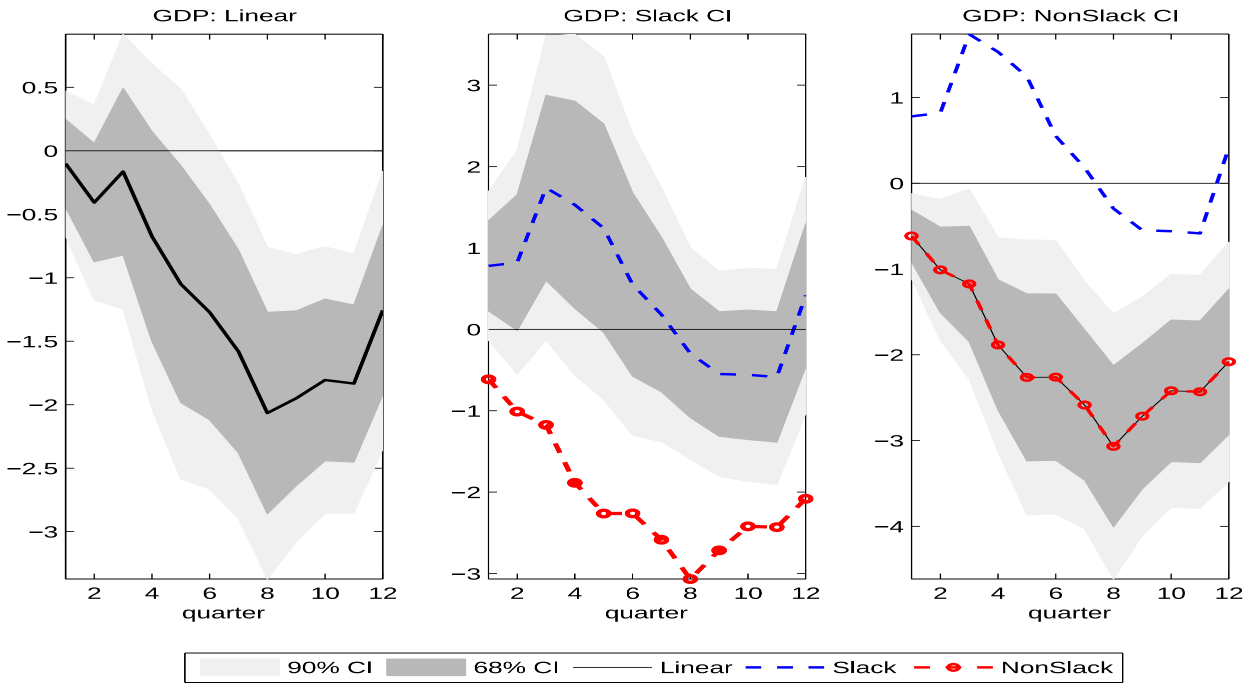
	OBS-B	Tax-B	Tax-G	Mean-B	Mean-G
Tax cuts	25	35	65	-0.021	-0.032
Tax increases	25	50	50	0.0168	0.0167

Figure 1.1: Unemployment Rate, 6.5% Threshold, and RR Exogenous Tax Shocks



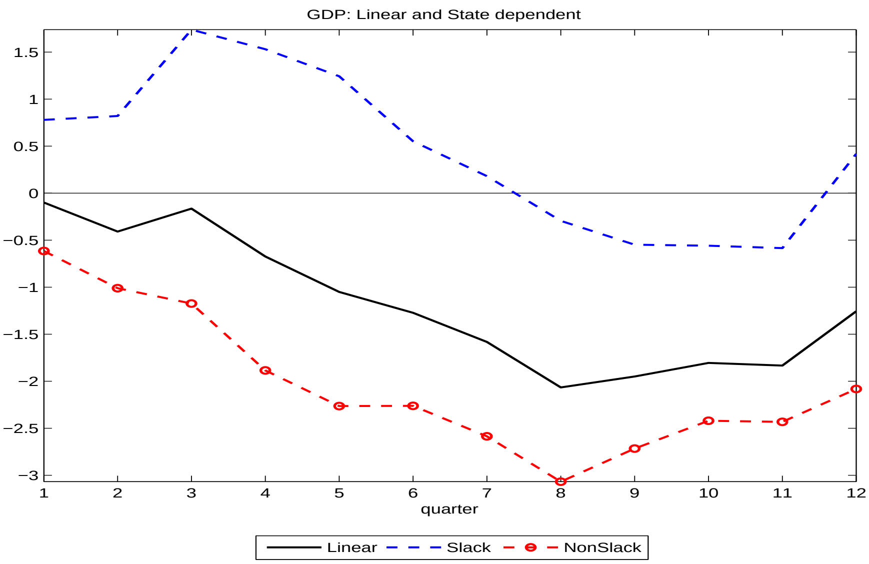
Notes: Dashed and solid lines in the top panel show 6.5% threshold, and unemployment rate, respectively. Shaded areas indicate time periods when the unemployment rate is above the threshold. Solid line in the bottom panel shows RR exogenous tax shocks. This definition of threshold results in about 25% of the observations being above the threshold and 43% of the shocks occur when the unemployment rate is above the threshold.

Figure 1.2: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Linear and State-Dependent Models



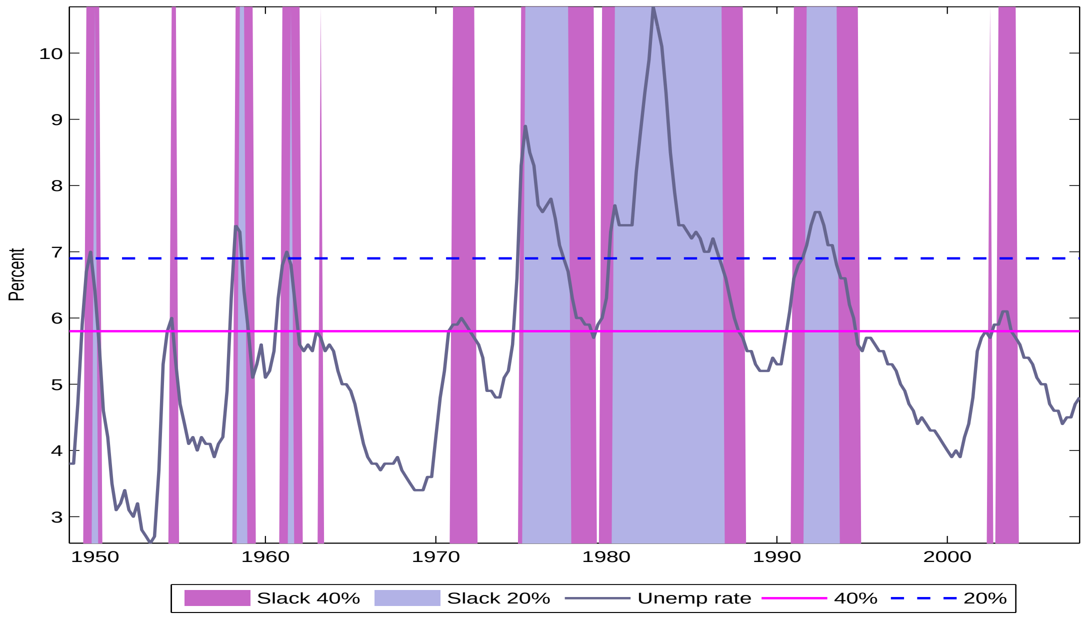
Notes: Solid line indicates response in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

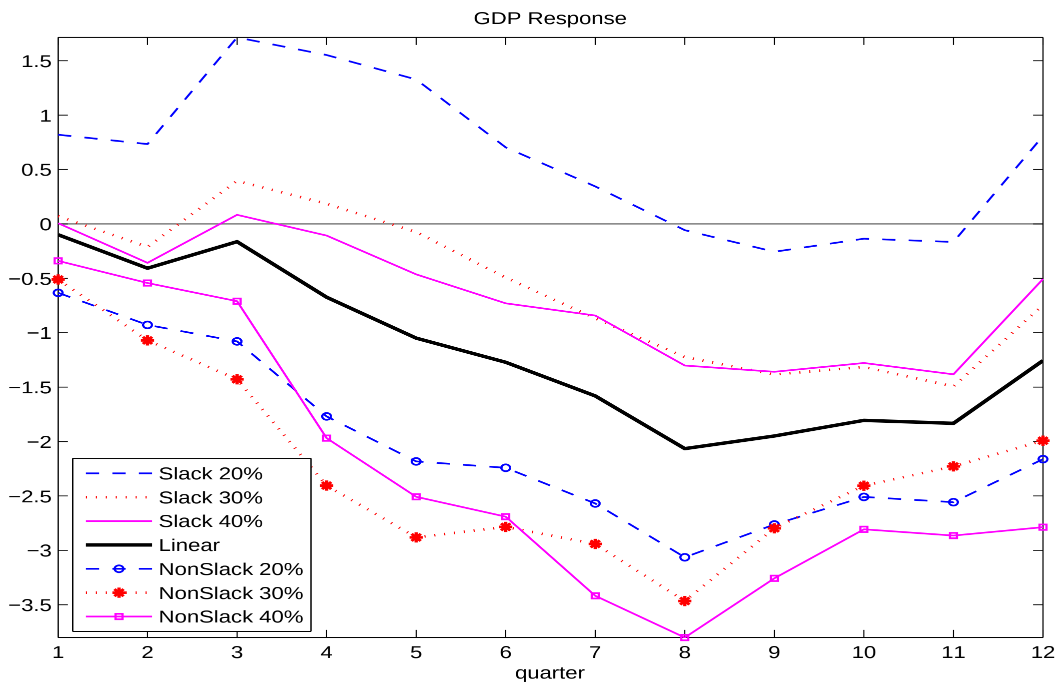
Figure 1.3: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Linear and State-Dependent Models



Notes: Solid line indicates response in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack).

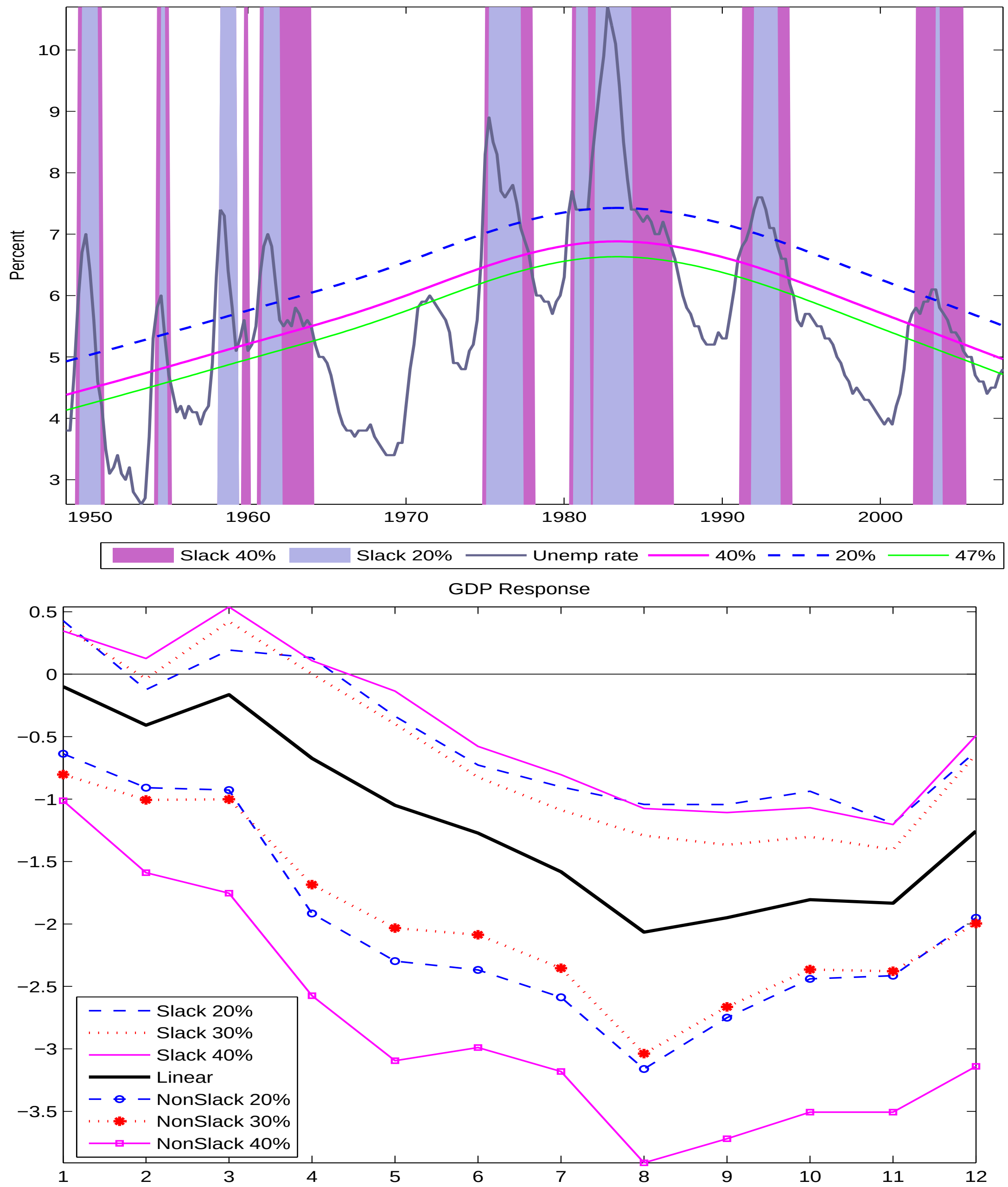
Figure 1.4: GDP Responses and Sensitivity to the Fixed Threshold





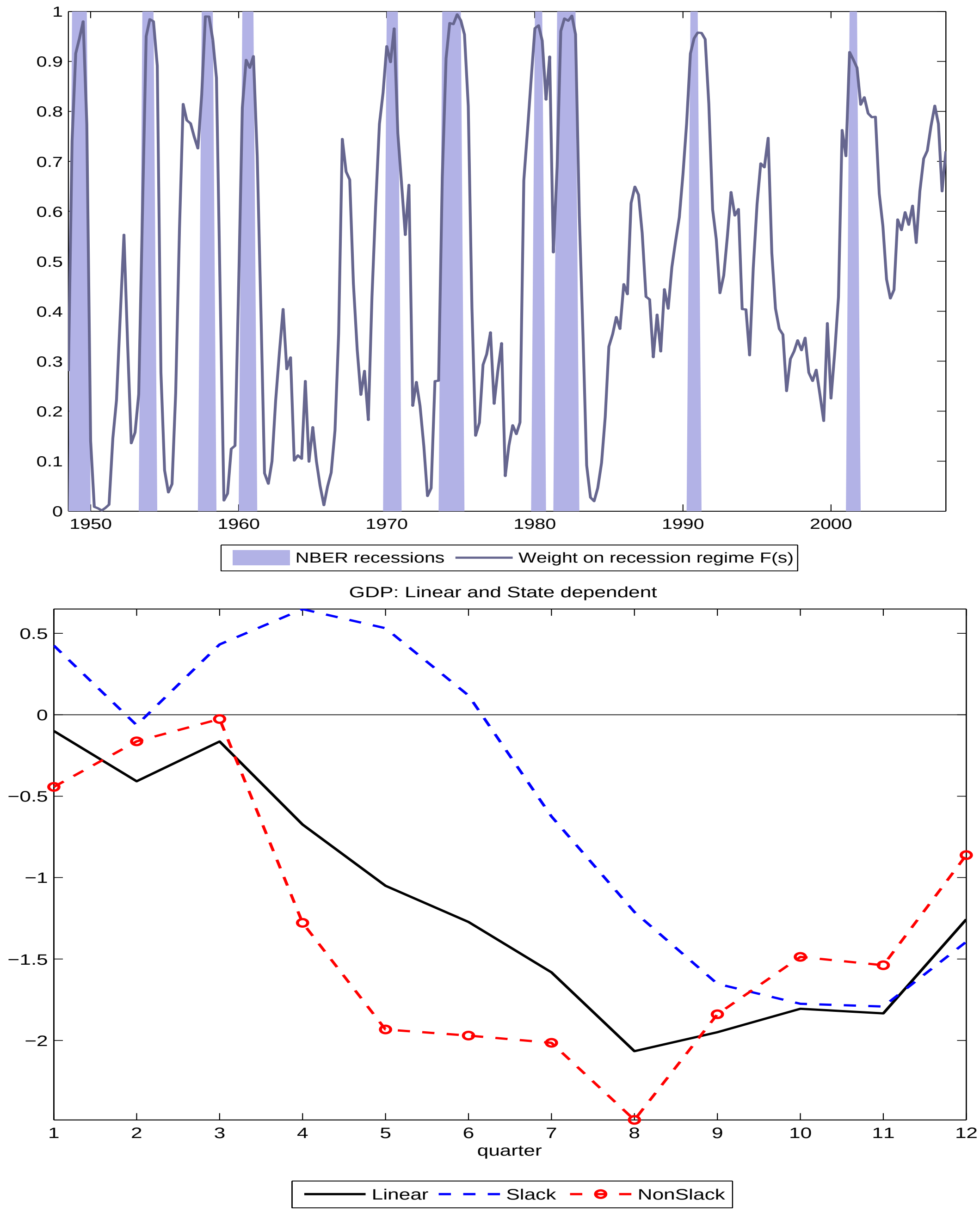
Notes: Dashed blue, and solid pink lines in the top panel show, respectively, fixed-thresholds for being 20%, and 40% in the slack times. Solid gray line indicates US unemployment rate. Blue and pink shaded areas represent 20% and 40% of the economy being in the slack times, respectively. Dashed blue, dotted red and solid pink lines in the bottom panel show GDP responses in bad times, when 20%, 30%, and 40% of the time being in the slack times, respectively. Dashed blue line with circle, dotted red line with stars and solid pink line with squares indicate GDP responses in good times, when 20%, 30%, and 40% of the time being in the non slack times, respectively.

Figure 1.5: GDP Responses and Sensitivity to the Time-Varying Threshold based on HP Filter with $\lambda = 10^6$



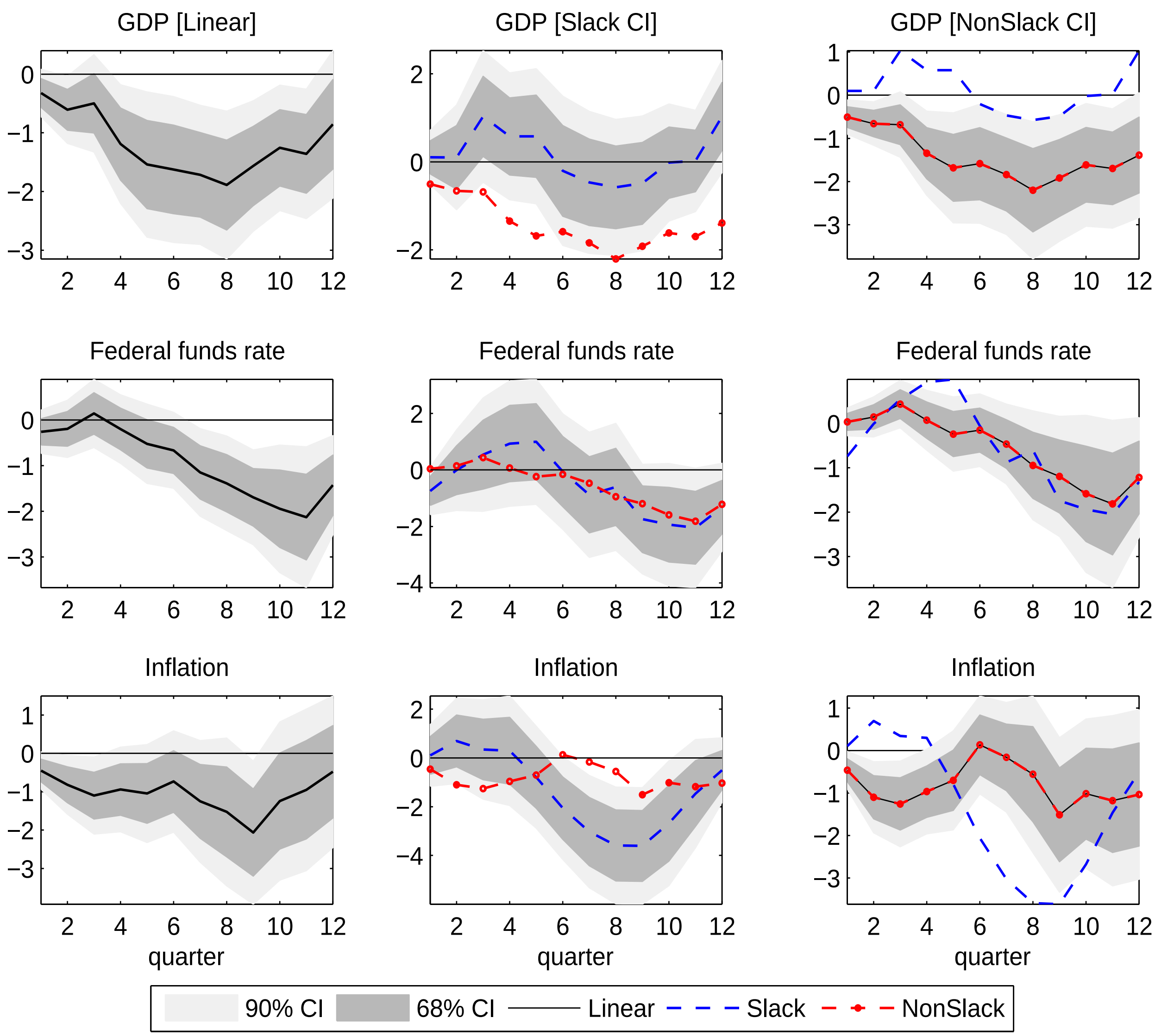
Notes: Dashed blue, solid pink and solid green lines in the top panel show, respectively, time-varying thresholds for being 20%, 40% and 47% in the slack times. Solid gray line indicates US unemployment rate. Blue and pink shaded areas represent 20% and 40% of the economy being in the slack times, respectively. Dashed blue, dotted red and solid pink lines in the bottom panel show GDP responses in bad times, when 20%, 30%, and 40% of the time being in the slack times, respectively. Dashed blue line with circle, dotted red line with stars and solid pink line with squares indicate GDP responses in good times, when 20%, 30%, and 40% of the time being in the non slack times, respectively.

Figure 1.6: NBER Dates and Weight on Recession Regime *F(s)*



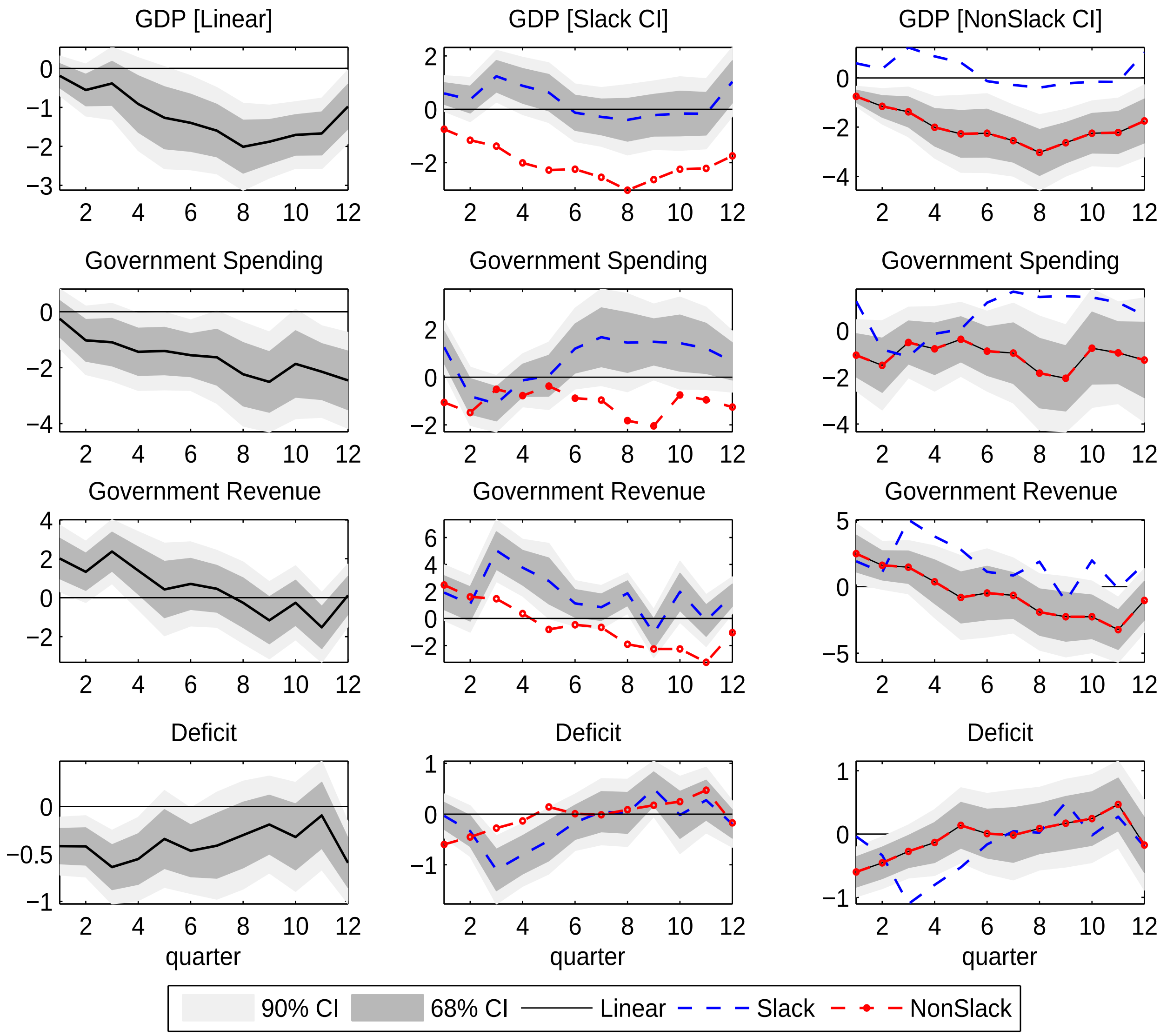
Notes: In the top panel, shaded areas shows recessions as defined by the NBER and solid line shows the weight on recession regime F(s). Value of the smooth parameter is 2. In the bottom panel, solid line indicates responses in the linear model, dashed blue line shows response in recessionary periods, and dotted red line with circle shows GDP response in expansionary episodes.

Figure 1.7: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Controlling for Monetary Policy



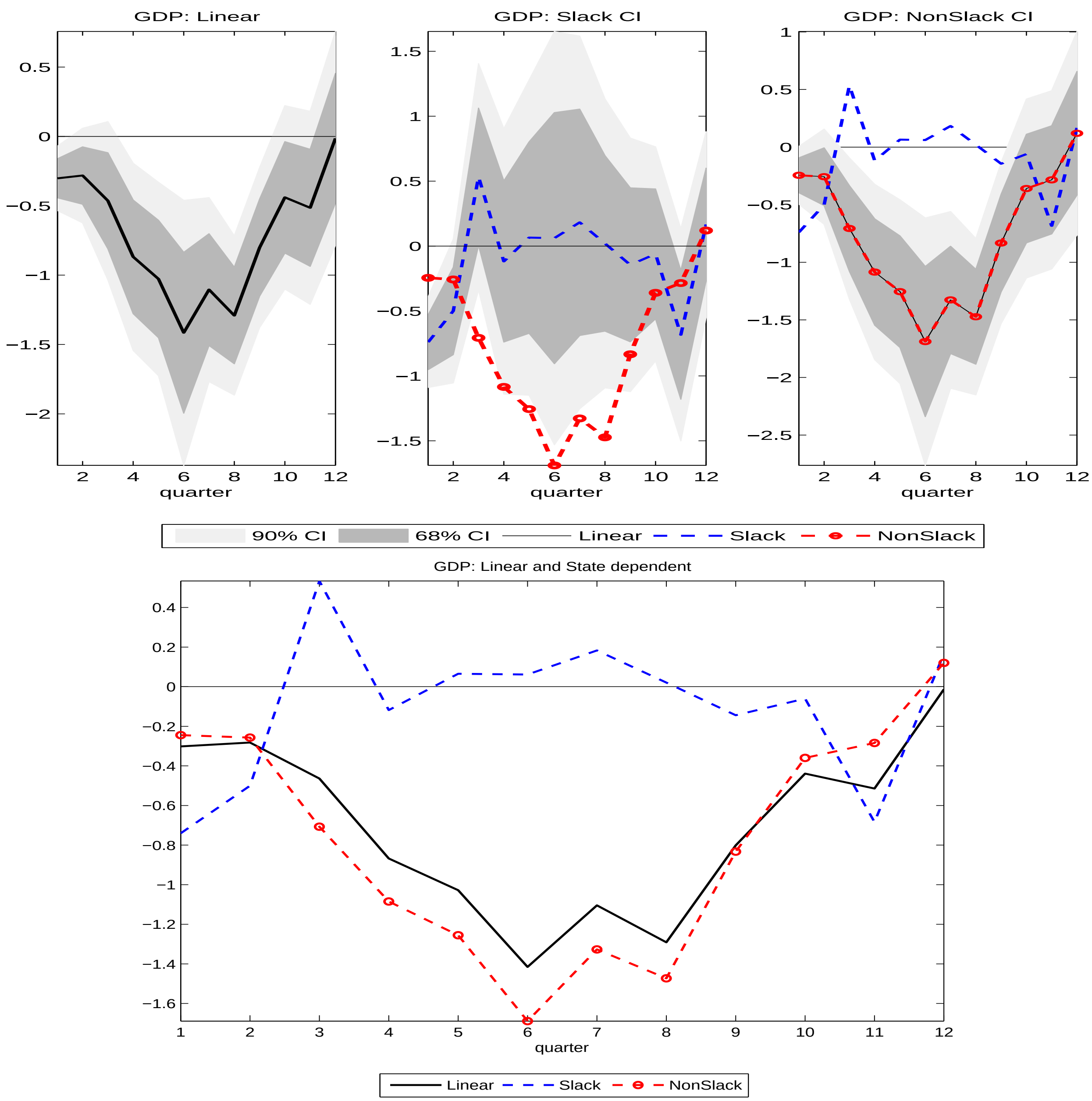
Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.8: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Controlling for Government Spending



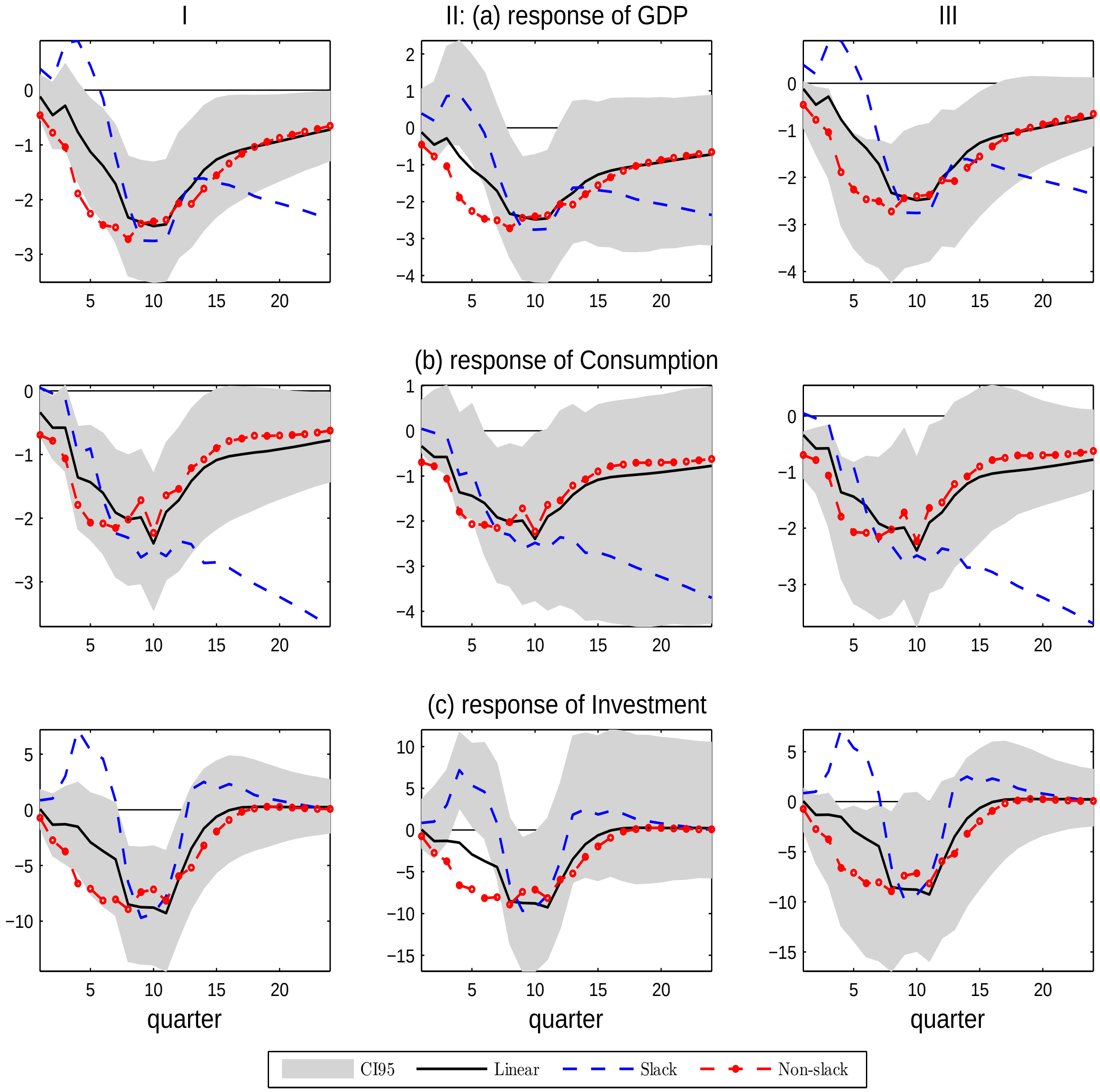
Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.9: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Unanticipated Tax Liability Shock



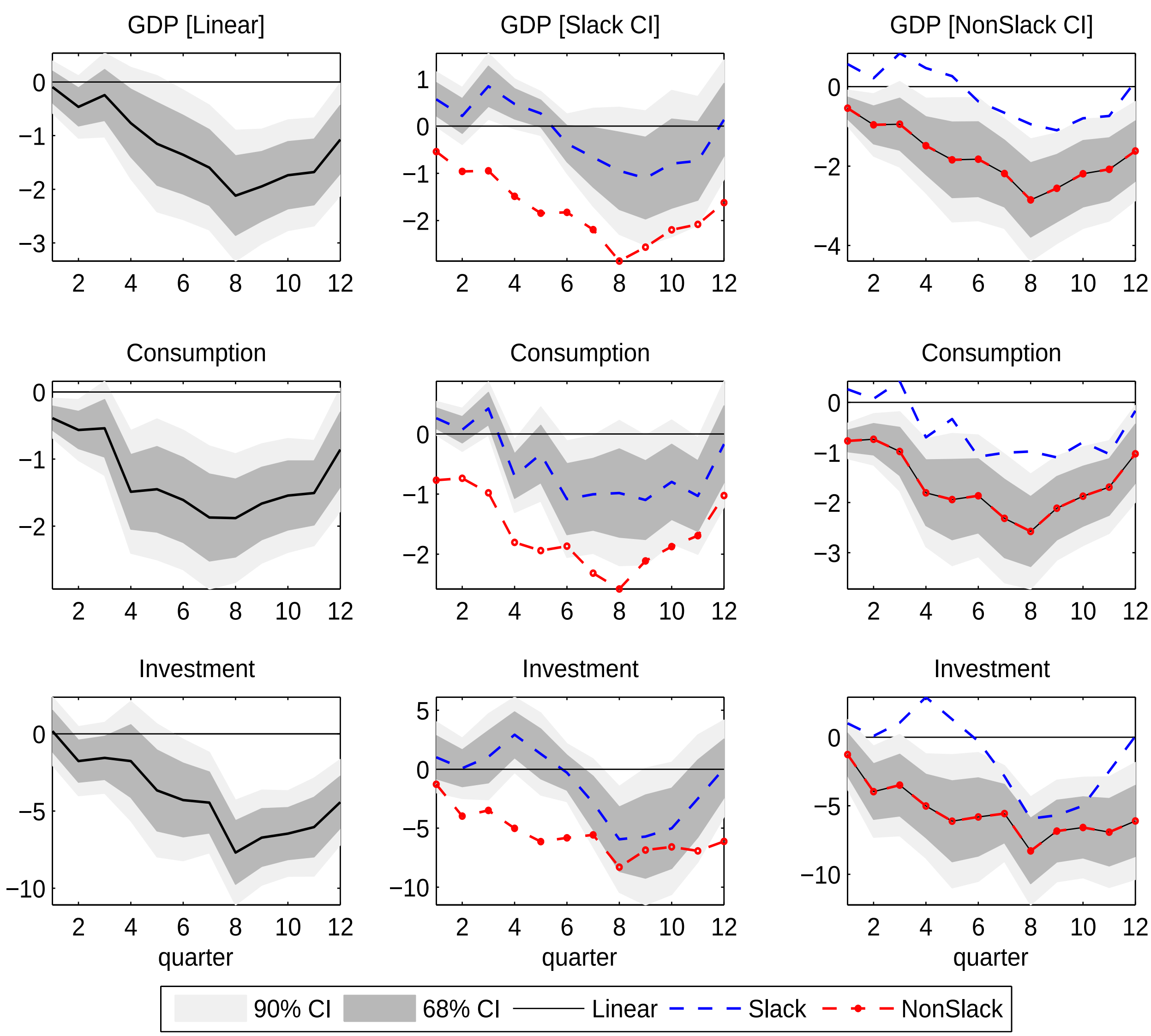
Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.10: The Impact of an Exogenous Tax Increase of 1% of GDP, VAR Specification



Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). The shaded areas represent 90% confidence intervals for the impulse responses of the linear model, bad times and good times in the I, II and III columns, respectively.

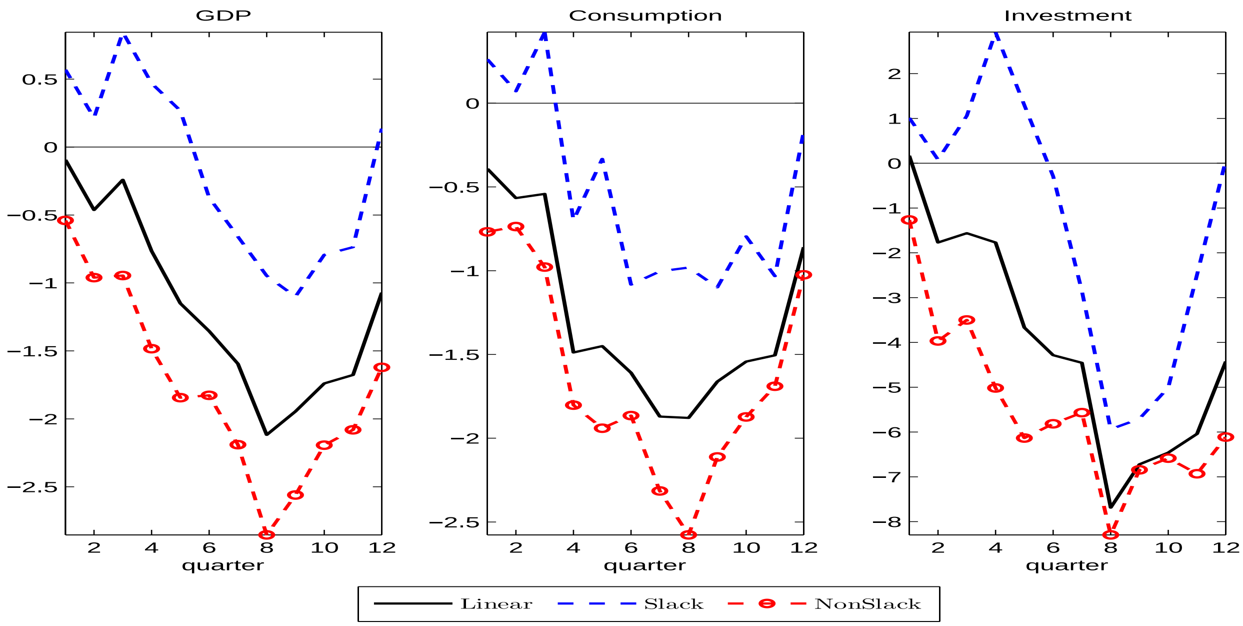
Figure 1.11: The Impact of an Exogenous Tax Increase of 1% of GDP on [Y C IN]



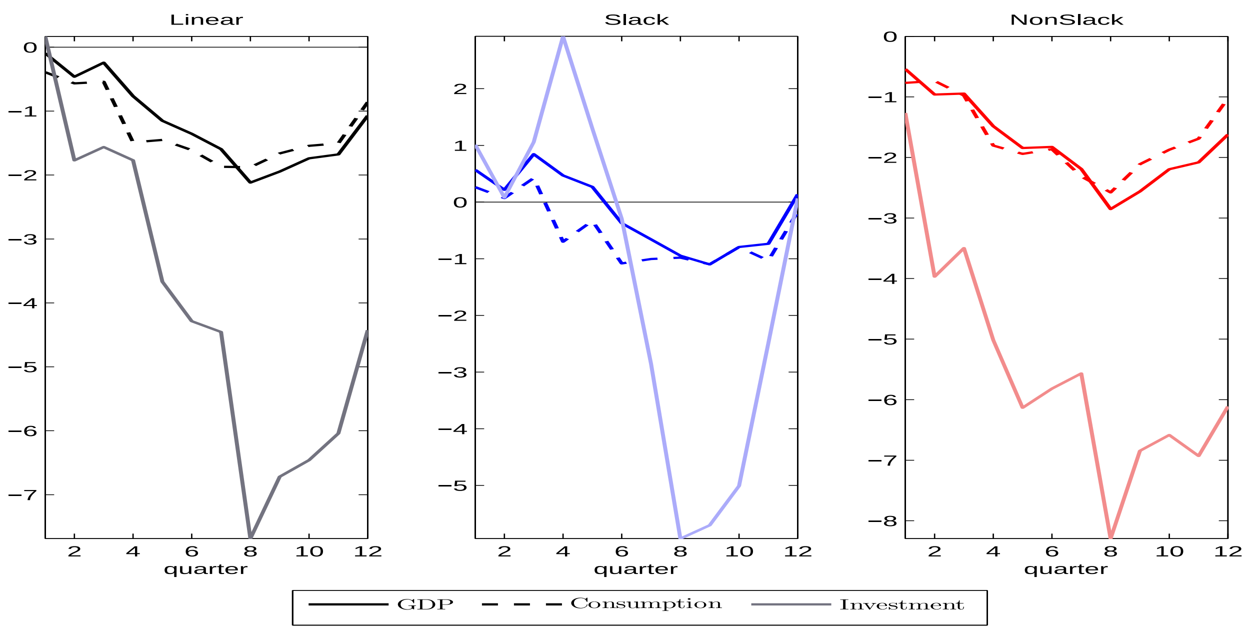
Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.12: The Impact of an Exogenous Tax Increase of 1% of GDP on [Y C IN]

A. Linear and State-dependent Models

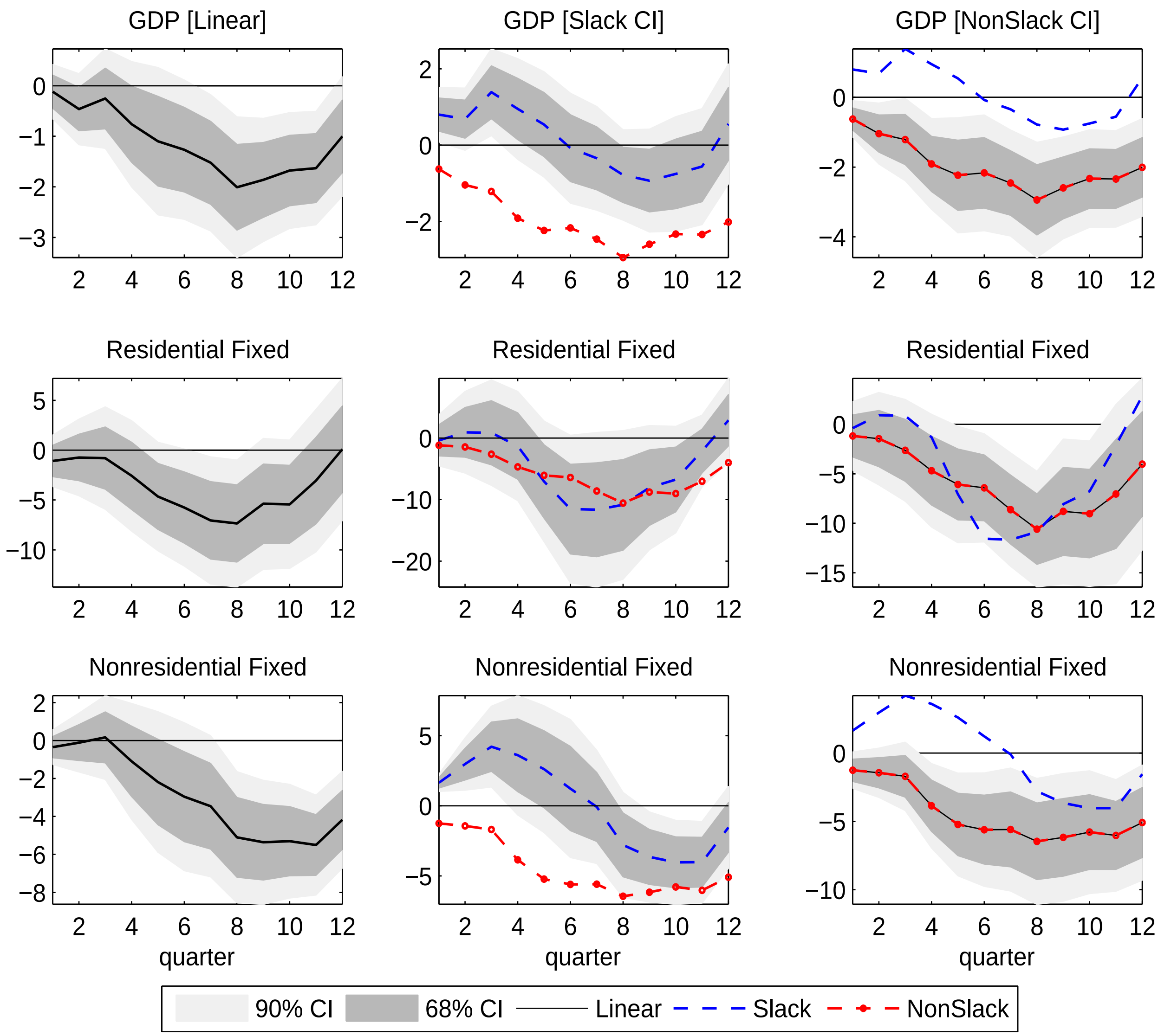


B. Comparing Responses of [Y C IN]



Notes: Black lines indicate responses in the linear model. Blue lines show response in the high unemployment states (states of slack), and red lines with circle show response in the low unemployment states (states of non-slack).

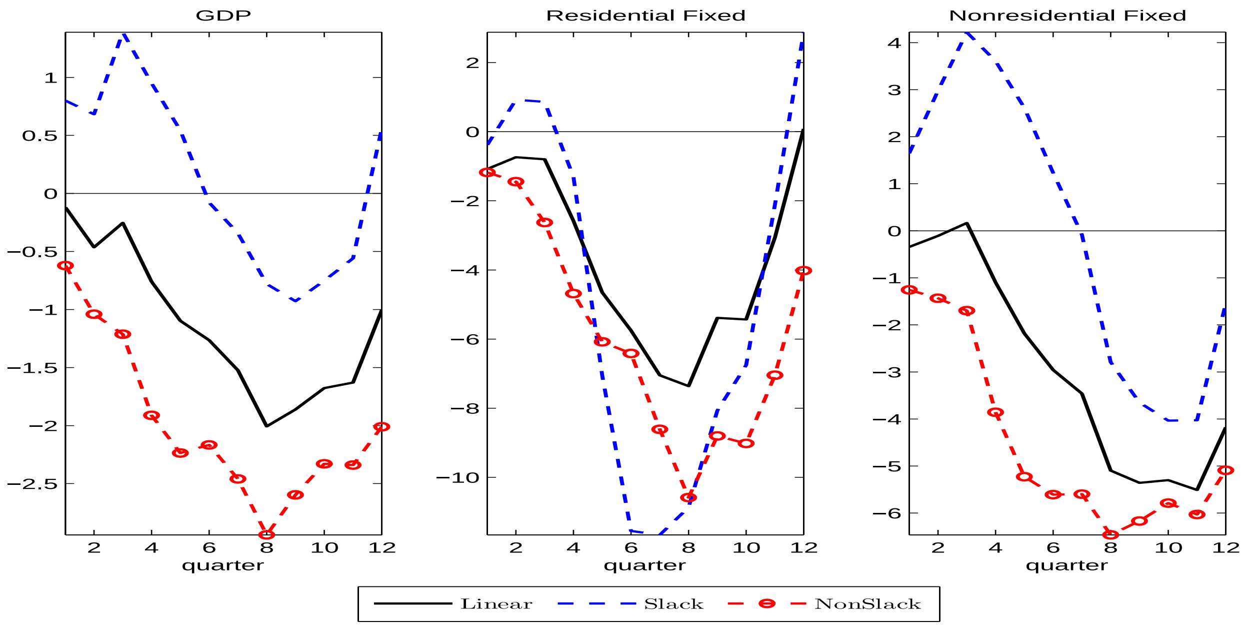
Figure 1.13: The Impact of an Exogenous Tax Increase of 1% of GDP on [Y RES NonRES]



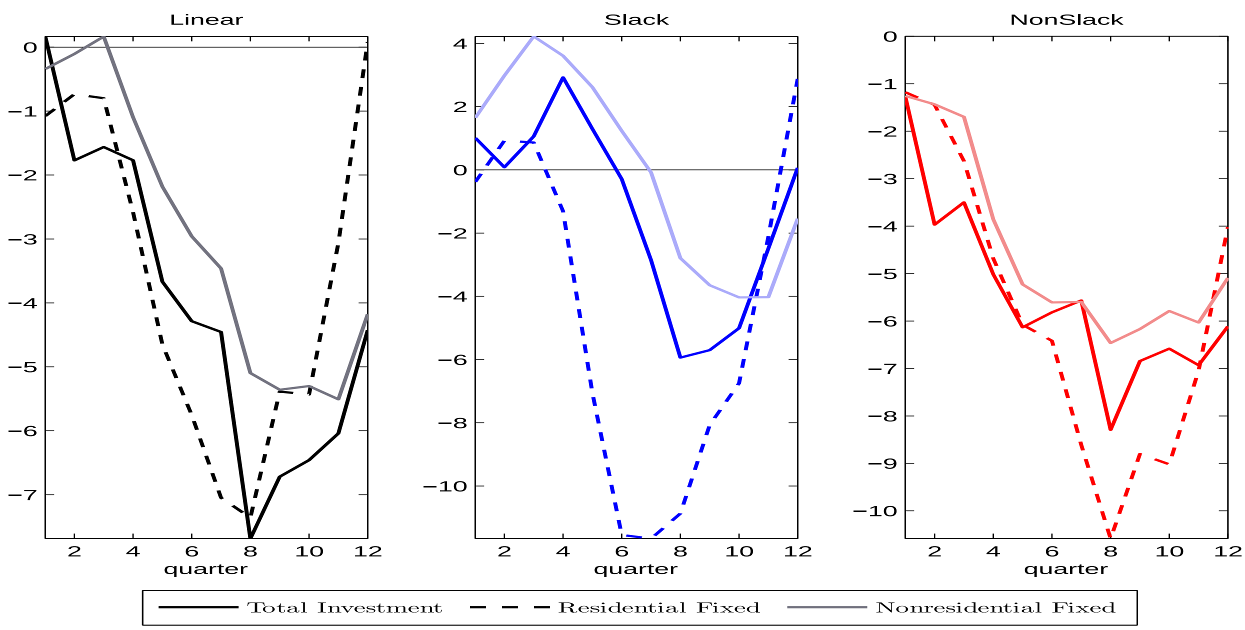
Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.14: The Impact of an Exogenous Tax Increase of 1% of GDP on [Y RES NonRES]

A. Linear and State-dependent Models

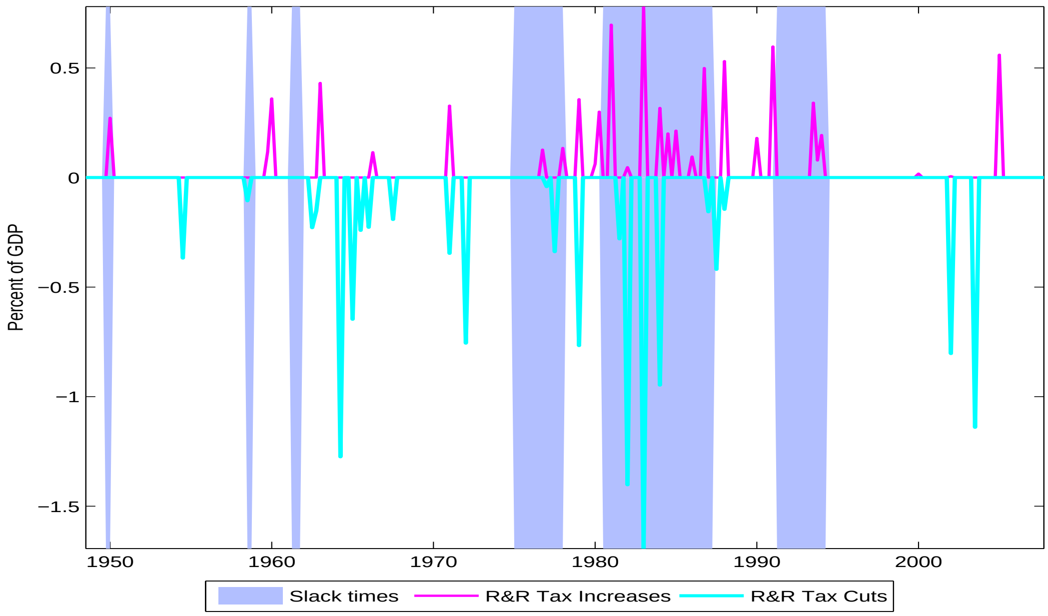


B. Comparing Responses of [IN RES NonRES]



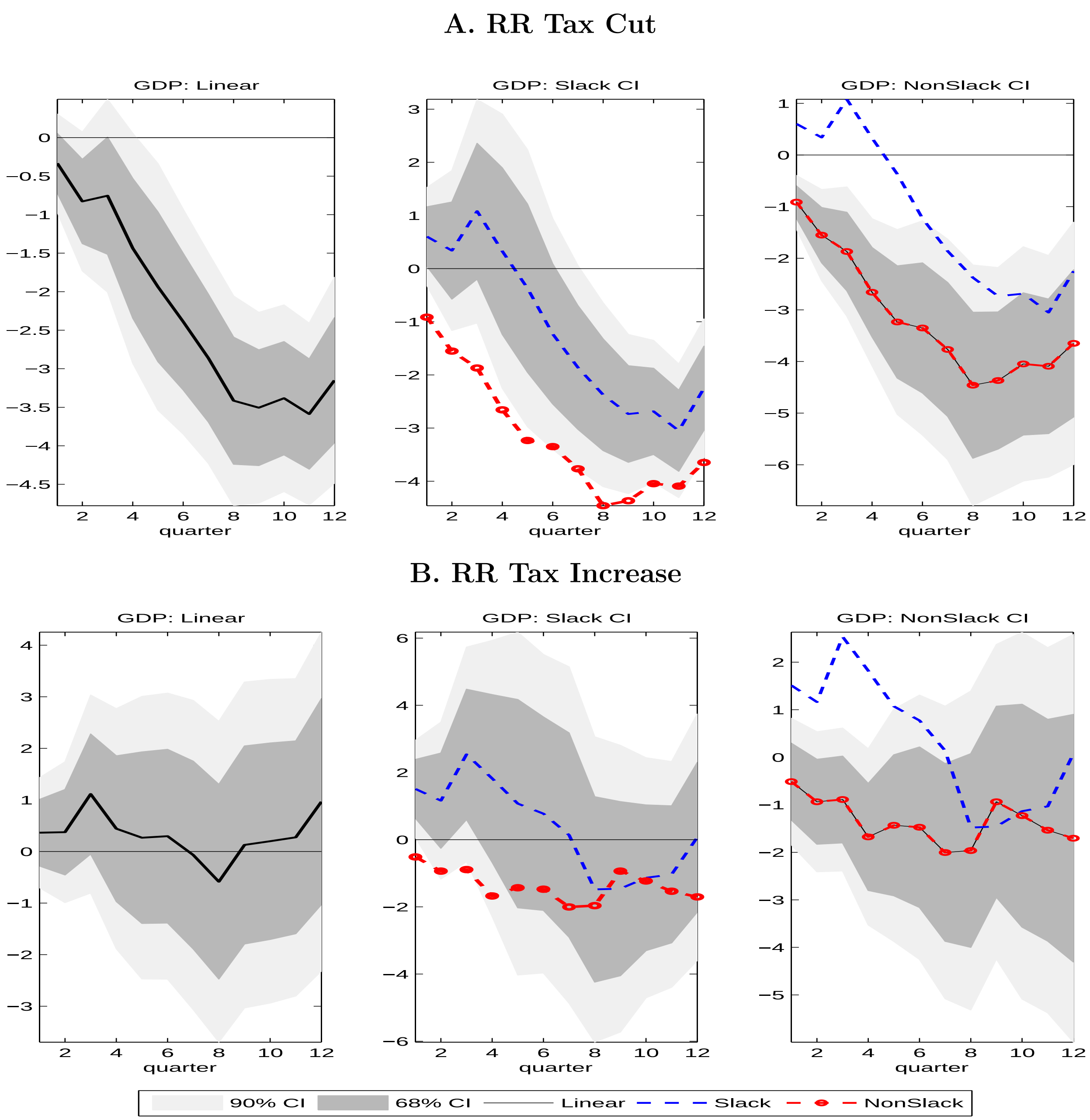
Notes: Black lines indicate responses in the linear model. Blue lines show response in the high unemployment states (states of slack), and red lines with circle show response in the low unemployment states (states of non-slack).

Figure 1.15: RR Exogenous Tax Cuts and Increases



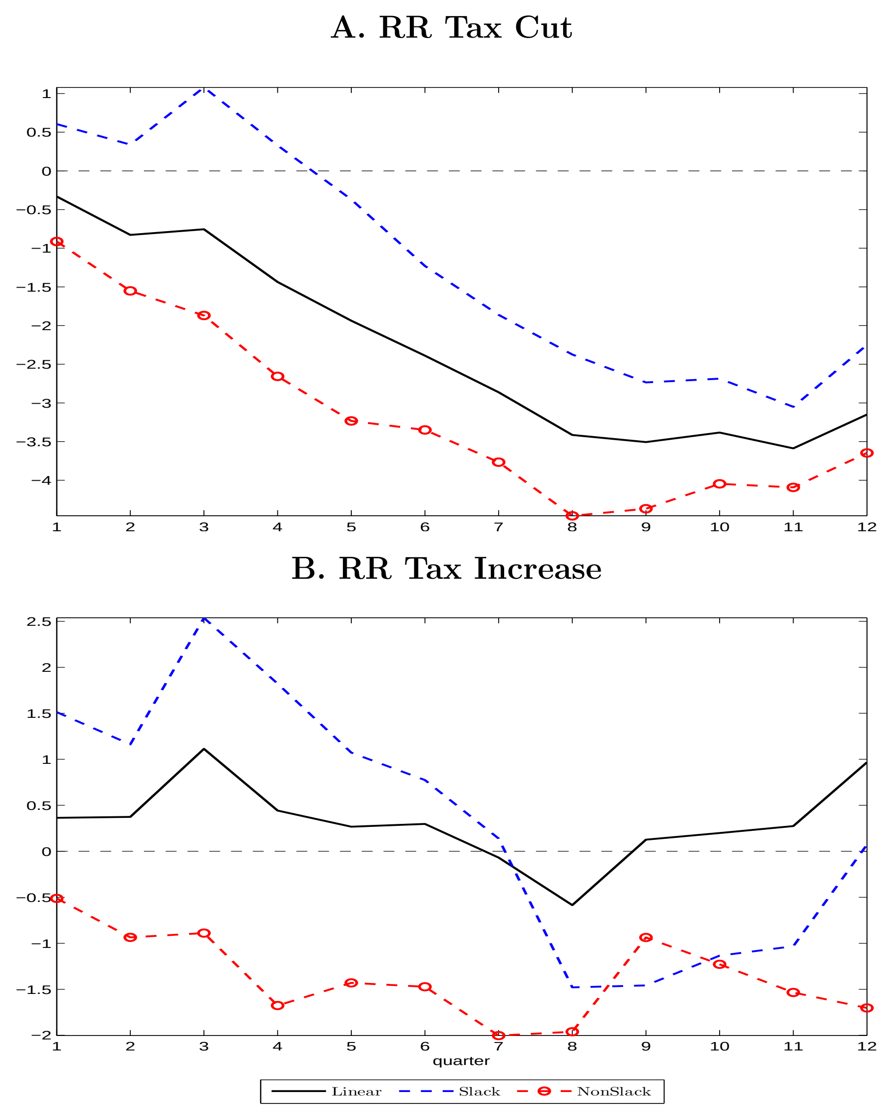
Notes: Solid cyan lines show RR exogenous tax cuts, and solid magenta lines show RR exogenous tax increases. Shaded areas indicate time periods when the unemployment rate is above the 6.5% threshold.

Figure 1.16: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Separated RR Tax Changes into Tax Cut ($\boldsymbol{RR}^{-}$) and Tax increase ($\boldsymbol{RR}^{+}$)



Notes: Panel A shows GDP responses for RR Tax Cut ($\boldsymbol{RR}^{-}$) and Panel B shows GDP responses for RR Tax Increase ($\boldsymbol{RR}^{+}$). Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 1.17: The Impact of an Exogenous Tax Increase of 1% of GDP on GDP, Separated RR Tax Changes into Tax Cut ($\boldsymbol{RR}^{-}$) and Tax increase ($\boldsymbol{RR}^{+}$)



Notes: Panel A shows GDP responses for RR Tax Cut ($\boldsymbol{RR}^{-}$) and Panel B shows GDP responses for RR Tax Increase ($\boldsymbol{RR}^{+}$). Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack).

Figure 1.18: The Impact of an Exogenous Tax Cut of 1% of GDP on GDP, RR All Tax Changes and RR Tax Cut ($\boldsymbol{RR^{-}}$)

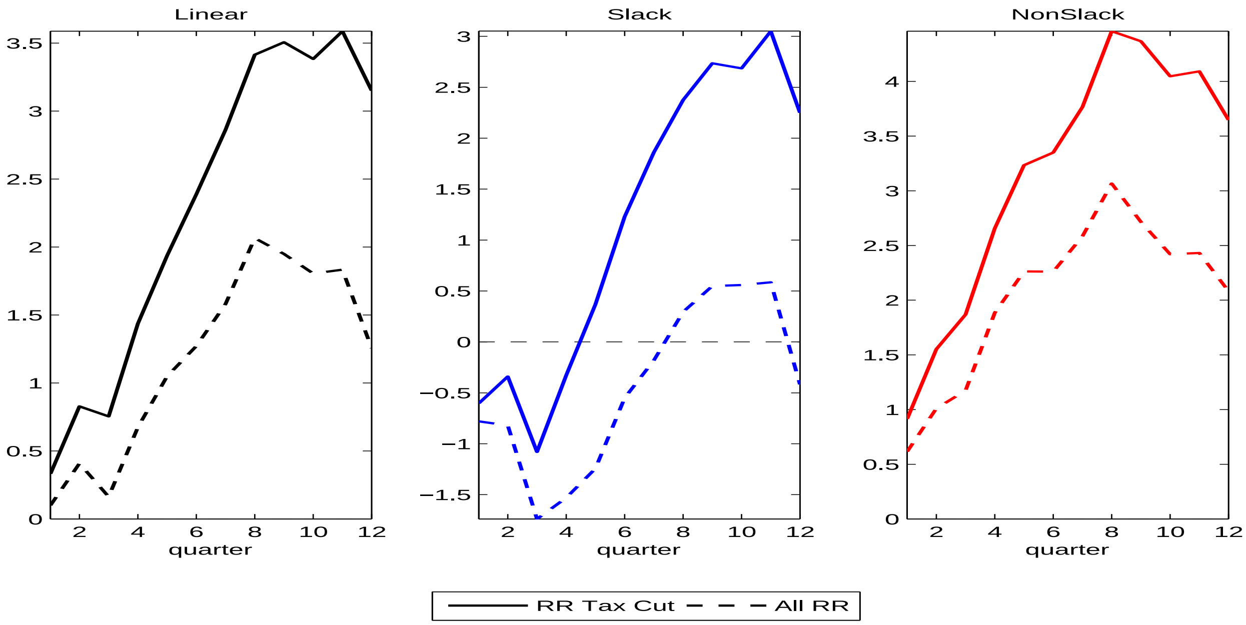
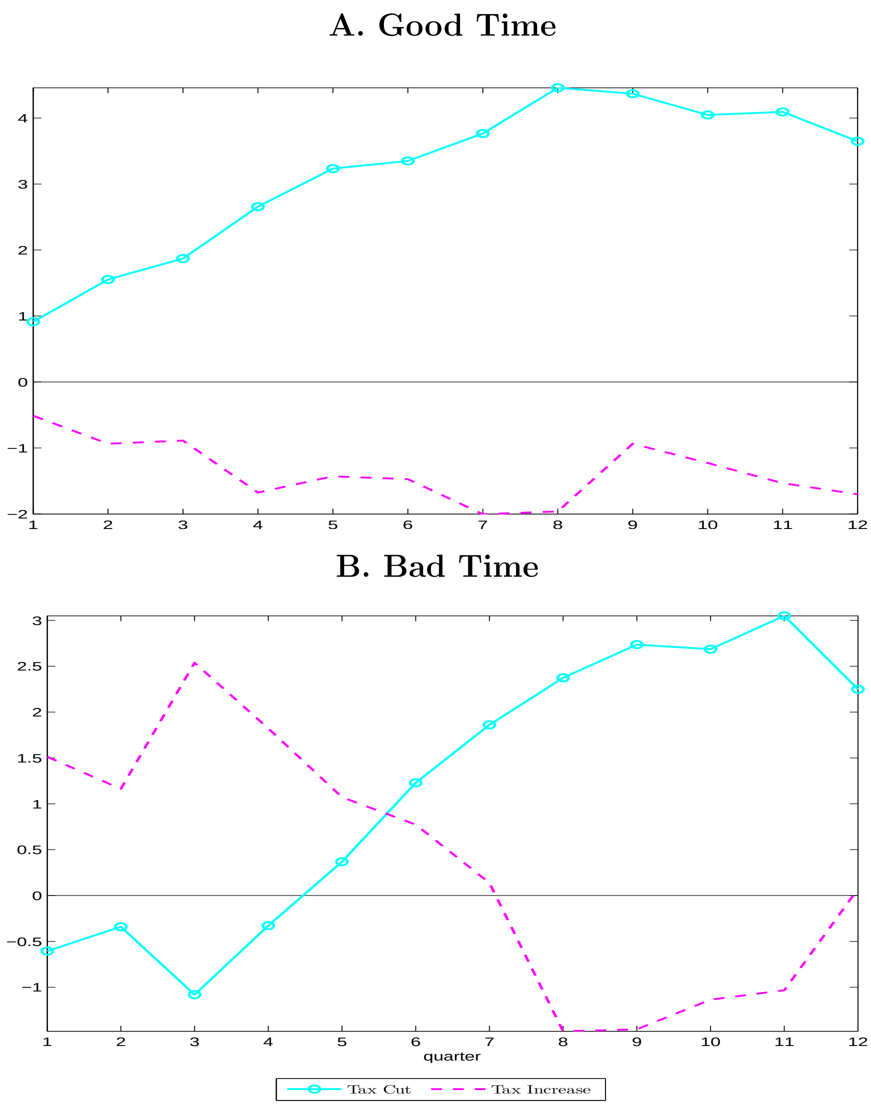
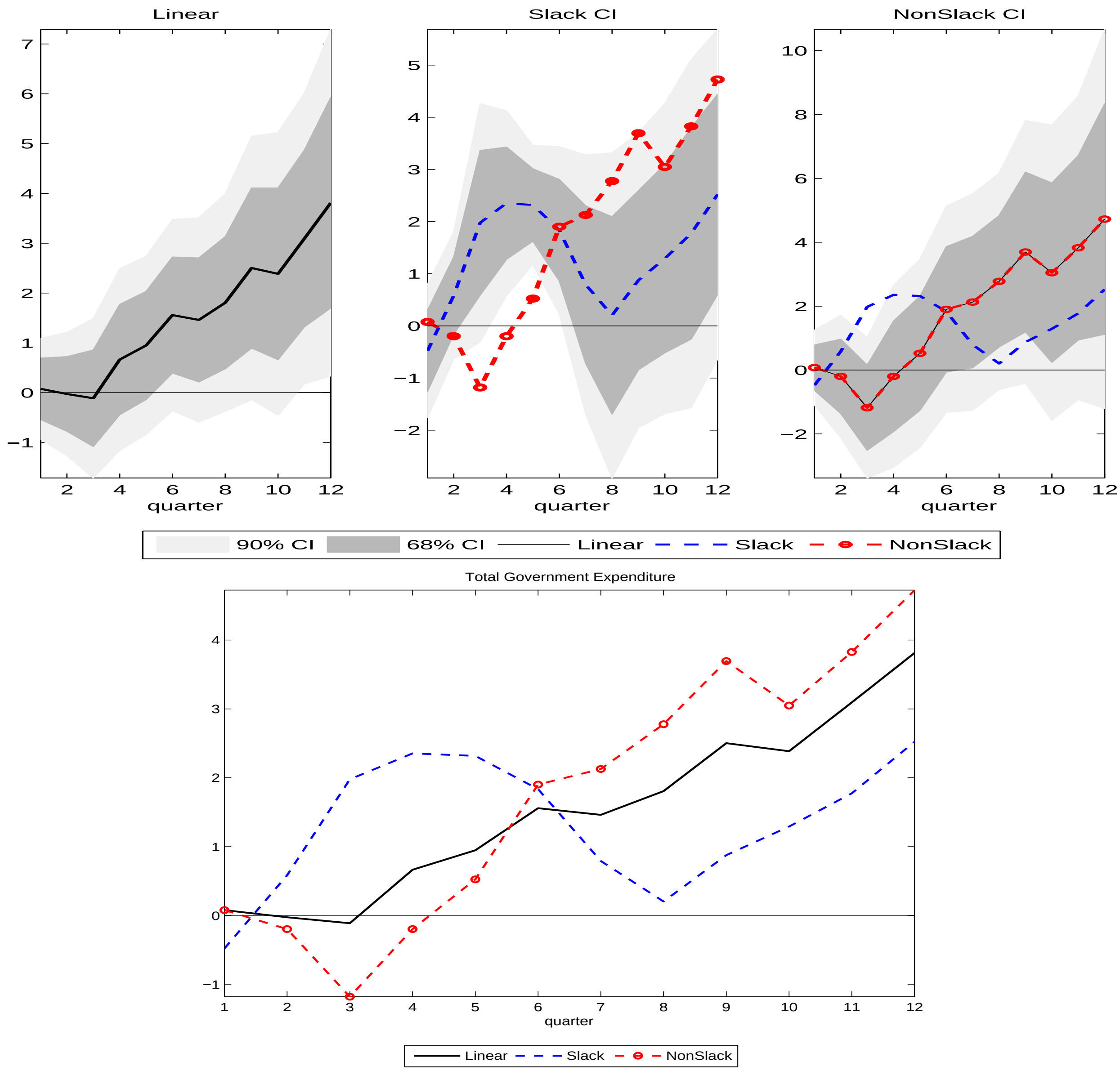


Figure 1.19: The Impact of an Exogenous Tax Changes of 1% of GDP on GDP, Separated into Good and Bad Times



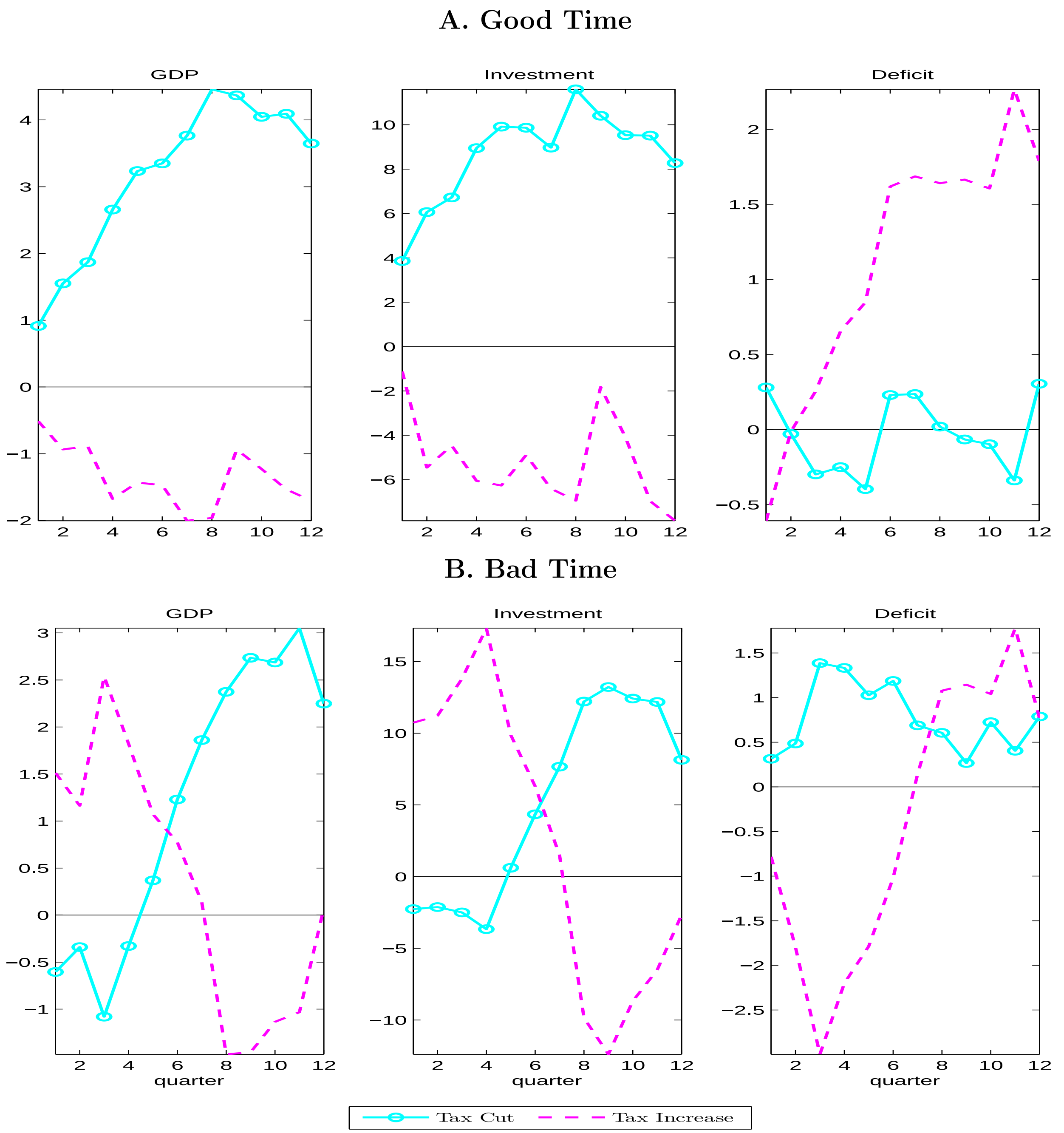
Notes: Panel A shows GDP responses for RR Tax changes in good time and Panel B shows GDP responses for RR Tax changes in bad time. Solid cyan line with circles shows responses to RR tax cut ($\boldsymbol{RR}^{-}$), and dashes magenta line shows responses to RR tax increase ($\boldsymbol{RR}^{+}$).

Figure 1.20: The Impact of an Exogenous Tax Increase of 1% of GDP on Total Government Expenditure



Notes: Solid line indicates responses in the linear model. Dashed blue line shows response in the high unemployment states (states of slack), and dashed red line with circle shows response in the low unemployment states (states of non-slack). Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

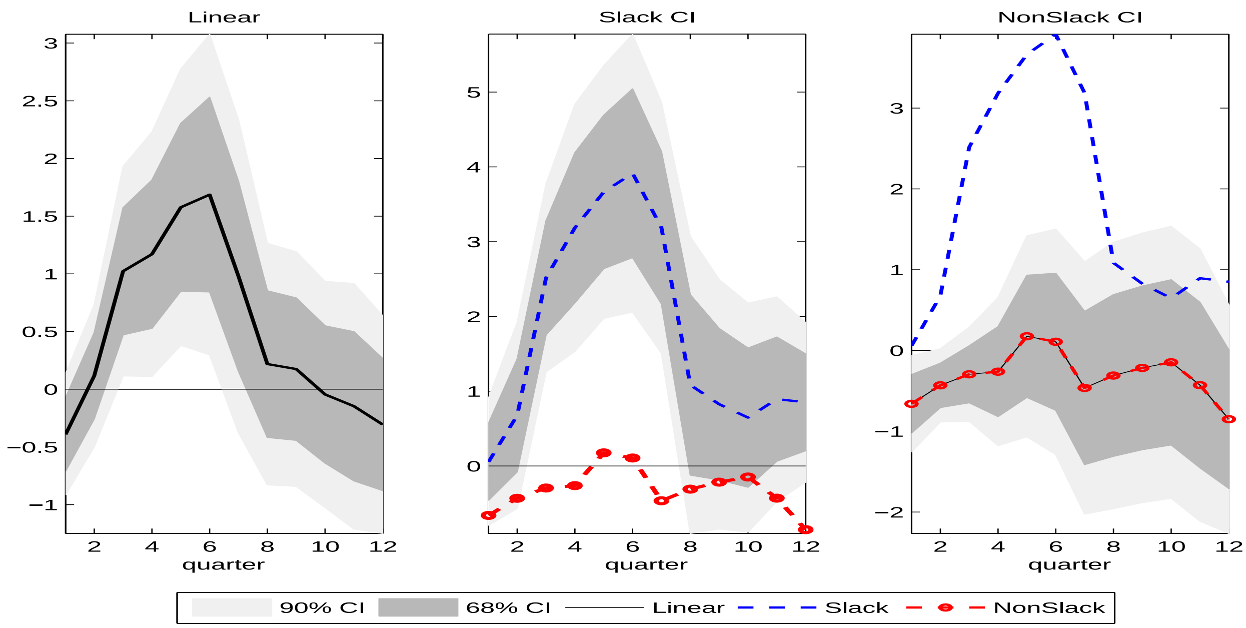
Figure 1.21: The Impact of an Exogenous Tax Changes of 1% of GDP on [Y INV DEFICIT], Separated into Good and Bad Times



Notes: Panel A shows responses for RR Tax changes in good time and Panel B shows responses for RR Tax changes in bad time. Solid cyan line with circles shows responses to RR tax cut ($\boldsymbol{RR}^{-}$), and dashes magenta line shows responses to RR tax increase ($\boldsymbol{RR}^{+}$).

Figure 1.22: The Impact of an Exogenous Tax Increase of 1% of GDP on Treasury Bond Rate

A. Ten-year Treasury Bond Rate



B. Three-year Treasury Bond Rate

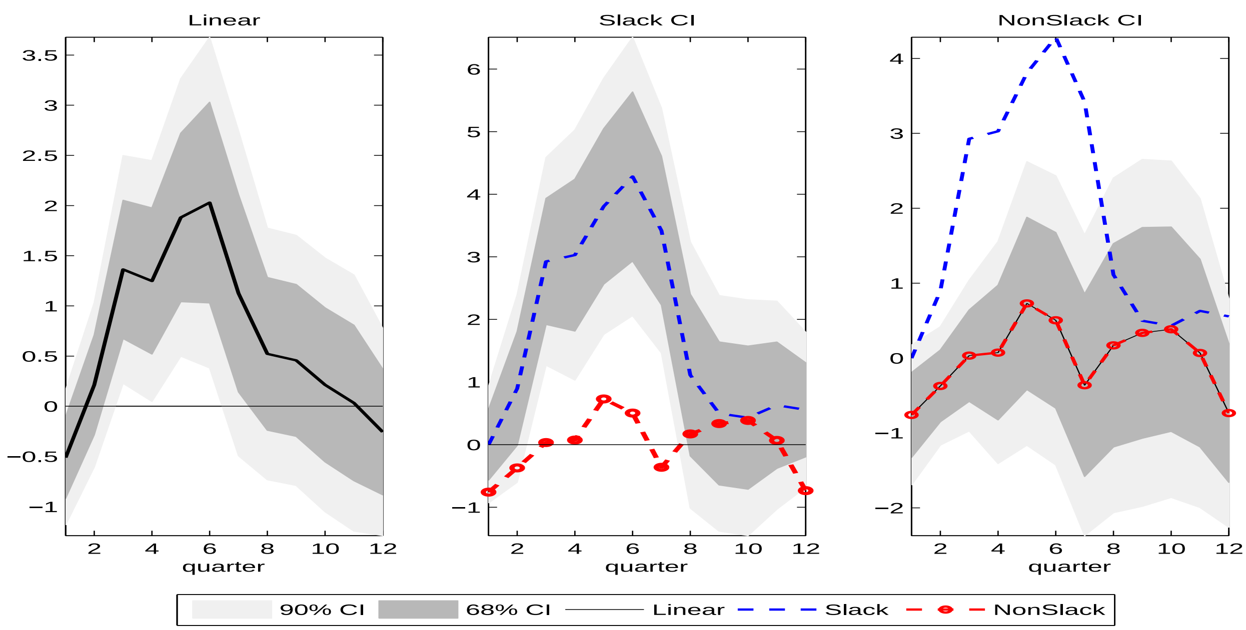
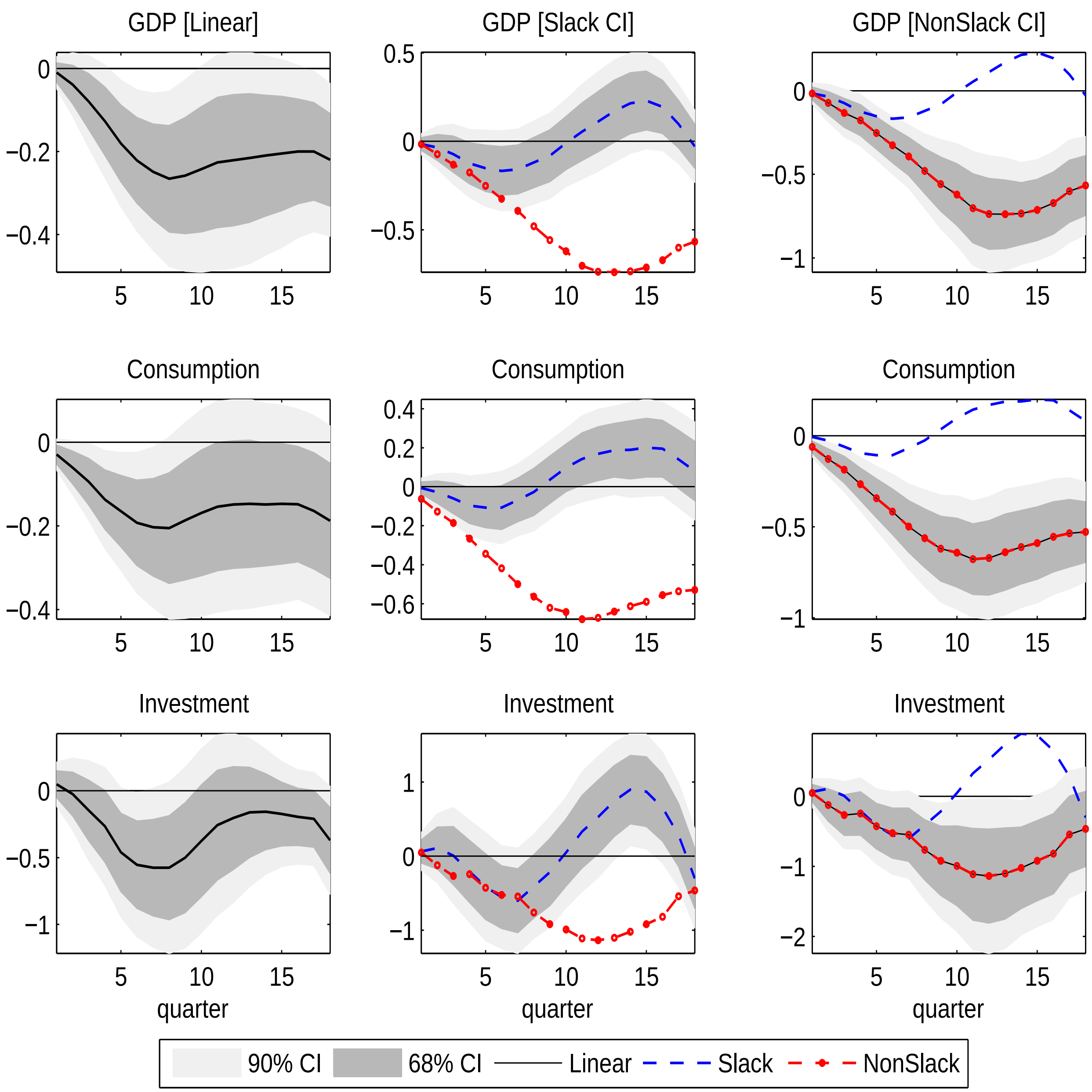


Figure 1.23: 1% Tax Increase: Barro and Redlick (2011) Average Marginal Tax Rate



Chapter 2

Tax Policy and Investment Behavior of Small and Large Firms

This paper investigates the distinct impact of corporate income tax changes on U.S. manufacturing corporation in different size classes over the post-WWII period. We use the narrative records and *Federal Corporate Income Tax Rates* to identify the size and timing of the exogenous corporate tax changes for small and large firms. Our estimates show that both small and large firms respond to exogenous tax cuts by boosting investment. However, while small firms rely more on debt to finance investment, large firms use a combination of debt and cash reserves. To explain this difference, we posit a model of precautionary cash-holding where firms' access to credit markets is endogenous. Based on this model, we argue how large firms optimize their capital structure towards a more diversified credit portfolio. Diversification of portfolio lowers the precautionary concerns and allows them to use cash reserves when investment opportunities arrive. On the contrary, small firms with limited access to financial markets have strong precautionary motives and hence rely on debt in such expansionary episodes.

2.1 Introduction

There exists a long-standing debate in the literature of fiscal policy about the impact of tax policies on macroeconomic aggregates. Although, the range of estimated tax multipliers in this literature are wide[1], the common view is that the effect of tax changes on aggregate business investment is sizable. In fact and based on the procyclical behavior of investment, such a strong investment response is the main transmission mechanism of tax policy on output[2].

This study contributes to this literature by exploring the distinct impacts of corporate income tax cuts on firms in different size classes. Specifically, the contribution is twofold. First, we investigate the role of size in firms' responses. To the best of our knowledge, there have been no controlled studies in fiscal policy comparing the responses of small versus large firms to corporate income tax changes. Second, finding that both firms respond by

[1] Tax multiplier lies between 0.5 and 3, a survey of this literature is in Favero and Giavazzi (2012).

[2] See Eskandari (2014) for a detailed discussion.

boosting investment, we explore firms financing behavior in such occurrences. For these purposes, we make use the *US Census Bureau, Quarterly Financial Report (QFR)*, which is an inclusive dataset of U.S. manufacturing firms. This dataset reports balance sheet and income sheet variables of manufacturing corporations of all sizes, which makes it proper for our research purposes. By using this dataset and highlighting the role of firm size, we shed light on the dynamic effects of corporate income taxation on U.S. manufacturing firms over the post-WWII period.

To identify proper shocks, we match the narratively identified tax cuts by Romer and Romer (2010) and Mertens and Ravn (2013) with the legislated corporate income tax brackets of the *US Tax Foundation* to identify unanticipated-exogenous changes in corporate income tax rate over the whole period. Therefore, employing a local projection method, we show that investment, sales and inventories increase across both small and large firms following the shocks. However, large businesses relatively contribute higher share of aggregate changes of business investment and the results are shown to be robust to many alternative specifications. We also find that both firms increase external financing. However, small firms rely more on debt while cash reserves appear to be a strong substitute of debt for large firms.

In order to explain this empirical evidence of differential responses, we posit a model of precautionary cash-holding in the presence of financial friction. The friction is introduced in terms of collateral constraint where outstanding debt is restricted by a fraction of invested capital. This fraction is stochastic and motivates firms to hold precautionary reserves to insure themselves against future tightening in financial markets. To do so, firms issue long-term debt and save it as short-term securities. However, precautionary motives of firms are different regarding their endogenous access to different credit markets. Accessibility to multiple credit markets has a fixed cost, but it reduces the likelihood of being constrained. Therefore, large firms with high credit demand pay the cost of having a diversified credit portfolio while small firms do not. On the other hand, the effect of tax cut is twofold. First it increases the marginal return of investment. Second, since cash reserves are kept in the form of short-term taxable securities, lower tax rate implies stronger precautionary motives. When tax rate declines, both firms increase their investment. However, since diversification of portfolio lowers the precautionary concerns, it allows the large firms to use cash reserves. On the contrary, small firms with limited access to financial markets have stronger precautionary motive which is stimulated after the tax cut. Hence small firms rely on debt in such expansionary episodes.

The rest of this paper is organized as follows. Next section briefly reviews the related literature. Section 3 describes data, identifying tax shocks and a descriptive analysis of the real and financial behavior of firms. Section 4 first lays out the basic specification of our econometric methodology and then reports our empirical results. Section 5 discusses a model of precautionary cash-holding to explain how firms optimize their capital structure. Section 6 discusses a number of robustness checks and extensions and Section 7 concludes.

2.2 Related Literature

Corporate income taxation has been one of the most widely discussed issues in the area of macroeconomics and public economics. Measuring the effects of tax policy on business investment is an important part of tax policy debates.

Many studies in public economics have found that the tax-policy have a significant influence on investment. Although some studies argue that this effect is small, Hassett and Hubbard (2002) provide a review of this literature and conclude that the aggregate elasticity of investment with respect to the user cost is between -0.5 and -1 and hence tax policy changes appear to have generally large effects on investment. However, as mentioned in Bond and Reenen (2007) "it is perhaps a little too early to agree with Hassett and Hubbard (2002) that there is a new 'consensus' on the size and robustness of this effect". Nonetheless, these studies almost entirely rely on the publicly traded firms, and since small firms are almost never publicly traded, the findings are thus biased towards large- and medium-sized firms.

On the other hand, the common view in the literature of fiscal policy is that the effect of tax changes on aggregate business investment is significant and many preexisting studies in this line of literature revealed that investment responds so strongly to tax changes. Romer and Romer (2010) apply a narratively identified tax changes and show that the accumulated impact of an exogenous tax increase of 1 percent of GDP on nonresidential fixed investment is around -8 percent after three years. Blanchard and Perotti (2002) also find that a positive tax shock has a strong negative effect on investment spending, it is 0.36 on impact and much smaller than Romer and Romer (2010), though. In addition, Eskandari (2014) shows that such a strong investment response to tax changes is the main transmission mechanism of tax policy on output, and also suggests that the important part of the output state-dependent responses appears to be due to the non-linear behavior of business investment. However, investigating in this strand of the literature has been limited to aggregate level analysis. There have been no controlled studies in fiscal policy comparing the responses of small versus large firms to corporate income tax changes.

In sum, while fiscal policy scholars mainly use aggregate data and then miss the marginal incentives, public economics scholars mainly rely on micro-data, such as *Compustat*, and then miss the overall economic conditions and also do not consider the small private firms. However, over the past few years, some empirical studies have provided evidence that tax policy effects are different depending on the size of firms. The focus of these studies is on the differential effect of bonus depreciation policy on firms of different sizes (e.g. Zwick and Mahon, 2014 and Winberry, 2015). A serious concern about these studies, however, is that U.S. bonus depreciation laws targeted specifically at small businesses (House and Shapiro, 2008) or at least the limits on its use tend to confine its benefits to small firms (Guenther, 2014). Hence, the results are biased and not very informative about the role of size.

In addition, the role of firm size in business cycles has been taken into consideration in other strands of macroeconomics. Gertler and Gilchrist (1994) (GG) employ *US Census Bureau, Quarterly Financial Report (QFR)* data from 1958 to 1992 to compare how the sales, inventories and short-term debt of firms of different sizes respond to credit contractions. They take the exogenous monetary policy dates of Romer and Romer (1994) and show that sales of small firms fall by more than large firms in response to a contractionary monetary policy shock. GG explain this differential response of the firms by their relative access to credit markets. Since size is a proxy for access to capital markets, small firms have, then, relatively less access than large firms. Thus, small firms suffer more after Romer-Romer monetary contractions, because a monetary contraction affects the economy by making credit markets relatively tight for small firms. In addition, while small firms play a surprisingly prominent role in the slowdown of inventory demand, large firms borrow more to accumulate inventories. Chari, Christiano, and Kehoe (2013) (CCK) confirm findings of GG by extending QFR data back to 1952Q1 and up to 2012Q4. They also propose an answer to the related question of what happens to the sales of large versus small firms during recessionary episodes instead of tight monetary policy dates. CCK conclude that unlike in the case of monetary shocks, no significant differential response to real business cycle shocks is observed between firms of different sizes. In a related work, Kudlyak et. al. (2010) produce results which corroborate the findings of the previous works. Moreover, they look at the firms' performance aftermath of the 2008 credit crunch through the lens of GG. Using the same dataset and the same methodology, they find that unlike during previous episodes of credit tightening, large firms were relatively more sensitive in the recent financial downturn. In another study, Moscarini and Posetl-Vinay (2012) document a stronger counter-cyclicality of large rather than small employers to unemployment cycles. They define employer size in terms of employee numbers and compare the net job creation rate of firms in different size brackets. They draw their data from the new Census Bureau's *Business Dynamic Statistics* (BDS), covering the period between 1978 and 2009, as well as matched employer-employee datasets from Denmark and France. They present evidence of higher volatility of large firms in response to unemployment dynamics.

Moreover, there are few related studies in public economics which use comprehensive data of both small and large firms. Gordon and Lee (2001) use US *Statistics of Income* (SOI) *Corporate Income Tax Returns* data (1950-1995) to estimate the effect of corporate income tax changes on corporate debt policies. Their results suggest that the effect of taxes on a firm's debt level is significant such that cutting the corporate income tax rate by ten percentage points (e.g. from 46% to 36%), reduces the debt to asset ratio by around 3.5%. Moreover, they run a difference-in-difference regression to see how size matters in the corporate use of debt. They find evidence of a large effect of taxes on debt-to-asset ratios for the smallest and the largest size classes, but much less of the effect for intermediate sized firms. They also use the aggregate data to estimate the separate effects of corporate and personal tax rates on debt-to-asset ratio. The results show significant and robust effect for both types of taxes, but with opposite signs. Contos (2005) extends the study of Gordon and Lee (2001) by estimating their model with the same data from 1993 to 2000. His results qualitatively agree with the findings of Gordon and Lee (2001). However, using micro-level data and constructing marginal tax rates from taxable income before the interest deduction, they evidence the positive relation between tax and debt usage in all three categories of small, medium and large firms. Another recent study conducted by Longstaff and Strebulaev (2014) examines the interaction of leverage and corporate income tax rates using micro-level data of SOI. Their results are consistent with those of other studies and suggest a positive relationship between corporate taxation and corporate leverage. However, by controlling for size they find that this relationship is significant for all asset size classes with the exception of small firms. They also find that the adjustment process of leverage in response to tax changes is faster for large firms. Large firms respond over a short period, while intermediate-size firms react with a lag.

Moreover, an extensive literature has studied how different taxes affect corporate financial decisions and investment. As Graham (2006) argues, there are multiple avenues for taxes to affect corporate decisions. In particular, studies have distinguished between corporate and personal taxation and their impacts of economic performance of the firms. Several studies thus far have linked corporate income taxation with the capital structure of firms. The key concept in this strand of literature is the notion of tax shield. Since firms can benefit from a reduction of income taxes by using an allowable deduction from their taxable income, corporations have an incentive to finance with debt rather than equity. According to this argument, firms with higher access to credit markets are expected to raise their leverage after any increase in the corporate income tax rates. All these empirical studies restrict their attention to the debt policy of corporations of different sizes. Moreover, there is no known study that documents the role of size in tax related analysis of firms' real variable decisions. In summary, the findings about how the interaction of tax and corporate real and financial variables is associated with size is still weak and inconclusive. This lack of relevant research indicates a need for more focus on various aspects of the issue.

Finally, identifying exogenous sources of tax shocks is another concern in measuring the effects of tax policy on investment. As we will discuss, papers in corporate and public finance typically do not exclude tax changes that are endogenous to macroeconomic conditions. This strand of literature do not separate tax changes to endogenous and exogenous shocks with respect to the macroeconomic conditions, but fiscal policy literature put stress on the identifying the exogenous changes in tax policy. Indeed, in this study we follow the narrative approach pioneered by Romer and Romer (2010) to identify exogenous corporate and personal income tax rates. In particular, will employ Mertens and Ravn (2013) approach to identify exogenous tax policy changes as proxies for structural tax shocks.

2.3 Data

In this section, we first introduce our data set and then discuss the narrative approach to identify exogenous changes in corporate income tax policy. We finally define asset as our indicator of the firm sizes and then present some pictures of the raw time series around episodes of exogenous corporate income tax cuts.

2.3.1 Data Description

This study seeks to make use of a neglected data set, *US Census Bureau, Quarterly Financial Report (QFR)* of U.S. manufacturing firms, to deal with the above mentioned issue by controlling the effect of firm size. The QFR program has collected and released statistics of U.S. manufacturing firms at quarterly frequencies since 1950[3]. Currently, the program also covers mining, wholesale trade, retail trade and some selected service industries as well. Based upon a sample survey, the QFR reports the income statements, balance sheets and related financial and operating ratios for US firms broken down by asset size and industry.

We use QFR for a number of advantages of this dataset for our research purposes. One advantage of this data set is containing a wide range of historical data, from 1954 to the

[3]The QFR program is conducted under the authority of Title 13 of the United States Code, Section 91, which requires that financial statistics of business operations be collected and published quarterly. The law imposes a joint obligation on corporations to respond and on the U.S. Census Bureau to maintain the confidentiality of information reported (http://www.census.gov/econ/qfr/historic.html).

present, which allows us to explore different episodes of tax changes. It is particularly important because exogenous variations in the tax rates are not very frequent in the United States. Another advantage of using QFR is the quarterly frequency of the reported data. Hence, we can include a large set of macroeconomic variables in our econometric framework. Many macroeconomic variables such as GDP and inflation as well as many other data series are originally being observed and reported in quarterly frequencies (Schorfheide and Song, 2013). QFR permits us to use the informational content of such macroeconomic time series[4]. Finally, the main advantage of QFR which makes it more proper for our research purposes is covering both small and large firms. Since small firms are almost never publicly traded, however, these firms' behavior to tax changes is the missing aspect in the literature of public economics which mainly relies on datasets of publicly traded corporations. In particular, this data set contains key real and financial variables of corporations, providing enough information to explore how investment responses to tax changes affect other real and financial policies of firms of different sizes.

Currently, the QFR semi-aggregate statistics are released in 8 asset size brackets (all in million dollars); under 5, [5 10], [10 25], [25 50], [50 100], [100 250], [250 1000], and over 1000. Moreover, there are some changes in size brackets and reported data items in 1974, 1980 and 1988. All these data we integrated in unified forms and transformed into electronic versions for the purpose of this project. However, prior to 1988, the data was only available in hard copies. We extended the data back to 1956Q1 by collecting data from various issues of the QFR books. We collected all balance sheet and income statement's items. The data are constructed using a simple version of the procedure applied in GG. However, these measures of size are all in nominal terms. This might lead to some measurement bias since inflation and growth trends cause firms to shift to larger size groups over time. In the next part we will introduce our categorization procedure to adjust for this bias.

2.3.2 Identifying Tax Shocks

The main challenge in measuring the aggregate effects of fiscal policy shocks is how to identify exogenous shifts in fiscal policy. One strand of the empirical literature considers exogenous shifts as unobservable and estimates the effects of fiscal policy shocks using a vector autoregressive (VAR) model by imposing short run restrictions (Blanchard and Perotti (2002), and Mountford and Uhlig (2009)). On the other hand, a very different identification strategy introduces a new set of observable exogenous tax changes identified via the narrative method (Ramey and Shapiro (1998), Romer and Romer (2010), Mertens and Ravn (2013) and Cloyne (2013)). In the empirical literature, different results have been obtained for the fiscal multipliers between standard VAR methods and the narrative approach for identifying

[4]There are two semi-aggregate datasets reporting real and financial variables of U.S. corporations in size classes; *Quarterly Financial Report* (QFR) and IRS's *Statistics of Income* (SOI). SOI reports taxable income sheet and balance sheet data of all U.S. corporations, broken down by firm size. Nonetheless, SOI has some absolute advantages over QFR data. While QFR is only based upon a sample survey, SOI is constructed from tax return reports of all corporations in the U.S. (around 150,000 firms in 2011). SOI is also richer in terms of data items and sectors which are included. Finally, the QFR data frequency is quarterly while SOI is conducted annually. In most business cycle applications, time series regressions are conducted based on quarterly observations to capture the aggregate fluctuations with more precision.

fiscal policy shocks. Ramey (2011) shows that timing is the key reason explaining this difference[5]. Favero and Giavazzi (2012) argue that these different results are not explained by the different identification of the shocks[6], but by the different models used to estimate the macroeconomic effects of the policy changes. However, Alesina, Favero and Giavazzi (2015) point out some of the main advantages of using narrative approach. Shocks identified by this approach are model independent and therefore are not affected by the possible omitted variables. Moreover, with the narrative approach we can distinguish between anticipated and unanticipated components of the shocks which is important to prevent the multiplier estimation biases in the presence of fiscal foresight [7]. Finally using narratively identified tax changes allows us to distinguish between corporate and personal tax changes which might have differential effects on firms.

In this study, we construct a new narrative dataset of legislated corporate income tax changes in the U.S. For the purpose of this research, we need to measure the marginal impact of tax changes on different firms. In the other words, we have to know the distinct changes of marginal tax rates for small and large firms after fiscal policy shocks. However, Romer and Romer (2010) and Mertens and Ravn (2013) only find the aggregate impact of the shock on government revenue without identifying the marginal impacts on firms. Here, we make use of U.S. corporation income tax rates which is provided by *US Tax Foundation* over the whole interval of our analysis. This provides the historical series of marginal corporate income tax rates for firms in different income brackets. However, since our size brackets are based on asset size while tax brackets are income based, we can not have a perfect match between them. But we roughly attribute the marginal tax rates of the lowest and highest income brackets to small and large groups in our sample. Then, in order to measure the tax decline for small and large firms in each Romer and Romer (2010) date, we use changes of marginal tax rates for the corresponding income brackets at the same dates. Moreover, since Romer and Romer (2010) have identified whether each policy change targets corporate income or not, we can restrict our attention to corporate income tax cuts in their narrative analysis and exclude all other shocks[8]. Figure 1 shows the *Federal Corporate Income Tax Rates* for different income brackets along with our measure of narrative tax changes for large firms. Figure 2 presents average marginal corporate income tax rates for each size classes of firms along with our narratively identified shocks. The resulting narrative measures and average marginal tax rates for large and small firms are depicted in Panel A and B, respectively. As shown in Panel A, we identified 9 exogenous changes in the U.S. corporation income tax rates matched with large firms and 6 exogenous shocks for small firms presented in Panel B. We use Mertens and Ravn (2013) identified average personal income tax rates only as a

[5]She shows that the narrative identification of shocks Granger-cause the VAR shocks, this implies the importance of anticipation effects.

[6]They show that the exogenous tax shocks identified by the two alternative methods are quite different, the correlation between them is 0.22.

[7]Information set of econometrician is smaller than that of the private agents in the presence of fiscal foresight, i.e., agents are aware of future and basing their choices on more information than the econometrician possesses. This fact generates an equilibrium with a non-fundamental moving average representation. Leeper, Walker, and Yang (2013) show that under fiscal foresight, standard VAR techniques cannot correctly estimate the fiscal policy shock.

[8]Other shocks include personal income bonus depreciation tax cuts in Romer and Romer. We also exclude all tax increases.

control variable in our empirical analysis.

[Figures 1, and 2 about here.]

2.3.3 Measure of Small and Large Firms and a Descriptive Analysis

In this subsection, we first introduce nominal asset as our indicator of the firm sizes. We next present some pictures of the raw time series around episodes of exogenous corporate income tax cuts.

Measurement of Small and Large Firms

Figure 3 shows the dynamic of total assets in each class size from 1956 onwards. Figure 4 depicts the same dynamic for inflation adjusted assets. As one can see from this figure, the total asset is decreasing in the smallest class. However, this trend is strictly increasing in the largest class, while there are some volatilities in intermediate-sized classes. This may be primarily due to the effect of inflation and growth dynamics. To adjust for this bias, we follow the procedure of GG to aggregate all size classes into small and large groups based on their assets. We sort the size classes and accumulate their assets beginning from the smallest class until we reach the thirtieth percentile of the total assets at each period.

[Figures 3, and 4 about here.]

More formally, let S_{it} denotes total assets of firms in category i, in period t. We define $\overline{S}_{it}$ as the accumulated assets for categories less or equal to category i, normalized by total assets in that period (N is the number of categories):

$$\overline{S}_{it} = \frac{\sum_{j=1}^{i} S_{jt}}{\sum_{j=1}^{N} S_{jt}}$$

Then we compute the threshold value i_t and weights ω_t and ω_{t-1} such that categories i_t and i_{t-1} average 30 percent of assets at time t:

$$i_t = \min_{i \leq N_t} \left\{ \overline{S}_{it} > 0.3 \right\}$$

$$\omega_t \overline{S}_{i_t-1,t} + (1 - \omega_t)\overline{S}_{i_t,t} = 0.3$$

Figure 5 depicts the cut-offs that straddle this thirtieth percentile over the period of analysis. When the cut-off falls inside the largest category, we simply set ω_t equal to one for calculating the growth rate of small firms.

[Figure 5 about here.]

Now we can define the growth rate of any variable of interest for both small and large groups as follows:

We define G as any variable of interest and g_t^S and g_t^L denote small and large firms.

$$g_t^S = \omega_{t-1}\frac{\sum_{j=1}^{i_{t-1}-1} G_{j,t}}{\sum_{j=1}^{i_{t-1}-1} G_{j,t-1}} + (1-\omega_{t-1})\frac{\sum_{j=1}^{i_{t-1}} G_{j,t}}{\sum_{j=1}^{i_{t-1}} G_{j,t-1}}$$

and

$$g_t^L = \omega_{t-1}\frac{\sum_{j=i_{t-1}}^{N_t} S_{j,t}}{\sum_{j=i_{t-1}}^{N_t} S_{j,t-1}} + (1-\omega_{t-1})\frac{\sum_{j=i_{t-1}+1}^{N_t} S_{j,t}}{\sum_{j=i_{t-1}+1}^{N_t} S_{j,t-1}}$$

Notice that the weight are the ones derived for period $t-1$. As discussed by GG, this procedure reasonably adjusts for biases arising from shifting firms across categories. The obtained growth rates of small and large firms are not seasonally adjusted. We perform this adjustment by using a moving average over four quarters and linearly detrended the series. Figure 6 displays the smoothed quarterly growth rates of investment, cash holding and total debt for small and large firms.

[Figure 6 about here.]

Descriptive Analysis of the Real and Financial Decisions of Firms

Following GG we next apply a simple statistical and graphical procedure for the descriptive analysis of the raw time series around episodes of exogenous corporate income tax cuts. Figure 7 shows a worm chart, which displays the smoothed linearly detrended growth rates of investment, cash holding and total debt for 8 quarters before and 16 quarters after the shocks. In fact, it plots the log deviations of small and large firm variables from their respective values at tax dates, relative to trend. The raw pictures indicate that, after corporate income tax cuts dates, investment raises but it is larger for large firms. Total debt also increases after dates and cash holding falls strongly for large firms than small firms.

[Figure 7 about here.]

In the next section, we supplement our descriptive analysis with a more formal evidence by using an econometric model.

2.4 Econometric Framework and Empirical Results

This section presents our econometric framework that is a linear local projection technique to estimate the effects of tax changes on firms' real and financial decisions, separately for each variables and across small and large firms. Estimated baseline results are discussed afterward.

2.4.1 Local Projection Technique

Following the methodology developed by Auerbach and Gorodnichenko (2013) and Ramey and Zubairy (2014), we use Jordà's (2005) local projection model to estimate impulse responses of the real and financial variables of firms of different sizes to exogenous tax changes. The Jordà model is based on sequential regressions that can be estimated by simple regression techniques for each horizon h and then constructing the impulse response function[9]. We apply this model for each interested variables separately and for small and large firms. The linear model looks as follows:

$$z_{t+h} = \alpha_h + A_h(L)X_{t-1} + B_h shock_t + \epsilon_{t+h} \quad for \;\; h = 0, 1, 2, ... \tag{2.1}$$

where z is the growth rates of variables of interest for small and large firms, i.e., $z_{t+h} \approx lnY_{t+h} - lnY_{t-1}$[10], *shock* is our exogenously identified unexpected corporate income tax cuts. We estimate the series of regressions using quarterly data, where X is the control variables and $A_h(L)$ is a polynomial of order 4. Indeed, the coefficient B_h gives the accumulated response of z at time $t + h$ to the shock at time t, for each variable of interest and each size classes of firms. In fact, each step in the accumulated IRFs is obtained from a single equation. The Newey-West corrected standard errors is employed to control the serial correlation in the error terms induced by the successive leading of the dependent variable.

Local projection technique compute impulse responses without specification and estimation of the underlying multivariate dynamic system. Thus, in contrast to the vector autoregression (VAR) model, where the impulse response coefficients are high-dimensional nonlinear functions of estimated parameters, local projection method directly estimates impulse response coefficients as a sequence of the B_h's estimated in a series of single regressions for each horizon. This means that the coefficients $A_h(L)$ only control dynamic effects of the baseline control variables and are not use directly to build IRFs[11]. Thereupon, Jordà model is less sensitive to misspecification of the SVAR models because it does not constrain the shape of the impulse response function. Thus, Jordà's method is a preferable alternative to VARs when calculating impulse responses is the object of interest.

Despite the above-mentioned advantages of Jordà's method, most of the estimated impulse responses using this method suffers from some weaknesses, such as erratic estimates because of the loss of efficiency and oscillations at longer horizons[12]. However, as also mentioned by Ramey and Zubairy (2014), for our analysis the short-run responses are concerned, and we are not interested in the long-run results. For this reason and also following Gertler and Gilchrist (1994), we estimate our impulse response functions over 16 horizons, i.e., $h = 0, 1, 2, ..., 16$.

[9] This technique has been used by Stock and Watson (2007) for forecasting the U.S. rate of price inflation.

[10] This definition of dependent variables allows us to compare the behavior of firms before and after shocks.

[11] Discussed in detail in the next subsection.

[12] See Ramey (2012b) for a detailed discussion, where she compares impulse responses estimated using Jordà's method with a standard VAR and a dynamic simulation.

2.4.2 Baseline Results

We begin by presenting the baseline results of our analysis using a minimalist specification of the local projection method and quarterly data over the sample from 1956 through 2006. Then, we perform extensive robustness checks with respect to the inclusion of a variety of control variables[13].

Following Romer and Romer (2010), we first present the baseline results by considering a minimalist specification of the model to estimate the effects of corporate income tax cuts on firms. The model can be written as follows[14]:

$$z_{t+h} = \alpha_h + B_h shock_t + \nu_{t+h} \quad for \;\; h = 0, 1, 2, ... \tag{2.2}$$

where z is the growth rates of investment, cash-holding and total debt of small and large firms. *shock* is an exogenous corporate income tax cut based on our identification strategy. Since our corporate income tax series are assumed to be truly exogenous, they are unlikely to be systematically correlated with other factors affecting output in the short or medium run, then there should be no need to control for other shocks[15]. However, many other factors besides tax changes affect real and financial decisions of firms. Cost of capital, cash flows, personal tax shocks and macroeconomic conditions, as well as dynamics of investment, cash-holding and total debt are all likely components of ν. In the next part and in order to rule out the possibility of such correlations, we experiment with an augmented model with a variety of control variables.

We now present the results of our baseline analysis using the equation 2. Figure 8 shows the estimated responses of variables of interest for both groups of firms. First row of Figure 8, shows the responses of investment to a corporate income tax cuts. As one would expect, corporate income tax cut raises investment of both small and large firms. The investment response is significant at every horizon and bigger for large firms. In particular, our estimates show that an exogenous cut of 1 percent of corporate income tax rate is associated with a 5 and 3.5 percent increase in investment of, respectively, large and small firms after three years. This implies that, the impact of an exogenous corporate income tax policy on investment are different across firms and it is 1.5 percent higher for large firms in three years. Also, total responses are quite similar to the responses of large firms. Thus, our estimates show that large businesses relatively contribute higher share of changes in aggregate business investment following corporate income tax shocks. The light and dark shaded areas represent, respectively, 90% and 68% confidence bands for the linear model and are based on Newey-West corrected standard errors.

Perhaps the most controversial result of this paper is the responses of cash holding to tax policy changes. Despite the fact that small firms hold relatively more cash (cash-to-asset) than large firms, and then one would expect that small firms use their cash when investment

[13]In Section 6 we test other robustness checks of the finding with respect to the measure of firm size, identification method, and to our econometric methodology.

[14]Our results are robust using a VAR model instead of a projection technique.

[15]Romer and Romer (2010) tax changes motivated by factors unrelated to the current or prospective state of the economy.

opportunities arrive, instead, our finding show that large firms rely more heavily on cash. Figures 9 and 8 present, respectively, the fact and our estimated responses of cash-holding to tax shocks. As shown in the second row of Figure 8, percent peak decline in cash holding are 37% and 6% for large and small firms, respectively. Also third row of Figure 8 shows that the responses of total debt across small and large firms that look similar to investment behavior.

[Figures 8 and 9 about here.]

Table 1 presents the credit portfolio composition before and after tax cut at 1979:1. Investment, debt and equity raises and cash falls after tax cut for both small and large firms.

We now verify the sensitivity of our benchmark results with respect to the numerous control variables. To this end, we estimate our model by augmenting many other factors that affect real and financial decisions of firms. We first control the macroeconomic conditions. Recent research in corporate finance has emphasized that the macroeconomic conditions has a profound impact on corporate financing decisions. Korajczyk and Levy (2003) argue that macroeconomic conditions are significant for capital structure choice for unconstrained firms, but less so for constrained firms. They also show that relatively unconstrained firms follow counter-cyclical leverage strategies, but financially constrained firms exhibit pro-cyclical leverage behavior. Hackbarth, Miao, and Morellec (2006) develop a framework for analyzing the impact of macroeconomic conditions on credit risk and dynamic capital structure choice of firms and find that macroeconomic conditions should have a large impact not only on credit risk but also on firms' financing decisions. In addition, Chari, Christiano, and Kehoe (2013), also investigate responses of small and large firms by using QFR data and conclude that real business cycle shocks have slightly different effects on firms of different sizes. Also, Kudlyak et. al. (2010) use the same dataset and find that large firms are relatively more sensitive in the recent financial downturn. Finally, Moscarini and Posetl-Vinay (2012) document a stronger counter-cyclicality of large rather than small employers to unemployment cycles. They present evidence of higher volatility of large firms in response to unemployment dynamics. In order to address this issue we augment our model with variables that allow us to control macroeconomic conditions. We estimate equation 2 along with the growth rates of GDP and separately with unemployment rate[16]. In a different exercise we estimate our baseline equation by including other omitted variables. In particular, we include four lags of the US bank prime loan-middle rate- and US BAA corporate bond yield as two measures of the cost of capital[17]. Finally we estimate a full specified model with respect to all mentioned control variables.

Figure 10 compares sensitivity of small and large firms to many different specification which controls for macroeconomic conditions, cost of capital, cash flow, and dynamics of the variables. Controlling macroeconomic conditions has a significant effect across firms. While the response of small firms to tax shocks are not very sensitive to the growth rates of GDP and unemployment rate, large firms strongly reacts to the macroeconomic conditions.

[16]Our results are robust to detrended log level of GDP instead of GDP growth.

[17]Cash flow is measured by: $CF_t = NIAT_t - [CA_t - CA_{t-1}] - [CH_t - CH_{t-1}] + [CL_t - CL_{t-1}]$, $NIAT$, CA, CH, and CL indicate, respectively, net income after tax, total current asset, cash-holding, and total current liabilities.

These findings are consistent with a large body of preexisting studies as discussed above. By augmenting the model with bank and bond rates, cash flow and leverage, along with corporate income tax shocks and macroeconomic conditions, we estimate a full specified model. Interestingly, we find that small firms strongly consider marginal incentives, such as cost of capital, cash flow and leverage rather than macroeconomic situations which again consistent with the empirical literature. However, for our analysis, responses to corporate tax cuts across firms are concerned, and we are not interested in the reactions of firms to macroeconomic conditions or other control variables. Figure 10 shows the responses of investment, cash-holding and debt policies to a corporate income tax cut across firms using a full specified model. Estimated responses are similar to our baseline results where large firms account for a major share of aggregate changes of investment following a corporate income tax cuts. This implies that our baseline results are robust to other specifications.

To summarize, we find that both small and large firms respond to exogenous corporate income tax cuts by boosting investment, but they use very different financial sources. While both firms increase their use of external financing, small firms rely much more heavily on debt. Cash reserves of large firms appear to be a strong substitute for debt in response to a corporate income tax cut. In the next section and in order to explain this difference among small and large firms, we provide a model of precautionary cash-holding where firms' access to credit markets is endogenous.

[**Figure 10 about here.**]

2.5 Theoretical Model

In this part, the main idea of the paper is presented with dynamic stochastic partial equilibrium model.

2.5.1 The Basic Model

The economic environment consists of firms maximizing the net present value of their dividend distribution over an infinite time horizon. In each period firms issue debt, invest, and decide how much cash to hold and how much dividend to distribute. There is a single multi-purpose good which is produced, used as capital and distributed as dividend. Cash is also held by investing in short-term securities. There exists a single multi-purpose good which is produced, used as capital and distributed as dividend. There is no uncertainty about firms productivity. Each firm uses the following technology to invest in which capital is fully depreciated:

$$f(z, k) = zk^{\alpha}$$

We assume that all firms share the same α. The return is taxed with rate τ.

Short-term debt: At each period, firms can issue short-term securities with face value b^s_{t+1} and price p^s_t (per unit of debt). Firms can also hold precautionary reserves by investing in short-term securities with the same price ($b^s_{t+1} < 0$ is interpreted as the accumulated cash).

The return of this cash is also taxed with rate τ since it is part of firms income. Hence the return of 1 unit of cash at t will be $\frac{(1-\tau)}{p_t^s}$ at $t+1$.

Long-term debt: Firms can also issue long-term debt. Here I follow the framework of Sun (2014) to define long-term debt. The outstanding long-term debt is denoted by b_t at the beginning of period t and the indebted firm must repay a fixed proportion δ of it. Hence, if the firm holds b_t at the beginning of period t and issues n_t during it, the dynamics of LT debt are:

$$b_{t+1} = (1-\delta)b_t + n_t$$

Financial friction: Firms face the following borrowing constraint:

$$p_t b_{t+1} + p_t^s b_{t+1}^s \leq \phi k_{t+1}$$

where $\phi = \underline{\phi}$ with probability q and $\phi = \overline{\phi}$ otherwise ($\underline{\phi} < \overline{\phi}$). This is the typical collateral constraint which implies that the total value of short-term and long-term debt should not exceed a fraction of invested capital. Parameter ϕ denotes credit market tightness which oscillates between $\underline{\phi}$ and $\overline{\phi}$. We assume that $\underline{\phi}$ to δ ratio is large enough such that:

$$p_t(1-\delta)b_t \leq \underline{\phi} k_{t+1}$$

and the firm is never obliged to repay more than δb_t which is the committed repayment.

Firms' optimization problem: Firms solve the following stochastic dynamic programming scheme:

$$\begin{aligned}
V(k_t, b_t, b_t^s, \Phi_t) &= \max_{d_t, n_t, k_{t+1}, b_{t+1}^s} d_t + \beta E_{\Phi_{t+1}} V(k_{t+1}, b_{t+1}, b_{t+1}^s, \Phi_{t+1}) \\
& \quad s.t. \\
d_t &\leq (1-\tau)\left[f(z, k_t) - \delta b_t - b_t^s\right] + p_t n_t + p_t^s b_{t+1}^s - k_{t+1} \\
b_{t+1} &= (1-\delta)b_t + n_t \\
p_t b_{t+1} + p_t^s b_{t+1}^s &\leq \Phi_t k_{t+1} \\
d_t &\geq 0
\end{aligned}$$

where d_t denotes the amount of dividend issued and k_{t+1} is the invested capital which yields next period. The only source of uncertainty is Φ_{t+1} which denotes the tightness of credit market in the following period. Without loosing the main intuition of the model, for the sake of simplicity we assume time invariant prices of both types of debt.

Lemma 1 *For small enough δ and τ, firms hold cash is some periods (b_{t+1}^s is negative).*

Proof. See Appendix ■

This lemma characterizes firms' cash policy. First of all, holding cash is costly as the return of short-term security is taxed. Hence, the cost of debt exceeds the return of cash.

Then, why do firms hold cash? In this model, cash helps firms to relax their credit constraint when credit market tightens. If the firm assigns a high probability to tight credit market in the following period, it can relax the next period credit constraint by issuing long-term debt. For each unit of debt the firm has to pay δ then. However, the firm can hold this amount in cash which yields $\frac{(1-\tau)}{\beta}$ in the following period. For small enough δ and τ, the firm can increase its available resources in the next period where the market is very likely to be tight.

Multiple credit markets: In this part we introduce accessibility to different credit markets. We assume that there is another credit market from which firms can borrow. Hence, there are two financial sectors in the economy - think about a representative bank and the bond market. The cost of issuing debt is equal in both sectors. However, access to bond market has a fixed cost which has to be paid in advance. More formally, to borrow from bond market at period $t+1$, the firm must pay $\overline{c}$ at t. Therefore, at each period some firms have access to both markets while the others' accessibility is restricted to the bank. Formally, this accessibility is denoted by dummy variable $x_{i,t}$, where $x_{i,t} = 1$ denotes access to both credit markets and $x_{i,t} = 0$ denotes restricted access to the bank and i is the firm's index. However, to keep the notation simple, we drop i in the rest of the paper. Firms are indifferent between two markets since they share the same price for debt. But what matters is the tightness of the markets and we assume that each market independently might be tight at each period. The collateral constraint is not relaxed by having access to both markets and the firms' total borrowing is still restricted by its collateral value. However, maximum capacity of debt is determined by the market which is less tight. If ϕ^b and ϕ^m respectively denote tightness of bank and the bond market, the credit constraint for a firm with access to both is:

$$p_t b_{t+1} + p_t^s b_{t+1}^s \leq \max\left\{\phi^b, \phi^m\right\} k_{t+1}$$

where $\phi^b, \phi^m \in \left\{\underline{\phi}, \overline{\phi}\right\}$ and the respective tightness probabilities q^b and q^m. In this setup, accessibility to bond market decreases the likelihood of being constraint. In the other words, the probability of facing $\phi = \underline{\phi}$ is $q^b q^m$ for the firms with access to both markets. Here, the trade-off is between paying the fixed cost of access to bond market and decreasing the likelihood of being constraint. Having x_t as a dummy variable for access to the bond market, the firms' optimization problem is as follows:

$$\begin{aligned}
V(k_t, b_t, b_t^s, \Phi_{x_t}) &= \max_{d_t, n_t, k_{t+1}, b_{t+1}^s, x_{t+1}} d_t + \beta E_{\Phi_{t+1}} V(k_{t+1}, b_{t+1}, b_{t+1}^s, \Phi_{x_{t+1}}) \\
& \quad s.t. \\
d_t + k_{t+1} &\leq f(z, k_t) + p_t n_t - \delta b_t + p_t^s b_{t+1}^s - b_t^s - \overline{c} x_{t+1} \\
b_{t+1} &= (1-\delta) b_t + n_t \\
p_t b_{t+1} + p_t^s b_{t+1}^s &\leq \Phi_{x_t} k_t \\
d_t &\geq 0, \ x_{t+1} \in \{0, 1\}
\end{aligned}$$

where:

$$\Phi_{x_t} = \max\left\{\phi^b, \phi^m\right\} x_t + \phi^b(1 - x_t)$$

and

$$E(\Phi_{x_{t+1}}) = x_{t+1}(q^m q^b \underline{\phi} + (1 - q^m q^b)\overline{\phi})k_{t+1} + (1 - x_{t+1})(q^b \underline{\phi} + (1 - q^b)\overline{\phi})k_{t+1}$$

which implies that firms with access to bond market are less likely to be constrained.

Claim 1. *There exists state dependent $\widehat{z}_t$ such that firms with $z_t \geq \widehat{z}_t$ pay the fixed cost of access to bond market (set $x_{t+1} = 1$) and the others do not.*

Proof. See Appendix. ■

The underlying intuition of this lemma is the opportunity cost of being constraint. The fixed cost of access to bond market is equal for all firms. However, the expected cost of being constraint is different for firms with different productivity. Hence, it is optimal for highly productive firms to pay the fixed cost and decrease the likelihood of being constraint. On the other hand, since this cost exceeds the expected benefits of this accessibility for lowly productive firms, they keep restricted to only one source of external financing.

It is also worthy to mention that more productive firms which invest more and accumulate more asset are typically larger. Hence, this result is fully consistent with the fact that large firms have a more diversified credit portfolio and rely more on direct financing than small firms which mainly use intermediary funds - see Figure 11.

Claim 2. *Within a proper range of state variables and parameters, an unexpected corporate income tax cut has a negative impact of firms' cash reserve. This effect is larger for large firms than small firms.*

Proof. See Appendix. ■

Corporate income tax cut has two opposite effects on firms' cash. The first effect is increasing the return of investment which causes firms to invest more. This investment is funded either by cash reserves or debt. The second effect is via precautionary motive. Since the cost of holding cash decreases by tax cut, cash holding motives are stimulated when marginal tax rate declines. However, this effect in not symmetric across firms. Small firms with limited access to credit markets have stronger precautionary motives and this impact is more influential for them. Large firms which are not very likely to be constrained, especially for small enough q^m, do not have such motives and do not increase their cash buffer. The final consequent of these two opposite forces determines the total impact on firms' cash holding. However, since the second channel is much weaker for large firms, on average, they are supposed to spend less cash after an unexpected tax cut for proper range of parameters.

This is the main theoretical result which explains the basic empirical findings in the previous section. In the next section, we present a series of checks that address the main concerns about the robustness of our empirical findings.

[Figure 11 about here.]

2.6 Robustness Checks and Extensions

In this section we conduct various robustness checks with respect to the inclusion of personal income tax shocks, to a different measures of firm size, and to our econometric methodology. We also extend our empirical results by examining how corporate income tax changes affect other real and financial variables of firms.

2.6.1 Identifying Personal Tax Shocks

Personal income tax policy is perhaps the most important omitted variable to consider. Ideally, we would like to estimate the effects of corporate income tax changes across firms, but there are a potential contemporaneous changes in corporate and personal tax rates. In our sample, the correlation between the personal income and corporate income narrative tax changes are 0.64 and 0.33 for small and large firms, respectively[18]. Accompanying effects of personal income taxation on firms has been widely discussed in the area of tax literature when estimating the effects of corporate income taxation is concerned. Many studies in this line of the research have addressed the effect of personal taxation on corporate bond spread. As Elton et. al. (2001) argue, personal income taxation has a significant effect on the spread between rates on corporate and government bonds. They suggest that state tax on corporations accounts for a substantial portion of the premium in corporate rates over treasuries. This premium exists since interest income from corporate bonds is taxed whereas the interest income from treasury and municipal bonds are not. This tax exemption motivates investors to demand a higher spread on corporate bonds which amplify the degree of firms' credit constraint. According to this story, any increase in income taxation put a higher pressure on the firms which rely more of public debt market. However, this also depends on the structure of the personal income tax. Higher personal income taxes on interest (relative to personal income tax) have a negative relation with the corporate use of debt. Since these are typically large firms, we expect large firms to be affected more through this channel.

We introduce two solutions to deal with this possible measurement errors. We first include the narratively identified personal tax shocks along with our exogenous corporate income tax shocks in equation 1. We then use an alternative solution to exploit information contained in personal tax shocks. We propose four lags of the average personal income tax rate[19] instead of the narratively identified personal tax shocks in equation 1. A comparison of these two identification strategies has shown in Figure 12. As this figure makes clear, different identification of the model with respect to two different tax policies do not affect our baseline results across firms. In fact, including personal income tax shocks in the model lowers the estimated investment response of both small and large firms but does not change the difference in the responses of firms. This indicates that potential measurement error due to correlation between two tax polices is not a serious concern in our analysis.

[18]See Mertens and Ravn (2013) for a detailed discussion, where they show the importance of distinguishing between personal and corporate income tax policies when estimating their effects on the aggregate macroeconomic variables.

[19]We use Mertens and Ravn (2013) constructed proxies for the average personal income tax rate and narratively identified personal tax shocks.

[Figure 12 about here.]

2.6.2 Different Thresholds of Cut-offs

Our analysis so far was based on the thirtieth percentile of the total assets as a measure of firm size at each period. Thus, it is important to consider different thresholds of cut-offs. We consider twentieth and fortieth percentiles of the total assets to consider, respectively, lower and higher share of total asset for small firms at each period. Figure 13 plots the estimated responses of investment, cash-holding and debt to a one percent cut in the marginal tax rate along with three different thresholds. It shows that our findings are robust to different definition of small and large firms.

[Figure 13 about here.]

2.6.3 Extensions: Various Real and Financial Policies

Finally in this part, we extend our results by examining the effects of tax changes on firms' various real and financial policies. Based on our baseline estimation we find that the effect of exogenous corporate income tax cut on investment, cash-holding and debt are different depending on firm size. We now estimate the responses of other variables to understand the workings of exogenous corporate income tax shocks and shed light on other aspects of the firms. To that end, we examine the responses of net sales and inventories from the real policies, as well as dividend and stockholders' equity for the financial side. Ideally, one would like to examine the effects of changes in short-term debt which contains valuable information about, specially, small firms external debt policies, but there are practical limits to the firms' short term loan in data availability.

Figure 14 plots the estimated net sales, inventories, dividend and stockholders' equity responses to a corporate income tax cut. The results for both real decisions look quite similar to the investment policy that large firms respond more than small firms. Perhaps somewhat surprising is that, while both firms pay more dividend for the first year, large firms decrease paying dividend after first year but small firms keep paying higher dividend. Stockholders' equity response look similar to debt and investment policies of firms.

[Figure 14 about here.]

2.7 Conclusion

This paper contributes to this literature by exploring the impact of corporate income tax cuts on firms in different size classes. Our estimates show that large firms account for a major share of aggregate changes of investment and sales following a corporate income tax cut. Results are shown to be robust to many alternative specifications. We find that all firms respond to corporate income tax cuts by increasing their investment, sales and inventories. In all three variables, the response of large firms are larger. However, the differential response is mainly significant for investment and inventory, but less for sales. In addition, we find that while both firms increase their use of external financing, small firms rely much more heavily on debt to finance investment. Cash reserves of large firms appear to be a strong substitute for debt in response to a corporate income tax cut. To explain this difference, we posit a model of precautionary cash-holding where firms' access to credit markets is endogenous. Based on this model, we argue how large firms optimize their capital structure towards a more diversified credit portfolio. Diversification of portfolio lowers the precautionary concerns and allows them to use cash reserves when investment opportunities arrive. On the contrary, small firms with limited access to financial markets have strong precautionary motives and hence rely on debt in such expansionary episodes. Since the cost of holding cash decreases by tax cut, cash holding motives are stimulated when marginal tax rate declines. However, since small firms with limited access to credit markets have stronger precautionary motives, this impact is more influential for them and hence they burn less cash in such occurrences.

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2.8 Appendix A: Proofs

Proof of Lemma 1. I use an auxiliary constraint which bounds the amount of cash holding. This can be implemented by putting a negative lower bound for short-term debt:

$$\underline{S} \leq p_t^s b_{t+1}^s$$

The Lagrangian formulation of the optimization problem is as follows:

$$\begin{aligned}
L \quad = \quad & d_t + \beta E_{\Phi_{t+1}} V(k_{t+1}, b_{t+1}, b_{t+1}^s, \Phi_{t+1}) \\
& -\lambda_t \left(d_t - (1-\tau)\left[f(z,k_t) - \delta b_t - b_t^s\right] - p_t n_t - p_t^s b_{t+1}^s + k_{t+1} \right) \\
& +\gamma_t (b_{t+1} - (1-\delta) b_t - n_t) \\
& -\theta_t (p_t b_{t+1} + p_t^s b_{t+1}^s - \Phi_t k_{t+1}) \\
& +\mu_t d_t \\
& +\rho_t (p_t^s b_{t+1}^s - \underline{S})
\end{aligned}$$

First order conditions for long-term and short-term debt imply:

$$\begin{aligned}
\lambda_t \quad &= \quad \left(\frac{p_{t+1}}{p_t} \beta (1-\delta) + \frac{\beta \delta}{p_t} \right) E_{\Phi_{t+1}}(\lambda_{t+1}) + \theta_t \\
\lambda_t \quad &= \quad \left(\frac{\beta}{p_t^s} \right) E_{\Phi_{t+1}}(\lambda_{t+1}) + \theta_t - \rho_t
\end{aligned}$$

However, as we assumed time invariant debt prices, we can simplify the above equalities as follows:

$$\begin{aligned}
\lambda_t \quad &= \quad \left(\beta (1-\delta) + \frac{\beta \delta}{p} \right) E_{\Phi_{t+1}}(\lambda_{t+1}) + \theta_t \\
\lambda_t \quad &= \quad \left(\frac{\beta}{p^s} \right) E_{\Phi_{t+1}}(\lambda_{t+1}) + \theta_t - \rho_t
\end{aligned}$$

where p and p_s are the prices of long-term and short-term debts respectively. In this structure, if δ and τ are small enough such that:

$$\delta < \frac{p(1-\tau-p^s)}{p^s(1-\tau-p)}$$

then multiplier ρ_t is positive which implies positive cash reserves.

Proof of Claim 1. A sketch of the proof is as follows. For any state, more productivity implies more invest. Moreover, optimal cash holding is increasing in investment. The tax-related cost of holding cash is τb_{t+1}^s which is larger for firms with higher productivity. However the probability of facing tight credit market depends on the accessibility to financial markets. This probability is either q^b or $q^b q^m$. In case q^m is small enough, firms can decrease the cost of cash holding by paying the fixed cost of access to credit market. Keeping the expected cost being constrained fixed, let's assume that tax-related cost of holding cash decreases proportionally, $\tau(\varepsilon b^s_{t+1})$, by getting access to bond market. When θ is large enough such that:

$$\tau\varepsilon b^s_{t+1} \geq \overline{c}$$

it is optimal for the firm to pay the fixed cost of access to both market. Trivially, for the firms with low enough productivity, it is optimal to hold more cash instead. For the uniqueness of the threshold $\widehat{z}_t$ we could provide this simple argument.

Assume $\theta \to \infty$. Hence the optimal investment is very large and the shortage of credit has a large cost which always exceeds $\overline{c}$. Of course this hold for any firms with larger θ as well.

On the other hand, for $\theta \to 1$, for proper ranges of $\overline{c}$ it is never optimal to pay this fixed cost. It is so for any firms with smaller productivity. Hence there is a threshold that firms with higher productivity pays the cost and the others do not.

Proof of Claim 2. A sketch of the proof is as follows. There are two channels. First, decreasing tax implies higher marginal return of investment and hence investment increases after an unexpected corporate income tax rate. Apart from cash flow, this amount is financed either via cash reserves or debt. Second, The cost of cash holding, τb^s_{t+1}, decreases by tax cut. Hence, optimal cash holding of firms increases after any tax decline. The total impact of tax cut is the consequence of these two effects. However, both channels implies higher long-term debt issuance.

Let's focus on the simple case in which the budget constraint is not binding for the pre-tax levels of debt but is constrained after the tax cut. Hence both firms with and without access to bond market issue debt.

For small enough q^m,large firms with the access to bond market, do not have strong precautionary motives and burn their cash when they get constrained. Therefore, they rely both on cash and external financing.

However, small firms with strong precautionary motives have incentive to increase their cash. On the other hand, they have also incentives to use their cash to invest as wealth. Hence, they are supposed to decrease cash reserves less than large firms with very weak cash holding motives because of high accessibility to credit markets. However, both of firms increase their leverage.

2.9 Appendix B: Tables and Figures

Figure 2.1: Federal Corporate Income Tax Rates and Narrative Measure for Large Firms

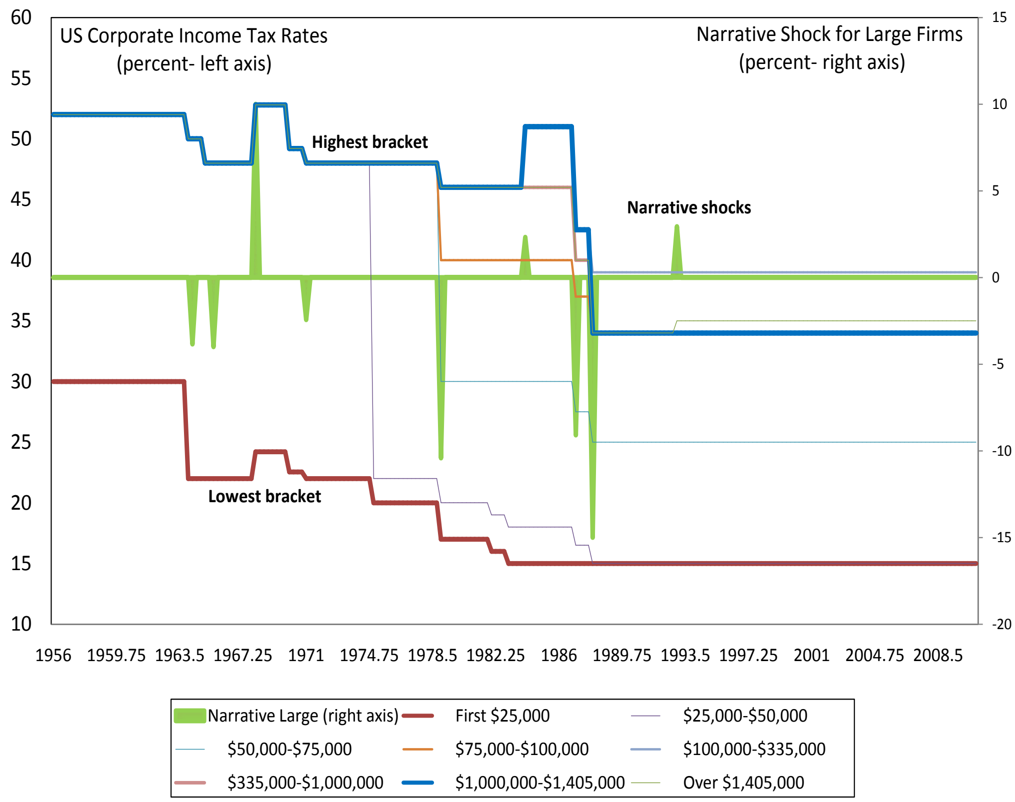
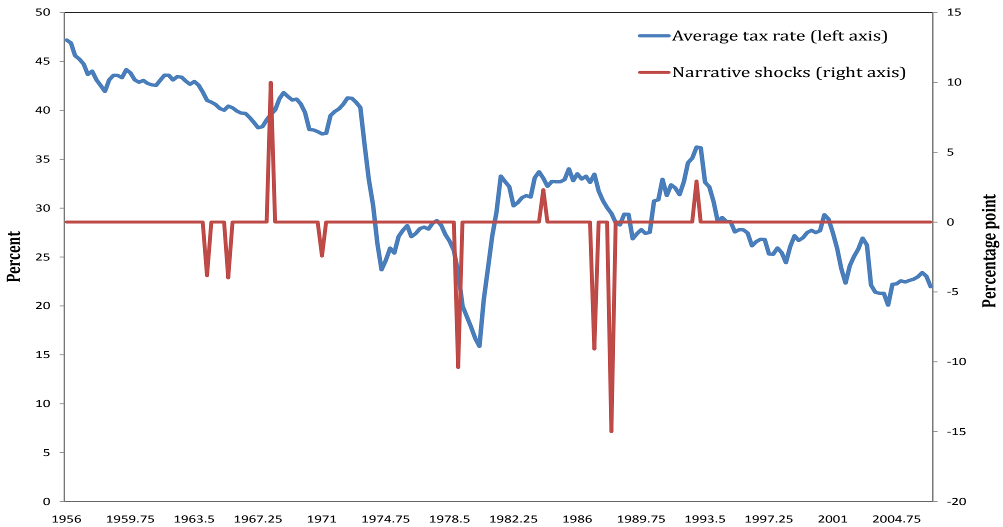


Figure 2.2: Average Tax Rates and Narrative Shock Measures, US 1956:I–2006:IV

A. Large Firms



B. Small Firms

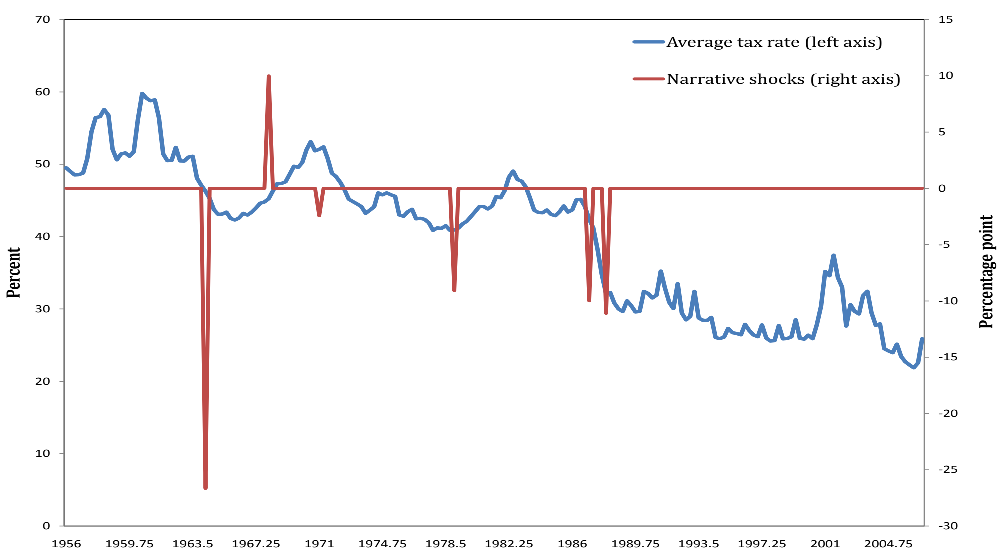
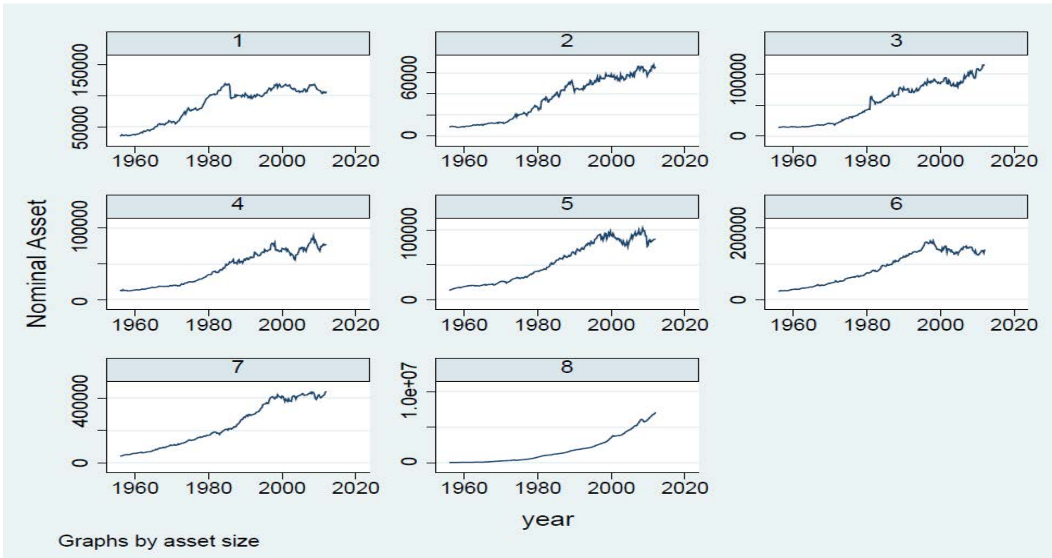
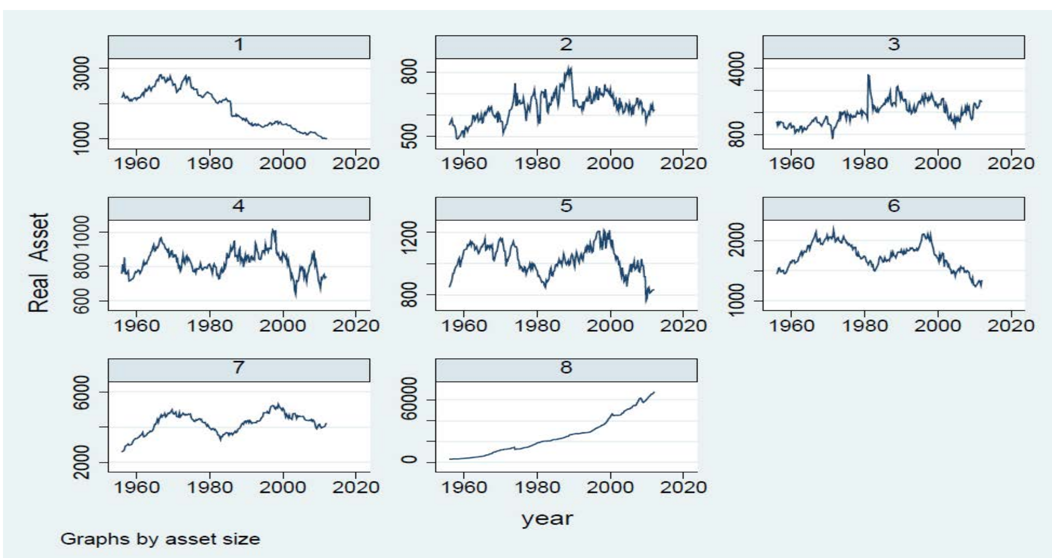


Figure 2.3: Nominal Asset in each Size Group



Source: QFR and authors' calculation.

Figure 2.4: Real Asset in each Size Group



Source: QFR and authors' calculation.

Figure 2.5: Percent of Manufacturing Sales by Cumulative Asset Size

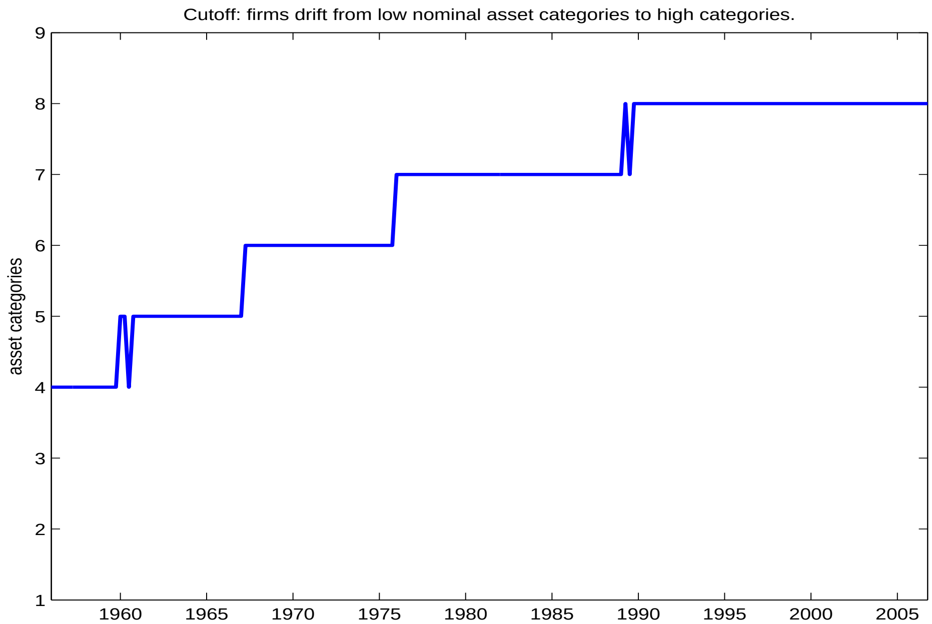
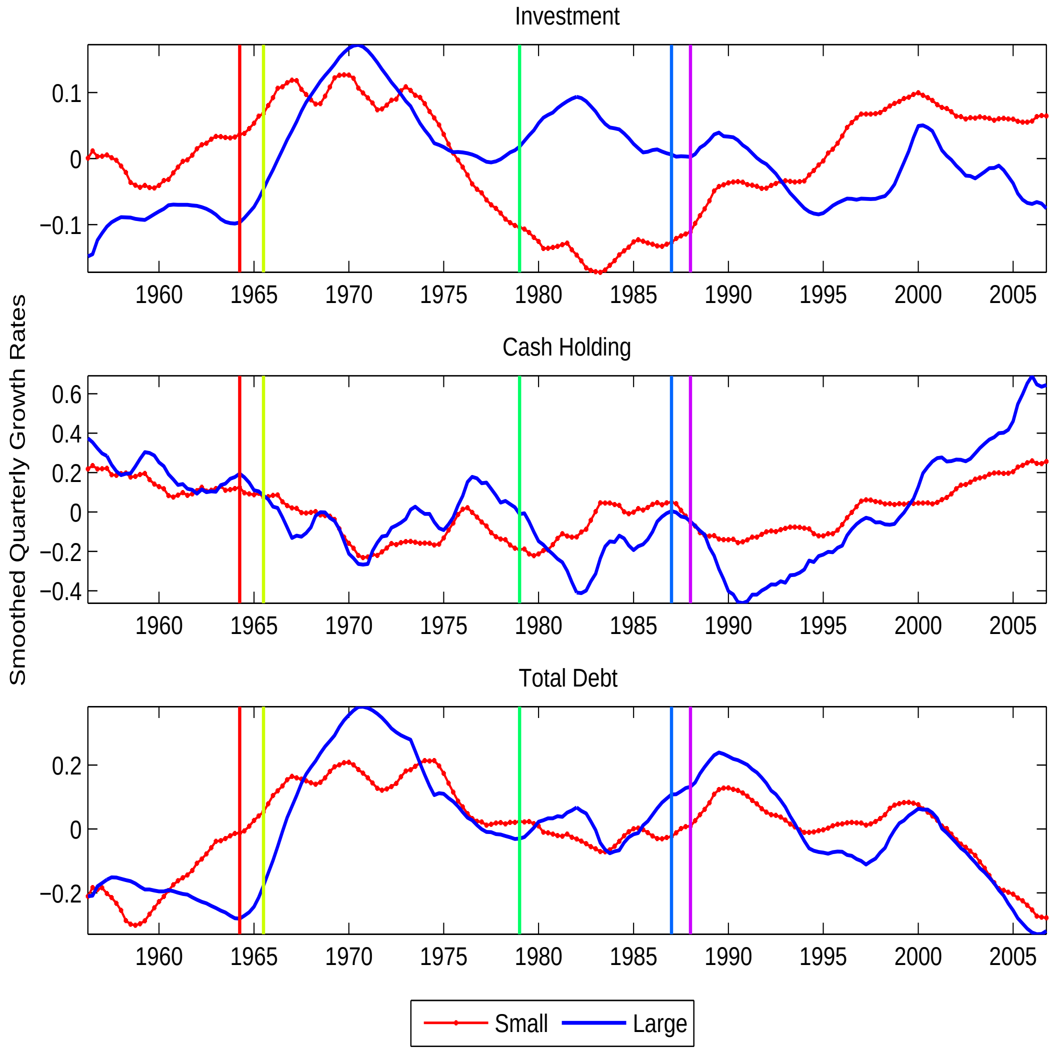
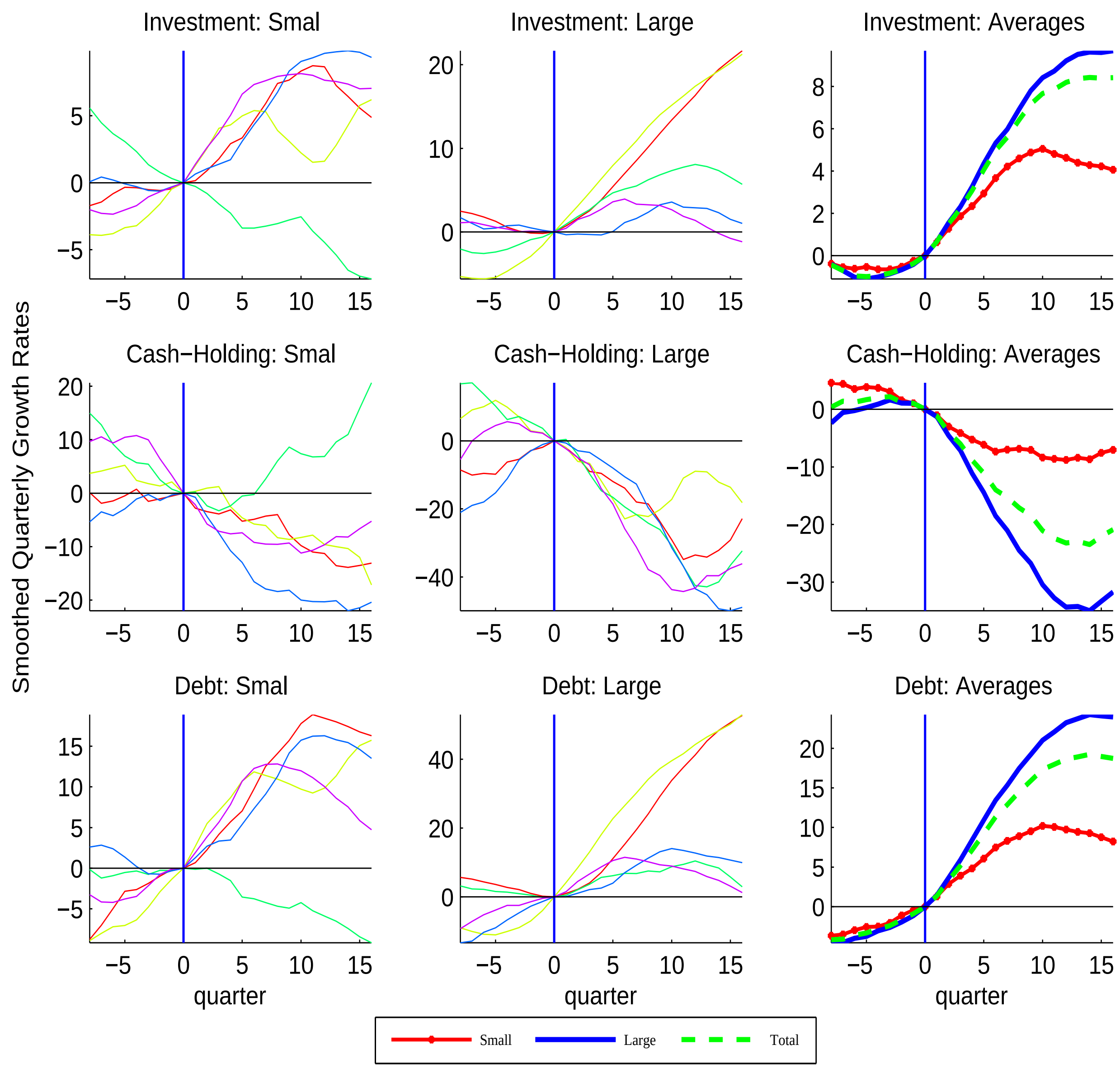


Figure 2.6: Cumulative Data, Smoothed and Linearly Detrended, and Tax Policy Dates



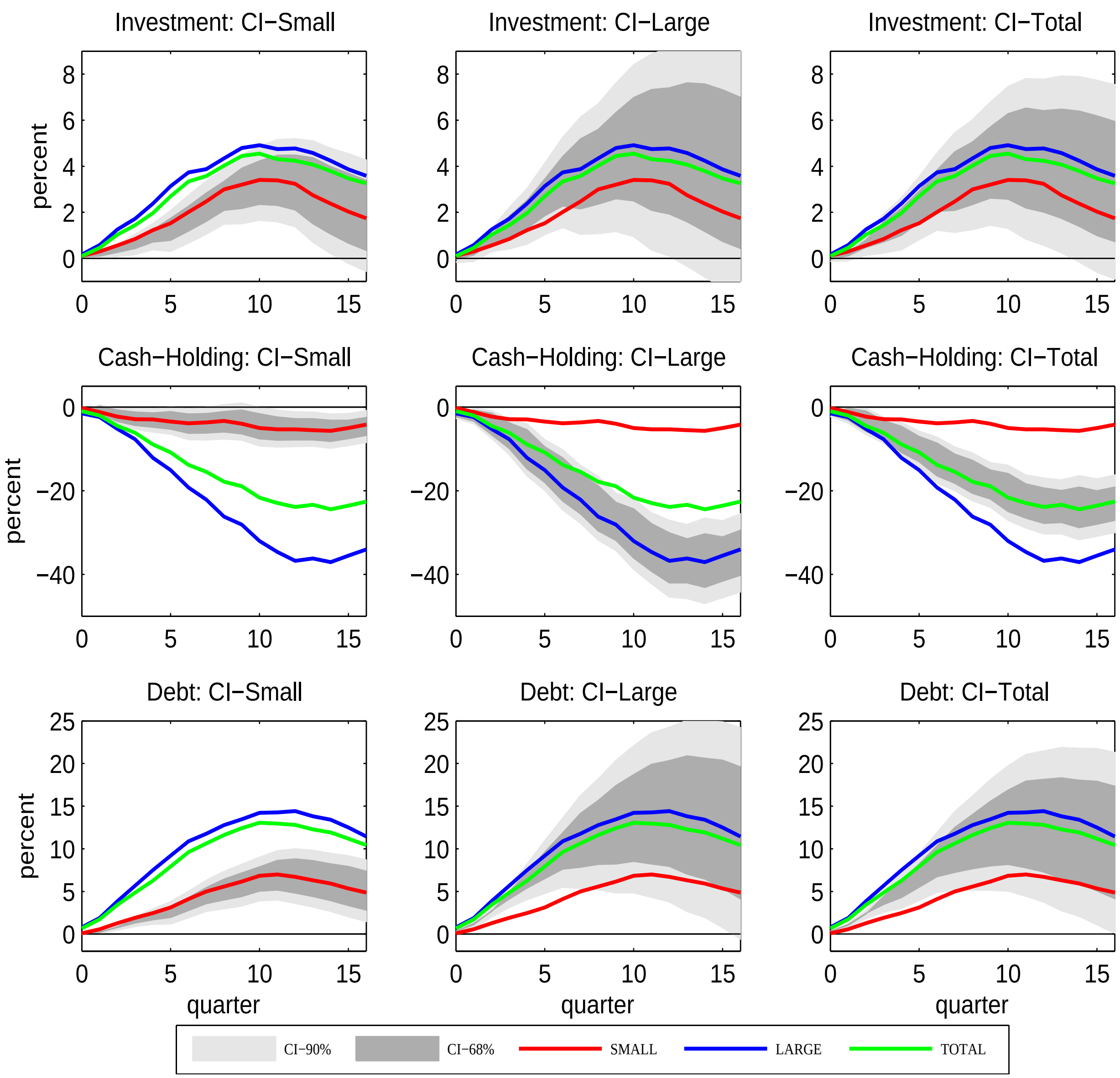
Notes: Red and blue lines show, respectively, quarterly smoothed growth rates of small and large firms. Vertical lines present dates of exogenous tax cuts.

Figure 2.7: Analysis in the Neighborhood of Exogenous Tax Policy Dates



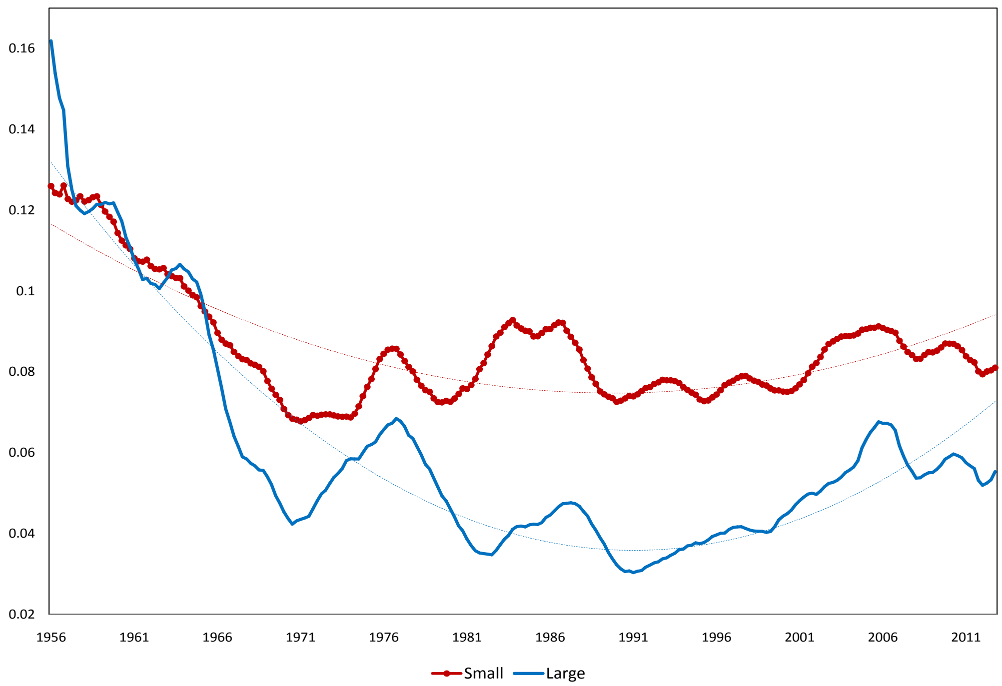
Notes: Red lines with stars, blue dashed lines and black dotted lines present changes in variables around tax dates, respectively, for small, large and total firms.

Figure 2.8: The Impact of an Exogenous Corporate Income Tax Cut on Investment, Cash-Holding and Total Debt across Small and Large Firms: Baseline Results



Notes: Red lines indicate responses of small firms, blue lines indicate responses of large firms and green lines show responses of total. First row shows the IRFs of investment and second row shows for total debt. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 2.9: Cash to Asset Ratio of Small and Large Manufacturing Firms



Source: QFR and authors' calculation.

Table 2.1: Credit Portfolio Composition: Tax Shock 1979:1

Small Firms	Cash	Investment	Debt	Equity
Before shock (mm)	665	3238	2153	4117
Average of 8 quarters after shock (mm)	640	3462	2323	4260
Changes (mm)	-25	224	170	143
Share of Investment Changes (%)	11	-	76	64
Large Firms				
Before shock (mm)	1166	11711	3759	10426
Average of 8 quarters after shock (mm)	967	12468	4065	10607
Changes (mm)	-198	758	306	181
Share of Investment Changes (%)	26	-	40	24

Figure 2.10: Sensitivity of the Baseline Results to the Control Variables

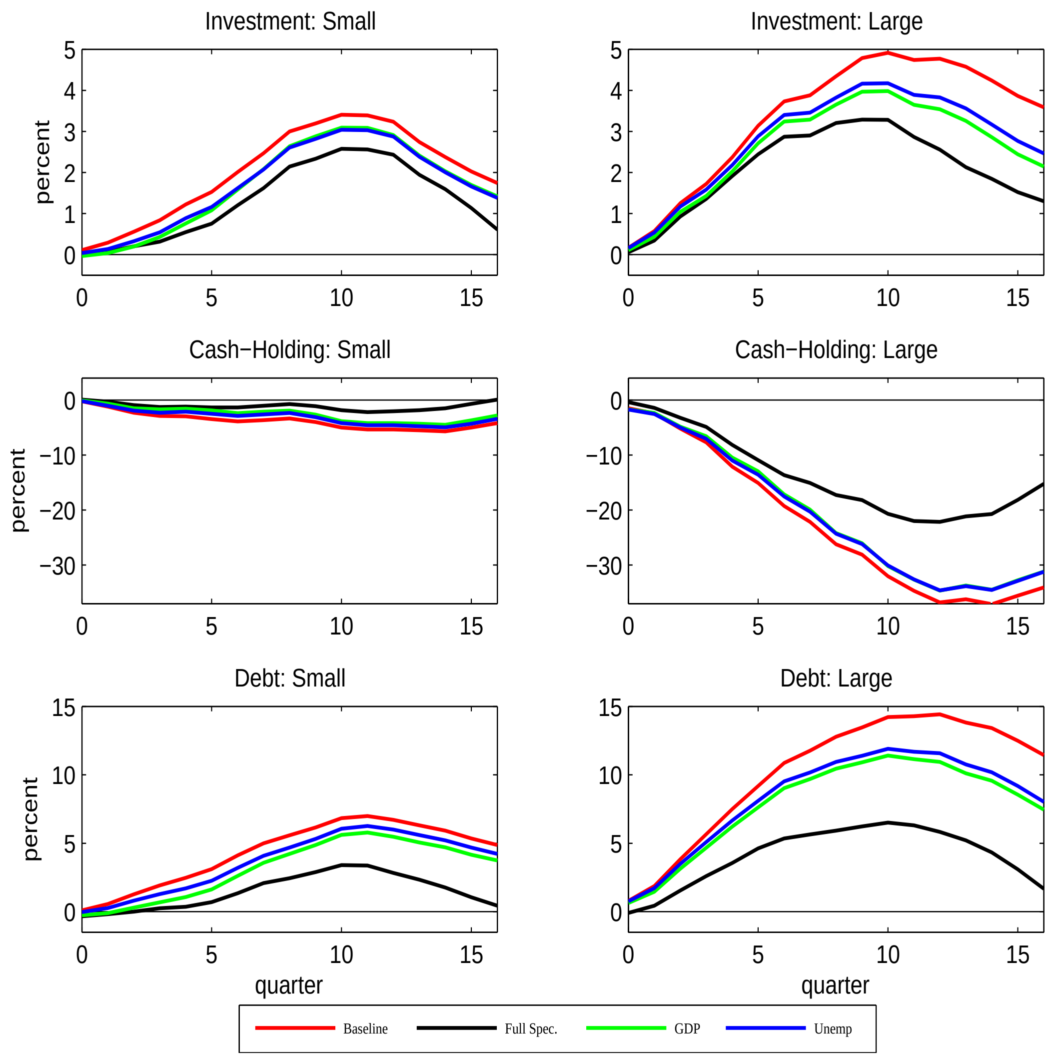
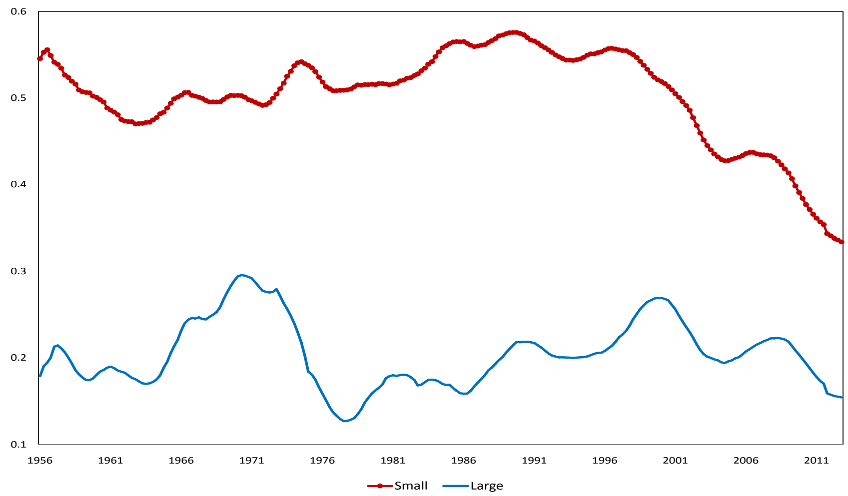


Figure 2.11: Reliance on Bank Loan of Small and Large Manufacturing Firms



Source: QFR and authors' calculation.

Figure 2.12: Sensitivity of the Baseline Results to the Personal Income Tax Shocks

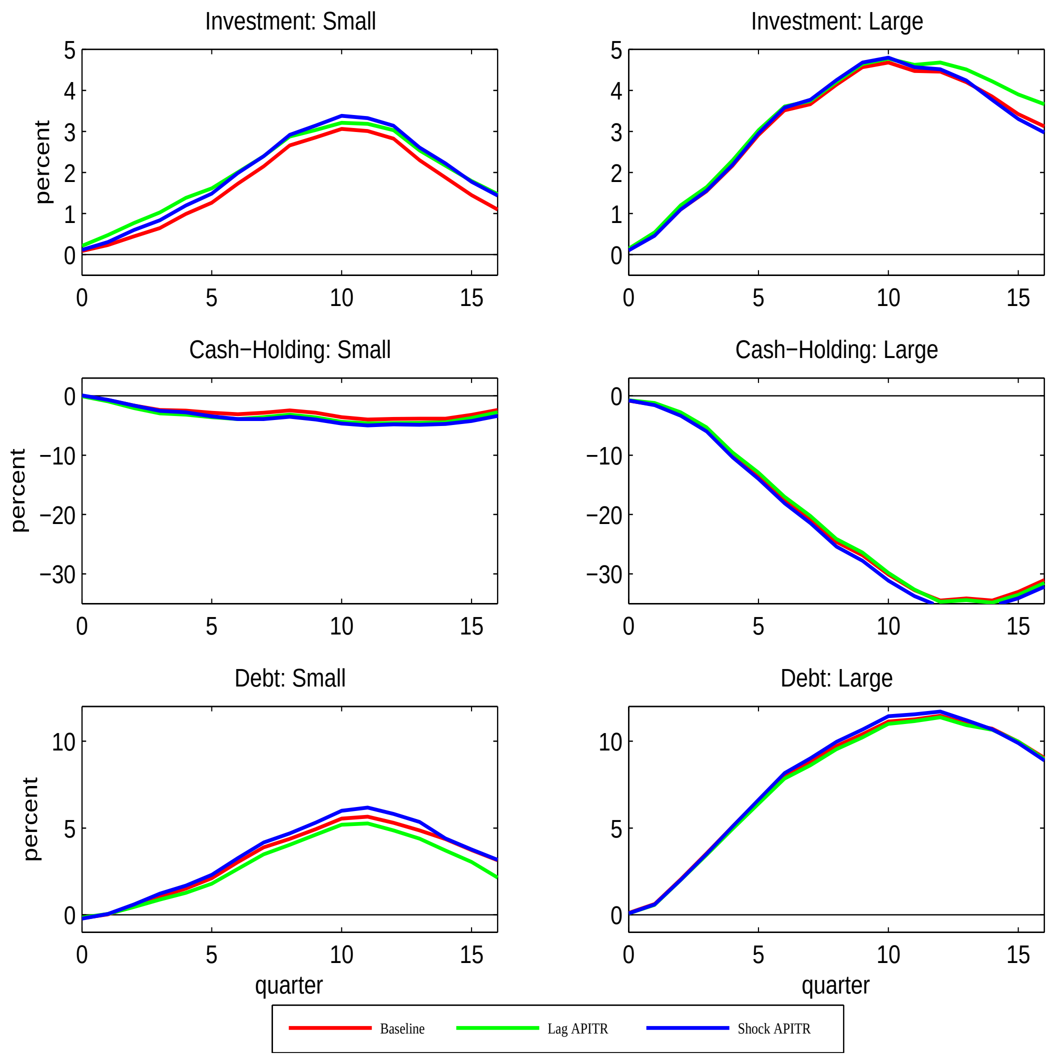


Figure 2.13: Sensitivity of the Baseline Results to the Different Thresholds of Cut-offs

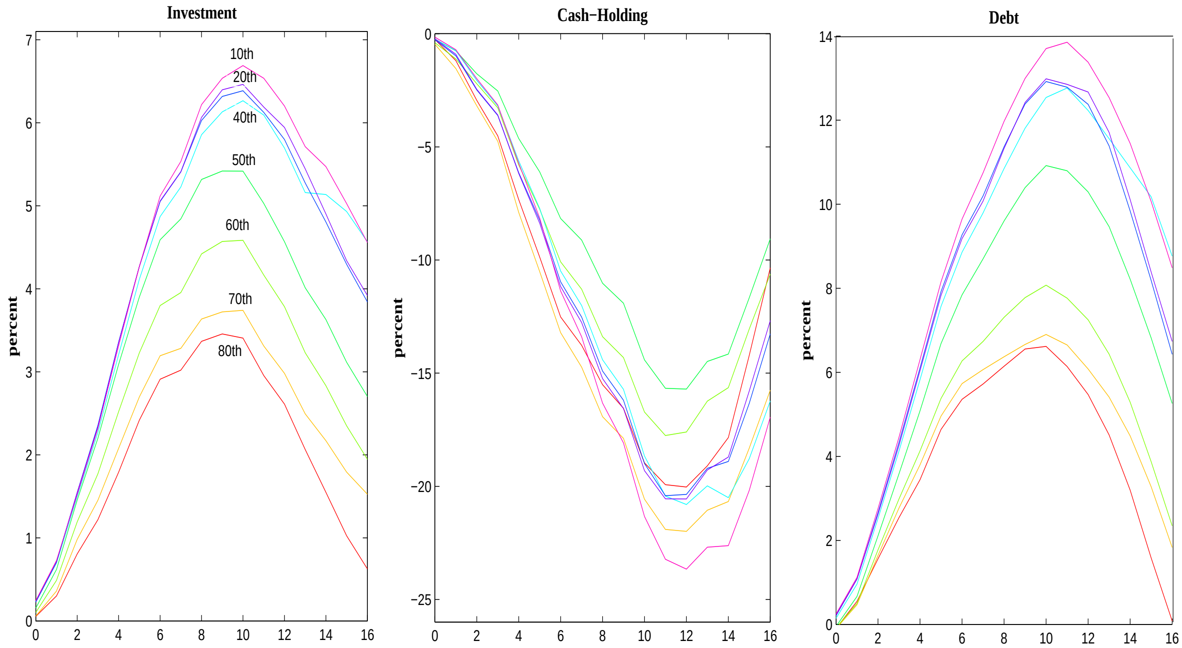
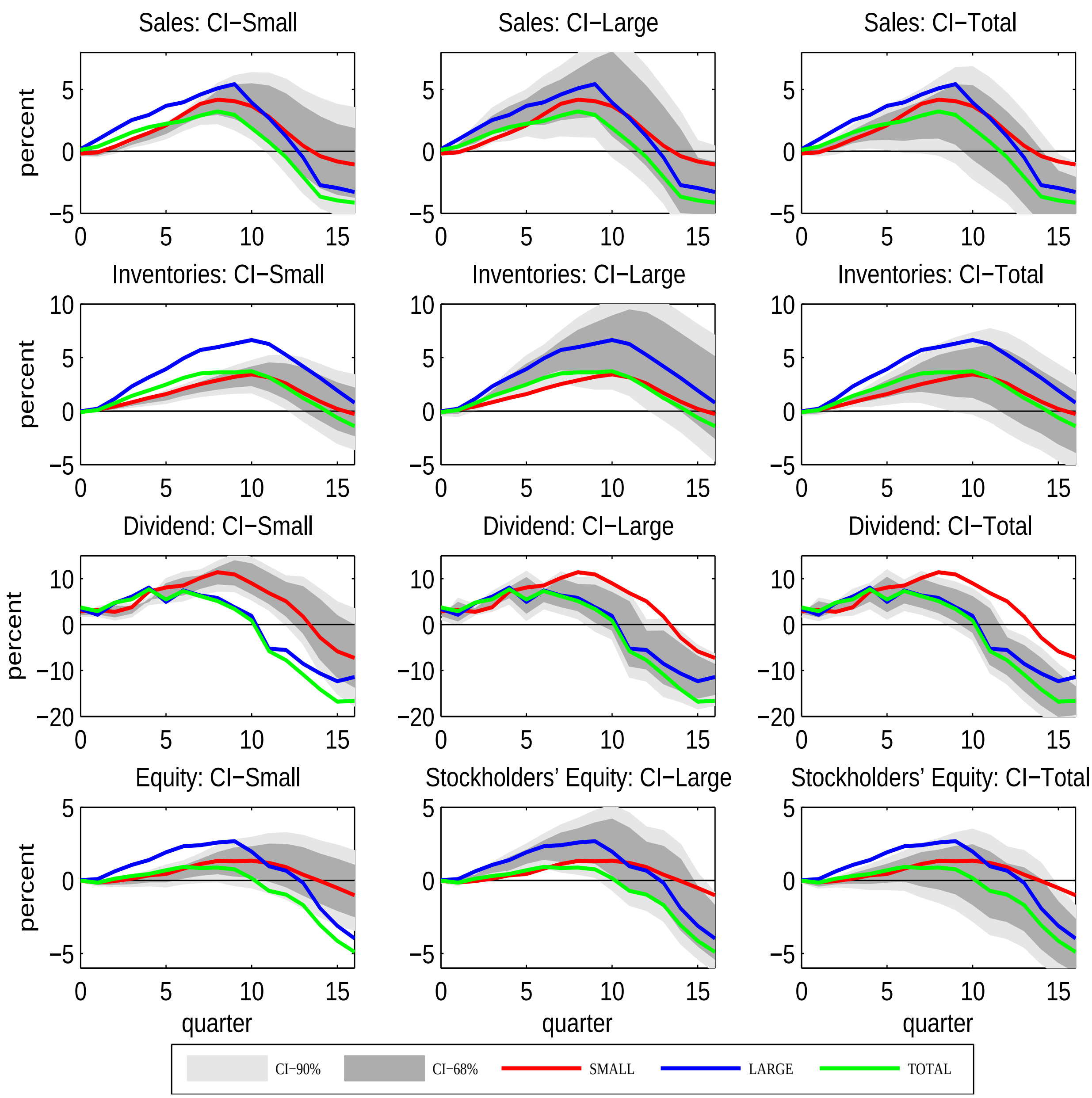


Figure 2.14: Extension: The Impact of an Exogenous Corporate Income Tax Cut on Sales, Inventories, Dividend and Stockholders' Equity across Small and Large Firms



Notes: Red lines indicate responses of small firms, blue lines indicate responses of large firms and green lines show responses of total. First row shows the IRFs of investment and second row shows for total debt. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Chapter 3

Dynamics of Cash Holding: Evidence from U.S. Manufacturing Firms 1956-2014

This chapter explores the long-run dynamics of corporate cash holding using a novel dataset of U.S. manufacturing firms. The results mirror previous empirical findings of increasing cash-to-asset ratio from the 1980s onwards. However, looking at a longer horizon we show that the trend of the cash ratio has been roughly U-shaped since 1955. To explain this fact, we review alternative theories of cash holding dynamics and show that cash flow volatility theory is the unique theory which can explain evolution of the cash ratio over the past six decades. In addition, using this dataset we show that the aggregate dynamics of cash holding is not driven by a particular size class of firms.

3.1 Introduction

Recent empirical studies show that U.S. firms have evolved since 1980 have doubled their cash-to-asset ratio over the last three decades. These studies have explained this increasing pattern by investigating changes in different determinants of cash holdings. Sánchez and Yurdagul (2013) point out two main reasons for this long-run pattern; strengthening precautionary motives and tax motives. They suggest that the main trends regarding precautionary motives are "increasing cash flow volatility" and "shortening debt maturity". Referring to a recent upward trend of cash flow volatility as a source of idiosyncratic risk, Bates, Kahle, and Stulz (2009) (henceforth BKS) show that the cash ratio increases as a firm's cash flow becomes riskier, and that firms in industries with the highest increases in idiosyncratic volatility account for the majority of increases in the ratio. Harford, Klasa, and Maxwell (2014) (henceforth HKM) highlight the impact of refinancing risk on corporate cash holdings, arguing that firms mitigate refinancing risk by increasing their cash savings. Moreover, shortening the maturity of firms' long-term debt over time implies more frequent refinancing which causes more risk. Consequently, firms increase their cash holdings to mitigate refinancing risk. A different strand of the literature emphasizes the role of tax motives, that firm holding cash in their subsidiaries abroad to prevent domestic taxation on their profits. Foley et al. (2007) discuss that one reason for the recent cash build up in U.S. firms is increasing taxation of foreign income. This argument is supported by the fact that multinational firms had experienced a higher cash accumulation than domestic firms. However, Pinkowitz et al. (2012) criticize this view by arguing that there is no significant difference between the cash holdings of U.S. and foreign multinationals during the pre-crisis episode.

The key contribution of this paper is employing and analyzing a novel dataset which spans historical periods that involve potentially informative movements of corporate cash holding. This helps us to test whether the existing theories are still relevant over this longer horizon where the cash ratio experiences a non-linear pattern. Furthermore, as our dataset includes small and private firms, we can study the cash holding of small and large firms separately, allowing us to check whether the aggregate trends are driven by a particular size category. This is an important aspect of our analysis since, to the best of our knowledge, all previous studies rely on datasets which are restricted to public firms – e.g. *Compustat*. Although some of these studies control for size, since small firms are mostly private they are excluded in such analysis and, thus, the results are biased towards large- and medium-sized firms.

3.2 Data and Stylized Facts (U-shaped Pattern)

In this section we analyze the dynamics of cash holdings using new historical data[1], utilizing the U.S. Census Bureau, Quarterly Financial Report (QFR), which is an inclusive dataset of U.S. manufacturing firms from 1956 through 2014. The QFR reports balance sheet and income sheet variables of manufacturing corporations of all sizes in 8 asset size brackets. We then follow Gertler and Gilchrist's (1994) procedure to define small and large firms and distinguish their different patterns of cash holding. This allows us to check whether the aggregate trend is driven by any extreme group of firms. Figure 1 shows the cash-to-asset ratio of small, large and all firms based on QFR data from 1956 onwards. Perhaps somewhat surprisingly, this ratio's long-run trend has roughly a U-shaped pattern, with its dynamics being divided into four clear periods[2].

At the beginning of the sample period of between 1956 and 1971, the ratios are strongly decreasing, and on average it falls by 8.4 percentage points (13.3% in 1956q3, down to 4.87% by 1971q1). Then, it stops and the trend is quite volatile and stationary until the end of 1990 (second period), with an average ratio of all firms being 5.7%. In the third period of between 1991 and 2006, consistent with the existing empirical literature it increases by 3.79 percentage points, to a peak of 8% in 2006q2. Finally, the trend actually reverses after the financial crisis and continues so until the most recent data. Note that in all episodes, small firms hold proportionally more cash than large firms which could be explained by their stronger precautionary motives.

[Figure 1 about here.]

[1]We calculate the cash-to-asset ratio for a sample of U.S. firms from Compustat from 1980 onwards which completely mirror the upward trend documented in the literature (Appendix - Figures A1-A2).

[2]Using the Bai-Perron structural break test yields results that seem to be broadly consistent with our four sample periods (Appendix - Figure A3).

3.3 Empirical Analysis

We now investigate which theories can explain the U-shaped pattern of cash ratio found in the previous section. Figure 2 shows cash flow volatility along with the cash-to-asset ratio for all U.S. manufacturing firms, the key fact being that they both have a U-shaped pattern and move together. The correlation between them is 0.60 for the full historical sample, and 0.88 between 1991 and 2006. This would imply that cash flow volatility is a key determinant of cash holding dynamics not only over the period studied in BKS (1980 to 2006), but also over a longer horizon from the 1950s up to now[3]. One interesting implication of this figure concerns the post-crisis decline which is not well documented in the literature; cash flow volatility might explain the slight falling pattern of the cash ratio after the Great Recession.

[Figure 2 about here.]

We then look at the debt maturity dynamics. Figure 3 shows the estimated portion of long-term debt[4] which matures in one, two and three years in our sample. As we only have the data of the amount of LTD that is due in one year (called installment), we estimate the portion of LTD which is due in two years by dividing the sum of this year and next year installments over the total outstanding LTD of this year, and the same for LTD due in three years – all measured at the first quarter of the year[5]. All portions have an increasing pattern which implies that LTD maturity has been shortening steadily over the last 60 years for both groups of firms. Therefore, this linear trend is inconsistent with the theory that the U-shaped pattern in cash holding over time can be systematically explained by shortening the maturity of LTD[6].

[Figure 3 about here.]

We now supplement our descriptive analysis with a more formal evidence by using an econometric model. A linear regression model is applied to evaluate the effect of cash flow volatility and debt maturities on the cash ratio. We first follow BKS and regress the logarithm of the cash-to-asset ratio on the logarithms of cash flow volatility (CFV), leverage, cash flow to asset ratio (CF/asset), and also net working capital to asset ratio (NWC/asset). Table 1 presents the estimated results for the full sample and also three sub-sample periods. As one would expect, cash flow volatility has a significantly positive effect on the cash-to-asset ratio for the full and three sub-samples. The sign of the coefficients on NWC/asset, leverage, and CF/asset are similar to those documented in BKS[7].

[Table 1 about here.]

[3] The same pattern holds for both small and large firms.

[4] LTD is defined as the debt maturing in more than one year.

[5] We use this procedure to estimate the HKM's maturity measurements.

[6] Decomposing LTD into bond and bank loans, we explain how LTD maturity differs across small and large firms (Appendix - Figure A4).

[7] Estimated results for small and large firms are available in the Online Supplementary Appendix (Tables A1-A4).

Finally, we test the hypothesis that the shortening of debt maturities explains a large fraction of the increase in cash holdings over the HKM sample period (1980 to 2008) and also at the longer horizon (1956 to 2014). To do so, we follow HKM and estimate two regressions for cash holdings; one with only debt maturity and other control variables, model (1), and in the other we also include cash flow volatility along with debt maturity, model (2). In both models, we also include the four-quarter moving average of the spread of Baa and Aaa corporate bond rates over the federal funds rate (Spread) as a proxy for the overall credit market conditions. As shown in Table 2, the coefficient on the long-term debt due in the next three years (LTDM 3-Year) is not statistically different from zero for the full sample period in both models 1 and 2[8]. However, the sign and significance of debt maturity are consistent with the HKM results over the sample period (1980 to 2008) that is positive. Therefore, while our findings support the important role of the cash flow volatility in explaining the U-shaped dynamics of cash holdings, we find no consistent evidence that shortening of debt maturity contributes to this pattern in the very long-run.

[Table 2 about here.]

3.4 Conclusion

This study makes use of the *U.S. Census Bureau, Quarterly Financial Report* (QFR), to explore the long-run pattern of corporate cash holding - from 1956 through 2014 - in the U.S. manufacturing sector. We show that the long-run trend of the cash ratio has roughly a U-shape. To explain this fact, we tested two main determinants of the cash holding dynamics in the literature - changes in precautionary motive and volatilities of cash flow - with the latter suggested as the main determinant of cash holding evolution over the last six decades.

[8]All the results of this section are robust to 1-Year and 2-Year LTDM.

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3.5 Appendix A: Tables and Figures

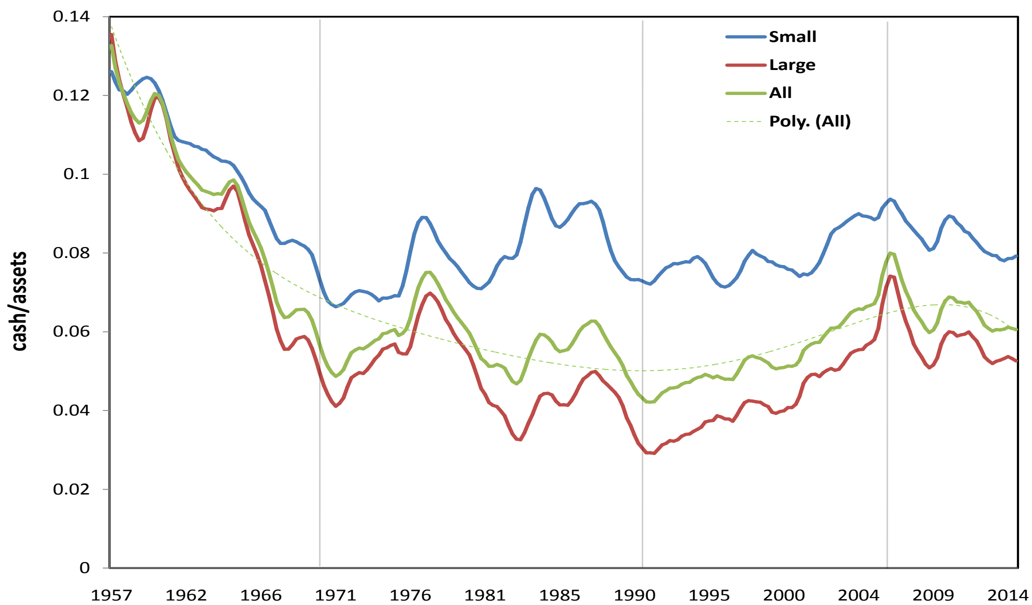

Figure 3.1: Cash-to-Asset Ratio of Small, Large and All Manufacturing Firms

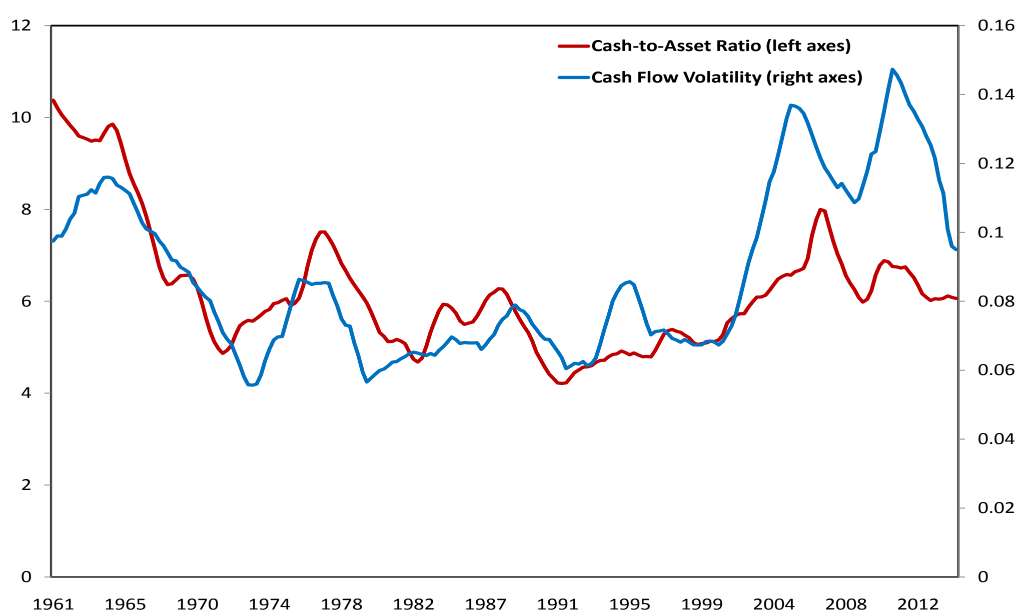

Figure 3.2: Cash-to-Asset Ratio and Cash Flow Volatility of All Manufacturing Firms

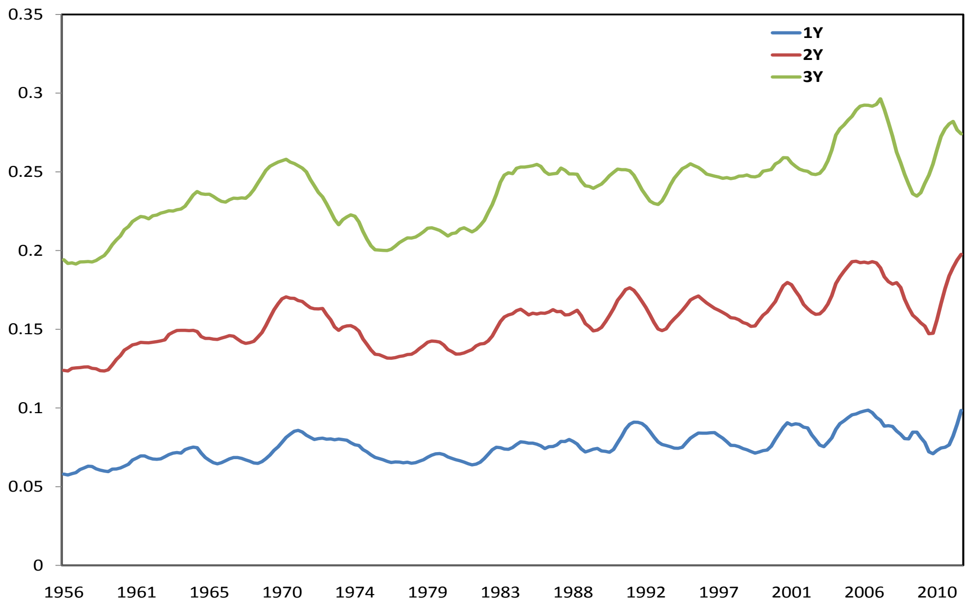

Figure 3.3: The Portion of Long-term Debt due in Next 1, 2 and 3 Years for All Manufacturing Firms

Table 3.1: The Effect of Cash Flow Volatility on Cash Holdings of All Manufacturing Firms

	Full Sample	**Sub Samples**		
Model	1961-2014	1st-Episode 1961 to 1979	2nd-Episode 1980 to 2006	3rd-Episode 2007 to 2014
Intercept	1.030**	0.568	1.169	0.485
	(2.177)	(1.108)	(1.591)	(1.276)
CFV	0.297***	0.236**	0.272**	0.192***
	(4.538)	(2.157)	(2.326)	(5.597)
Leverage	-0.933***	-1.369***	-0.686***	-0.988***
	(-6.437)	(-8.572)	(-3.327)	(-5.593)
NWC/asset	0.047	-1.718**	-0.451	10.625***
	(0.168)	(-2.125)	(-0.625)	(4.257)
CF/asset	-0.039	-0.031	-0.078	-0.056**
	(-0.739)	(-0.353)	(-1.020)	(-2.018)
$R^2 - adjusted$	0.862	0.941	0.707	0.790
$N\ obs$	214	76	108	30

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3.2: The Effect of Long-term Debt Maturity on Cash Holdings of All Manufacturing Firms

	Full Sample		**Sub Samples**			
	1961-2011		1961 to 1979		1980 to 2008	
Model	(1)	(2)	(1)	(2)	(1)	(2)
Intercept	0.294	1.317**	-0.526	0.400	1.610***	2.005***
	(0.483)	(1.972)	(-0.787)	(0.584)	(2.716)	(2.727)
LTDM 3-Year	0.189	-0.223	-0.302	-0.362*	0.757***	0.511**
	(0.826)	(-1.639)	(-1.192)	(-1.823)	(3.263)	(2.103)
CFV		0.378***		0.240***		0.214*
		(5.074)		(3.702)		(1.768)
Leverage	-1.320***	-0.860***	-1.470***	-1.217***	-0.798***	-0.644***
	(-11.340)	(-5.577)	(-13.037)	(-9.743)	(-4.818)	(-3.174)
OPI/asset	0.026	0.038	0.089	0.073	-0.014	-0.019
	(0.313)	(0.484)	(0.857)	(0.904)	(-0.182)	(-0.239)
NWC/asset	-0.607*	-0.275	-0.260	-0.618	-0.719	-0.196
	(-1.810)	(-0.977)	(-0.275)	(-1.075)	(-1.051)	(-0.271)
Spread	0.135***	-0.003	0.322*	0.296**	0.196*	0.034
	(4.722)	(-0.135)	(1.750)	(2.469)	(1.834)	(0.301)
$R^2 - adjusted$	0.808	0.870	0.944	0.961	0.731	0.751
$N\ obs$	203	203	76	76	116	116

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

3.6 Appendix B: Extensions

U.S. Compustat Data (1990-2009)

We calculate cash-to-asset ratio for U.S. non-financial non-utility firms since 1980[9]. Our finding completely mirrors the up-ward cash-to-asset ratio, which has been well documented in the literature of corporate finance. We consider the sample of U.S. manufacturing firms from *Compustat* over the period 1980 to 2014. We exclude financial and service companies as their cash policies might be impacted by other regulatory and economic factors which are not the interest of this study. We also exclude firms with negative asset and negative cash amounts. This sample includes respectively 226375 and 175777 firm-quarter observations for non-financial non-service sectors (SIC codes < 6000) and manufacturing sector (SIC codes [2000 3999]). The variable of interest is "cash and short-term investment" which represents cash and all securities as listed in the current asset. Short-term investment is included since firms hold part of their liquidity in the form of short term investment which is readily transferable to cash. The cash holding trend of firms in this sample is depicted in Figure 1. From this figure, it is apparent that during the last decades cash-to-asset ratio experienced an increasing trend in manufacturing and industrial sectors. Despite the fact that this increasing pattern is steeper after 2000, it becomes decreasing in the post-crisis episode. As one can see, while manufacturing firms represent about 77 percent of the sample, they are

[9]We focus on these firms to keep our analysis comparable with the previous studies discussed above.

fairly a very good representative of the whole non-financial non-service sectors. Therefore, in the rest of the paper, we restrict our attention to cash holding behavior of manufacturing firms. Figure 2 plots the cash-to-asset ratio for different quartiles of manufacturing firms. This figure implies that the general up-ward trend is not driven by particular groups of firms.

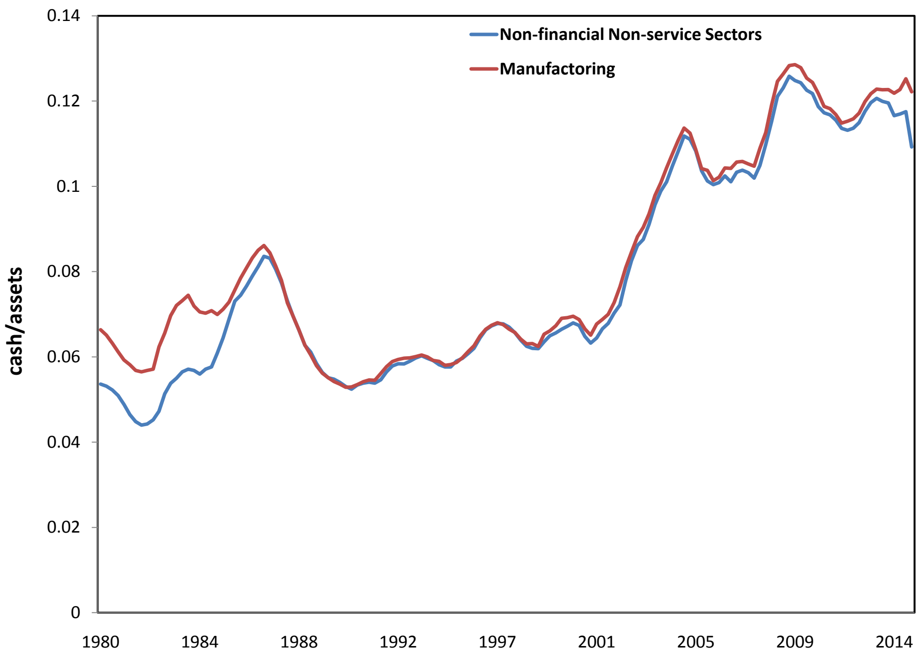

Figure 3.4: Cash-to-Asset Ratios of Non-financial Non-service and Manufacturing Firms

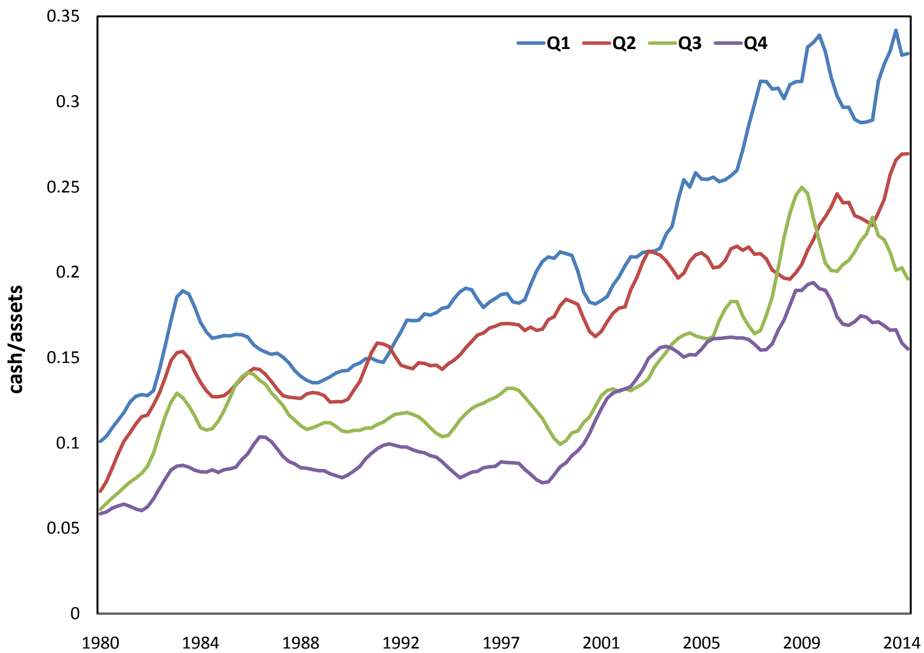

Figure 3.5: Cash-to-Asset Ratios of Non-financial Non-service Firms (Quartiles)

Bai-Perron Test

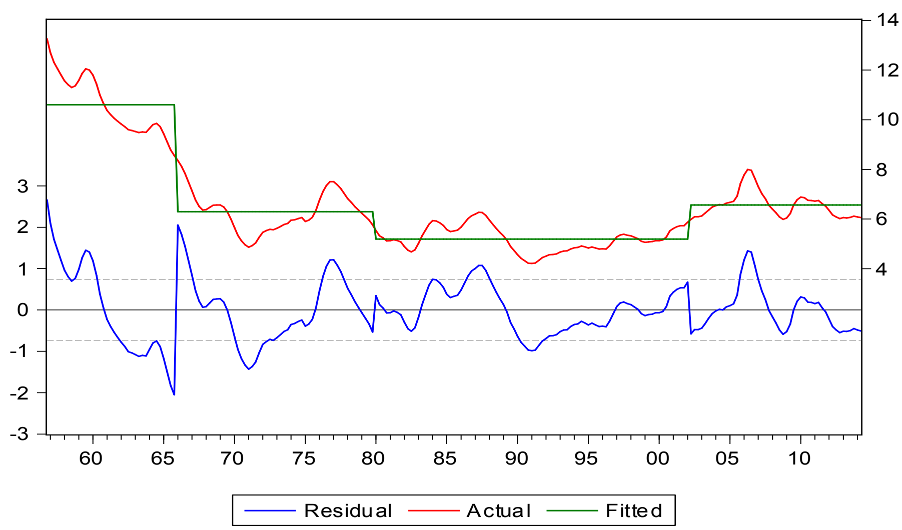

Figure 3.6: Bai-Perron Test for Multiple Structural Break in the Cash-to-Asset Ratio over the period 1956-2014

Debt Maturity

As shown in the first panel of Figure 4, debt maturity is decreasing for small firms and increasing for large firms; an upward trend implies maturity shortening. This result is not unexpected for small firms since these rely heavily on bank finance[10] and long-term bank debt maturity has been extended over time (see the second and third panels of Figure 4). This also implies that shortening the aggregate LTD maturities is explained only for large but not small firms.

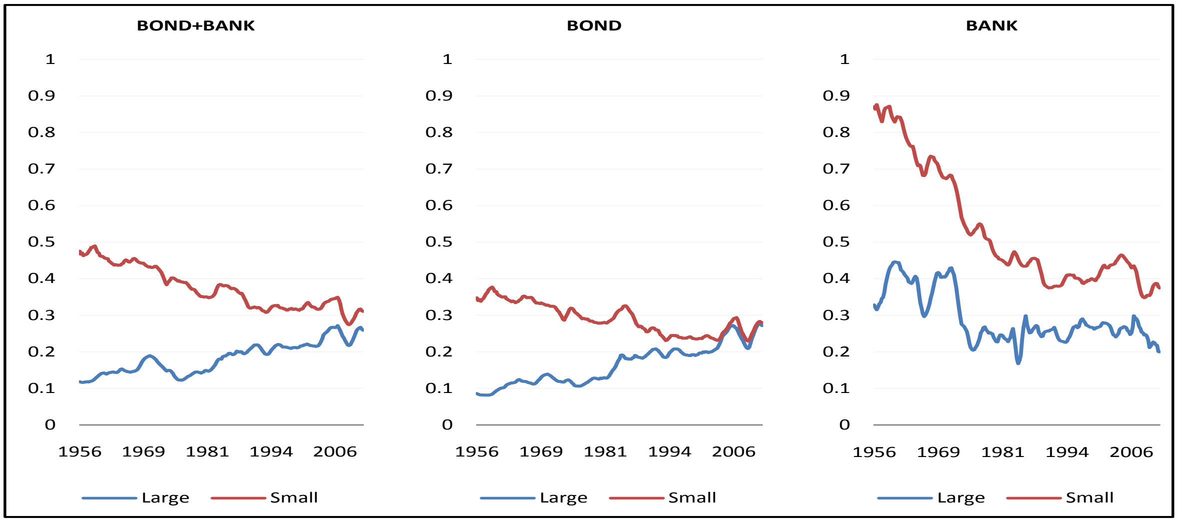

Figure 3.7: The Portion of Long-term Debt due in Next 3-years across Small and Large Manufacturing Firms

Extensions

Table 3.3: The Effect of Cash Flow Volatility on Cash Holdings of Large Manufacturing Firms

	Full Sample	**Sub Samples**		
Model	1961-2014	1st-Episode 1961 to 1979	2nd-Episode 1980 to 2006	3rd-Episode 2007 to 2014
Intercept	0.773*	-0.611	0.603	-0.053
	(1.177)	(-0.880)	(0.581)	(-0.121)
CFV	0.497***	0.194	0.327**	0.193***
	(5.504)	(1.473)	(2.069)	(3.590)
Leverage	-1.093***	-1.556***	-1.038***	-1.329***
	(-6.040)	(-8.662)	(-3.704)	(-5.568)
NWC/asset	0.878**	-0.494	-2.066**	8.919***
	(2.399)	(-0.644)	(-1.894)	(3.729)
CF/asset	-0.076	-0.122	-0.041	-0.071**
	(-0.973)	(-0.933)	(-0.372)	(-2.495)
$R^2 - adjusted$	0.814	0.917	0.622	0.671
$N\ obs$	214	76	108	30

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

[10] See Gertler and Gilchrist (1994) for a detailed discussion.

Table 3.4: The Effect of Cash Flow Volatility on Cash Holdings of Small Manufacturing Firms

	Full Sample	**Sub Samples**		
Model	1961-2014	1st-Episode 1961 to 1979	2nd-Episode 1980 to 2006	3rd-Episode 2007 to 2014
Intercept	1.907***	1.922***	1.408***	1.206***
	(3.187)	(3.165)	(2.850)	(7.464)
CFV	0.171***	0.058	0.127***	0.237***
	(2.761)	(0.660)	(2.979)	(6.486)
Leverage	-0.293***	-1.354***	-0.520***	-0.585***
	(-3.367)	(-6.538)	(-3.622)	(-8.714)
NWC/asset	-0.196	-4.674***	0.195	3.876***
	(-0.570)	(-2.862)	(0.561)	(5.438)
CF/asset	-0.071	0.138**	-0.092	-0.111***
	(-0.684)	(2.211)	(-1.047)	(-3.816)
$R^2-adjusted$	0.557	0.902	0.551	0.880
N obs	214	76	108	30

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3.5: The Effect of Long-term Debt Maturity on Cash Holdings of Large Manufacturing Firms

	Full Sample		**Sub Samples**			
	1961-2011		1961 to 1979		1980 to 2008	
Model	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.284	1.307	-1.525**	-0.763	0.845	1.028
	(0.305)	(1.331)	(-2.419)	(-0.837)	(0.826)	(0.941)
LTDM 3-Year	0.359*	-0.148	-0.318**	-0.293**	0.629**	0.225
	(1.697)	(-1.067)	(-2.056)	(-2.098)	(2.133)	(0.637)
CFV		0.550***		0.170**		0.289*
		(4.540)		(1.867)		(1.595)
Leverage	-1.450***	-1.009***	-1.518***	-1.394***	-1.143***	-1.046***
	(-7.561)	(-4.770)	(-11.985)	(-8.710)	(-4.153)	(-3.712)
OPI/asset	0.082	0.051	-0.024	-0.009	0.011	0.001
	(0.559)	(0.369)	(-0.193)	(-0.075)	(0.083)	(0.013)
NWC/asset	0.505	0.318	0.743	0.392	-1.329	-1.613
	(0.912)	(0.707)	(1.123)	(0.696)	(-0.881)	(-1.091)
Spread	0.260***	0.067	0.415***	0.448***	0.235	0.041
	(4.443)	(1.339)	(2.681)	(2.781)	(1.379)	(0.210)
$R^2-adjusted$	0.738	0.819	0.939	0.946	0.645	0.665
N obs	203	203	76	76	116	116

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3.6: The Effect of Long-term Debt Maturity on Cash Holdings of Small Manufacturing Firms

	Full Sample		**Sub Samples**			
	1961-2011		1961 to 1979		1980 to 2008	
Model	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	1.628***	2.411***	2.561***	2.609***	3.018***	3.342***
	(3.214)	(4.428)	(2.878)	(2.970)	(5.542)	(6.915)
LTDM 3-Year	0.153	0.006	0.253	0.195	0.835***	0.731***
	(0.591)	(0.028)	(0.854)	(0.615)	(3.562)	(3.600)
CFV		0.191***		0.044		0.108***
		(3.541)		(0.591)		(3.005)
Leverage	-0.554***	-0.375***	-1.386***	-1.305***	-1.338	-0.212
	(-3.581)	(-2.732)	(-11.102)	(-7.275)	(-1.338)	(-1.556)
OPI/asset	-0.013	0.043	0.258***	0.237***	0.056	0.085**
	(-0.217)	(0.698)	(3.428)	(3.462)	(1.199)	(2.298)
NWC/asset	-0.855***	-0.806***	-5.576**	-5.357**	-0.764**	-0.794**
	(-3.436)	(-3.215)	(-2.301)	(-2.197)	(-2.267)	(-2.541)
Spread	-0.003	-0.045	0.219	0.200	0.249***	0.122*
	(-0.107)	(-1.512)	(1.191)	(1.087)	(2.942)	(1.663)
$R^2 - adjusted$	0.481	0.583	0.916	0.916	0.667	0.728
$N\ obs$	203	203	76	76	116	116

Note: Robust standard errors are reported in brackets: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.