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RESEARCH ARTICLE

Heterogeneous responses to corporate marginal tax rates: Evidence from small and large firms

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Summary

Do small and large firms respond differently to tax cuts? Using new narrative measures of the exogenous variation in corporate marginal tax rates and a unique dataset of US manufacturing firms, we find that the investment of large firms is more sensitive to a marginal tax cut than that of small firms. Furthermore, we show that small firms finance their new investments almost entirely through debt, whereas large firms use both cash and debt. Following a tax cut, the tax advantage of debt financing falls relative to cash financing. This substitution effect is more pronounced for large firms and induces them to rely on cash financing to a larger extent than small firms.

1 | INTRODUCTION

The impact of tax policies on corporate investment has been examined in numerous studies in the public finance and macroeconomic field. These studies, however, have primarily focused on specific tax reforms, such as depreciation allowances, investment incentives, and dividend tax credits (House & Shapiro, 2008; Yagan, 2015; Zwick & Mahon, 2017). The recent Tax Cuts and Jobs Act (TCJA), signed into US law on December 22, 2017, has also sparked renewed interest in the effects of tax policies on corporate decision making (Auerbach, 2018). In this paper, we extend the literature by examining how changes in corporations' marginal tax rates (MTRs) affect their real and financial decisions. Our main contributions are twofold: (i) We construct new narrative measures of the exogenous variation in MTRs for US manufacturing firms; and (ii) we analyze the real and financial responses of small and large firms to this variation. In particular, we estimate the responses of investment, cash, and debt to a decline in the MTR. Our results show that large firms increase their investment more than small firms in response to a marginal tax cut. In addition, we show that small firms' new investments are financed almost entirely by debt, whereas large firms use both internal cash and debt.

We construct a distinct series of exogenous changes in corporate MTRs for small and large manufacturing firms based on postwar tax reforms in the United States. To do this, we perform the following steps: (i) We identify all instances where statutory corporate tax rates have changed (a proxy for MTRs); (ii) we restrict the sample to instances where these changes were exogenous to economic conditions, using the narrative identification approach (identifying the dates); and (iii) we calculate the size of these exogenous changes in MTRs for the group of small and large firms at each tax date (measuring the size).[1] This selection procedure yields a total of six exogenous declines in MTRs at 1964Q2, 1965Q1, 1979Q1, 1982Q1, 1983Q1, and 1987Q3.

[1]Because our data are semiaggregate, we cannot directly measure the marginal rates for our sample of small and large firms. We, therefore, use statutory tax rates (STRs) as a proxy for MTRs (see also Mertens & Montiel Olea, 2018). STRs are a valid proxy for MTRs because they represent the maximum marginal rate a firm pays for every additional dollar it earns (see Section 4).

Using our constructed tax series, to the best of our knowledge, this paper is the first to estimate the heterogeneous responses of small versus large firms to changes in MTRs. Most existing studies rely on publicly traded firms and ignore private, smaller, bank-dependent firms, which are often considered to be more financially constrained. Their results are therefore biased toward large- and medium-sized firms.[2]

Allowing for heterogeneous responses, we examine whether a tax cut applied to large firms stimulates more investment growth than a similarly sized tax cut for small firms. Our estimates show that both small and large firms respond to exogenous tax cuts by boosting investment.[3] However, large firms increase investment more than small firms.[4] In particular, the results generated using local projections and structural vector autoregressive model reveal that the IRFs for the differences between large and small firms reach a maximum of, respectively, 0.18 and 0.63 percentage points after a 1% cut in MTRs.[5] The behavior of total debt displays a pattern similar to investment in that the relative rise of large firm debt growth is much more pronounced than that of small firms. These results hold for the major components of short- and long-term debt, namely, bank loans and commercial paper. The response of cash varies significantly across firms. While small firms' cash holdings exhibit a slightly negative response (largely insignificant) at all horizons, large firm cash closely mimics small firm cash until quarter five, but then drops sharply. This switch in behavior is statistically significant.

We highlight two mechanisms to explain these results. First, there is an income effect. Reducing the marginal tax rates reduces firms' tax liability, which effectively increases their retained earnings and allows them to increase their investment. Our results show that large firms increase their investment more than small firms.[6] Second, there is a substitution effect stemming from the tax deductibility of debt. Following a tax cut, firms have the incentive to use cash instead of debt. Because the value of the tax shield depends on the tax rate and the amount of outstanding debt, a reduction in the tax rate decreases the value of holding debt and the advantage of debt financing. This effect is stronger for large firms as they are more leveraged and benefit more from the tax shield. They are thus more likely to substitute cash for debt to finance their investments. In addition, they require a higher level of funds than smaller firms as their investments increase more following the tax cut. The substitution effect, therefore, contributes to the greater cash financing (cash decline) seen in large firms. Our contribution is to isolate the substitution effect of changes in MTRs on firms' financing decisions.

For our empirical analysis, we use the US Census Bureau's Quarterly Financial Report (QFR), a dataset that includes a large proportion of small and private firms. The QFR is, to some extent, a less explored dataset because it is only available in hard copy prior to 1988, and there have been some changes in its size brackets over time. We extended it back to 1956 by collecting data from various issues of QFR books and microfiches, transforming these data into electronic versions, and integrating them into unified forms. The QFR has several advantages relative to other publicly released firm-level datasets, making it appropriate for our research purpose. First, while most datasets are restricted to public firms, the QFR provides information on both publicly and privately held firms. Using the QFR thus helps us to improve the representativeness of our sample, enabling us to explore the effect of financial constraints.[7] In addition, the QFR has a long period of coverage that allows us to explore different episodes of exogenous tax shocks, mainly from the 1960s to the 1980s, the period in which most of the exogenous tax shocks occurred in the United States. This is particularly important because exogenous variation in tax rates have not been very frequent over recent decades in the United States. Finally, the data are reported at a quarterly frequency, thereby facilitating policy and business cycle analysis.

We also use a firm-level dataset of US firms to corroborate our results for the QFR firms. The results of the firm-level analysis are remarkably similar to our semi-aggregate QFR analysis. In addition, we conduct robustness checks with respect to outliers and the sample period, controlling for various tax reform provisions and dropping every single tax

[2]Zwick and Mahon (2017) and Yagan (2015) are two recent exceptions, analyzing the effect of bonus depreciation policies on corporate investment and how it varies across public and private firms.

[3]This finding reflects the intensive margins of the tax cut. As noted in Auerbach (2018), a decline in the corporate tax rate provides an incentive for corporations to increase investment from due to lower marginal effective tax rates (intensive margin) and lower average tax rates (extensive margin).

[4]The fact that large firms benefit more from a tax reduction than small firms is consistent with the theoretical view that unconstrained firm investment is more responsive to changes in MTRs than constrained firm investment (Devereux & Griffith, 2003; Djankov et al., 2010; Fazzari et al., 1988; Holtz-Eakin et al., 1994; Hassett & Hubbard, 2002).

[5]Our estimates are based on a 1% cut in MTRs; however, the average changes in MTRs in our sample are 14% and 15% for small and large firms, respectively. Consequently, using our estimates, we can project the near-term impact of the TCJA on the investment of small and large US firms. The TCJA cut the top marginal federal corporate tax rate from 35% to 21% (a 40% reduction). In Appendix S1, we provide a "back-of-the-envelope" exercise to investigate the investment/cash/debt behavior of small and large firms before and after the enactment of the TCJA.

[6]This result is in line with Moyen (2004), who shows that unconstrained firms have an additional incentive to invest relative to constrained firms following a positive cash flow.

[7]Private firms are smaller, bank-dependent, risky, younger, and informationally opaque. They, therefore, have less access to public debt markets and consequently face more severe constraints in their ability to issue debt (Erickson & Whited, 2000; Frank & Goyal, 2015).

date, a different data transformation, and find little change in our results. In particular, we exclude every single tax shock, including the largest exogenous tax cut in 1987Q3, to ensure that our results are not driven by one particular tax date. In Appendix S1, we provide further robustness checks with respect to our measures of firm size, tax increases versus decreases, unanticipated versus anticipated tax changes, "apples-to-apples" comparison, the measurement error in our narrative shocks, and the responses of eight asset size brackets and all QFR firms. Finally, we extend our results by examining the effects of tax changes on various real and financial variables.

The rest of the paper is organized as follows. In Section 2, we review the related empirical literature and explain our contributions. In Section 3, we present the data and our measurement of small and large firms. In Section 4, we describe the identification of tax shocks. In Sections 5 and 6, we provide a descriptive analysis of firms' real and financial behavior, present the main specification of our econometric methodology, and report our empirical results. In Section 7, we show firm-level evidence on the effects of changes in the MTR, before concluding in Section 8.

2 | LITERATURE REVIEW

Our paper is related to several strands of the literature. First, our paper complements the literature exploring the heterogeneous responses of firms to tax reforms. Zwick and Mahon (2017) use a sample of more than 120,000 small and large firms to examine the effect of bonus depreciation policies on corporate investment and how it varies across firms. They analyze two bonus periods of 2001–2004 and 2008–2010 and find that small firms are substantially more responsive to bonus depreciation schedules.[8] Yagan (2015) uses a sample of private C- and S-corporations and shows that the investment response to the 2003 dividend tax cut was weak and insignificant. Alstadsæter et al. (2017) use unlisted firms in Sweden to study the effect of a dividend tax cut on corporate investment. They find that after Sweden's 2006 dividend tax cut, cash-constrained firms increased their investment relative to cash-rich firms. In our paper, we explore the heterogeneous effect of changes in MTRs on small and large firms.

Second, our paper is also related to the recent empirical studies that have begun to address the impact of personal marginal income tax rates on economic aggregates (Barro & Redlick, 2011; Mertens & Montiel Olea, 2018; Zidar, 2019). In particular, Mertens and Montiel Olea (2018) construct new narrative measures of the exogenous variation in personal marginal income tax rates associated with postwar personal tax reforms in the United States. As they discuss, of the 15 instances of unanticipated tax policy shocks identified as exogenous by Romer and Romer (2010), eight shocks corresponded to tax reforms directly affecting personal marginal income tax rates. The other seven instances affected average tax rates but did not change the marginal rates. The authors show that policies directly affecting marginal rates are key events that generate real economic effects. They find no evidence for any impact on incomes when personal average tax rates decline but marginal income tax rates do not. Our study makes a novel contribution by constructing new narrative measures of the exogenous variation in corporate MTRs for our panel of small and large firms.

In addition, our findings expand the literature regarding the sensitivity of small versus large firms to macroeconomic volatilities. In their seminal paper, Gertler and Gilchrist (1994) present evidence that small firms are more responsive to monetary policy shocks. They use the QFR data and show that small firms account for a significantly disproportionate share of the manufacturing decline that follows the tightening of monetary policy. On the other hand, Kudlyak and Sanchez (2017) use the same methodology and QFR data and find that the short-term debt and sales of large firms declined much more than that of small firms during the 2008 financial crisis and most recessions since 1969. Moscarini and Postel-Vinay (2012) also show that the net job creation of large firms is more sensitive to the business cycle. More recently, Mehrotra and Crouzet (2020) employ the QFR confidential microdata from 1977 to 2014 and find evidence of greater cyclical sensitivity among small firms. They also find that this greater sensitivity cannot easily be accounted for by financial factors. We highlight the importance of financing constraints in firms' real and financial decisions, such as investment, cash, and debt, by estimating the varying responses of small versus large firms to corporate tax policy.

Finally, our paper is related to a well-developed body of fiscal policy literature addressing the real effect of taxation on economic activities. Mountford and Uhlig (2009) find that deficit–financed tax cuts improve GDP, with a maximal present value multiplier of five dollars of total additional GDP per dollar of the total cut in government revenue 5 years after the shock. Romer and Romer (2010) use the narrative method to identify exogenous tax changes and their impact on economic aggregates. Mertens and Ravn (2013) improve their measure by distinguishing between changes in per-

[8]These laws often include additional investment incentives that explicitly target small firms or that are subject to limitations on their use that effectively confine their benefits to such firms. See, for example, House and Shapiro (2008), Guenther (2018), and Kitchen and Knittel (2016) for more discussion.

sonal and corporate income tax rates, finding large short-run effects on output associated with unanticipated changes in either tax component. Mumtaz and Surico (2018) look at taxation through the lens of economic uncertainty. They argue that although the effect of spending and monetary policy uncertainty appears to be small, uncertainty about tax changes has detrimental consequences for real activity. We contribute to this literature by using new narrative measures of the exogenous variation in corporate MTRs to explore how tax policies affect firms' real and financial activities over a long horizon.

3 | DATA AND MEASUREMENT OF SMALL AND LARGE FIRMS

This section describes the data and the procedure used to construct the time series for small and large firms.

3.1 | The quarterly financial report

In this paper, we use the US Census Bureau's Quarterly Financial Report (QFR) of manufacturing firms. The QFR program has collected and released statistics of US firms at quarterly frequencies since 1947.[9] This program currently covers manufacturing, mining, wholesale trade, retail trade, and some service industries. The QFR data are used by the Bureau of Economic Analysis as a primary source to estimate corporate profits for the National Income and Product Accounts (NIPA).[10] The QFR uses a sample survey to report the income statements, balance sheets, and related financial and operating ratios for US firms broken down by asset size and industry. At present, the QFR semiaggregated statistics are released in eight asset size brackets: under 5, 5–10, 10–25, 25–50, 50–100, 100–250, 250–1000, and over 1000 (all in million dollars). Data prior to 1988 are only available in hard copies. We extended the dataset back to 1956 by collecting data from various issues of the QFR books and microfiches. There were also changes in size brackets in 1974, 1980, and 1988. We, therefore, integrated the data into unified forms after transforming them into electronic versions. We conducted extensive robustness analyses to verify the accuracy of the data collected. We then used this dataset to construct the aggregate time-series of investment and other variables of interest. Previous studies employing the QFR, such as Gertler and Gilchrist (1994), have restricted their analysis to very few data items such as sales and total debt. To the best of our knowledge, our study is the first to explore additional variables such as investment, cash holdings, and short- and long-term debt.[11]

The QFR offers a number of advantages for our research question. One advantage is that it contains a wide range of historical data from 1947, allowing us to explore different episodes of exogenous tax shocks. This is particularly important because exogenous variation in taxation have not been very frequent in the United States in recent decades. Another critical advantage of the QFR is that it is an inclusive dataset and nontraded firms dominate the lower tier of its sample size distribution. Because small firms are rarely publicly traded, they are excluded in many datasets. Most existing studies are therefore restricted to public firms, which are typically large. Finally, the quarterly frequency of the reported QFR data means that they are compatible with macroeconomic time series reported in quarterly frequencies. Using these data therefore enables us to include a large set of macroeconomic time series and their informational content in our econometric framework. In light of these advantages, the QFR is an appropriate and informative dataset for exploring how tax policies affect the performance of firms in different size classes.

[9]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 US Census Bureau to maintain the confidentiality of the information reported (https://www.census.gov/econ/qfr/historic.html).

[10]Data collected by the QFR are also widely used by the Federal Reserve Board to assess industrial debt structure, liquidity, and profitability and by the Treasury Department to estimate corporate tax liability. The Council of Economic Advisors and the Congressional Committees utilize key indicators derived from the QFR data to design economic policies and draft legislation. The Federal Trade Commission (FTC) uses the series as a basic reference point for analyzing the financial performance of American industries, while banking institutions and financial analysts draw upon the series for their investment evaluations.

[11]The primary purpose of the QFR is to provide timely, accurate data on business financial conditions for use by government and private-sector organizations and individuals. The primary public users are the Bureau of Economic Analysis (BEA), Federal Reserve Board (FRB), Council of Economic Advisers, Small Business Administration, US Treasury-Office of Tax Analysis, and Joint Committee on Taxation. The QFR data have also been used by Meltzer (1960), Jorgenson et al. (1970), Gertler and Gilchrist (1994), Leary (2009), Kudlyak and Sanchez (2017), and Mehrotra and Crouzet (2020), among others.

3.2 | Constructing the time series for small and large firms

We construct our small and large groups using a similar version of the procedure applied in Gertler and Gilchrist (1994). We introduce sales as our indicator of firm size and aggregate all firms into either the small and or the large groups. As the QFR brackets are classified based on asset size, we sort the classes from the smallest asset bracket to the largest. We then accumulate their sales, beginning from with the smallest asset class until we reach up to the 30^{th} percentile of the total sales in each period, our cut-off for small firms. Large firms are those above this cut-off, with forming the 70^{th} percentile of total sales. This procedure reasonably adjusts for biases arising from firms shifting firms across categories over time. This shift is mainly caused by the choice of nominal assets as the measure of size in the QFR data. The nominal nature of this measure causes inflation to shift firms from low nominal asset categories to high ones over time (see Appendix S1 for more details).

Gertler and Gilchrist (1994) show that this grouping of small and large firms provides a measure of size as a reasonable proxy for access to capital markets, such that small firms are more vulnerable to capital market imperfections (Fazzari et al., 1987; Gertler & Gilchrist, 1994). The rationale for using size is the assumption that smaller firms are younger and opaquer and, therefore, are more likely to face borrowing constraints (Erickson & Whited, 2000).

Because the QFR data are reported quarterly and are not seasonally adjusted, we seasonally adjust the series using the X-13ARIMA-SEATS program (Win X-13). However, even after seasonal adjustment, considerable volatility remained in our time series, as the seasonal adjustment does not account for irregular factors in the data. We therefore use the simple four-quarter moving average to smooth the data and determine the underlying trend.[12] Note that all variables are in real terms. Appendix S1 details our measurement of small and large firms.

Because the responses of small and large firms might be affected by the different scales of the variables in these two groups, we use the cumulative growth rates of the variables rather than their levels to ensure that the results were comparable. We then detrend the cumulative growth rates of variables for small and large firms. Note that we are interested in the relative performance of small and large firms over a number of quarters around each tax date. We therefore detrend our time series to explore the cyclical components of the variables of interest for both groups of firms at each tax date. This is a particularly useful adjustment when seeking to understand the cyclical components of the series, and was also employed by Gertler and Gilchrist (1994) for the same reason. For definitions of the variables and summary statistics (Table A1), see Appendix A.

4 | IDENTIFYING TAX CUTS

This section details the construction of our measures of tax cuts for small and large firms using the narrative identification approach. Because our study aims to compare the impact of taxes on small and large firms, we need to construct a measure to estimate the response of firms to a similarly sized tax shock. Variation in MTRs are a suitable measures for this purpose. Unlike other tax reforms, changes in MTRs apply to every corporation subject to progressive income taxes, allowing us to examine whether a tax cut that goes to large firms stimulates more investment growth than a similarly-sized tax cut for small firms.

However, because the QFR data are semiaggregate, it is not possible to measure the marginal rates for our sample of small and large firms. We therefore use statutory corporate income tax rates (STRs) as a proxy for MTRs, which is also common in the macroeconomics and fiscal policy literature; see Mertens and Montiel Olea (2018). STRs are a suitable proxy for MTRs because they represent the maximum marginal rate a firm pays for an additional dollar of earnings. In addition, as discussed in Mertens and Montiel Olea (2018), MTRs are endogenously determined by nontax determinants of income that makes tax rates procyclical and induce a downward bias in the elasticity estimates. To address this problem, the authors suggest instrumenting the MTRs with only the policy-induced changes in marginal rates, such as changes in statutory rates. STRs therefore help to alleviate this bias.

4.1 | Identifying the dates

To construct our series of tax shocks, we select all shifts in US federal STRs between 1956 and 2008. We use changes in STRs as a proxy for changes in MTRs (see, e.g., Auerbach, 2018; Mertens & Montiel Olea, 2018). According to the IRS's

[12]The results obtained with smoothed and unsmoothed data are materially identical (see Figure C4 in Appendix C.3).

TABLE 1 Corporate tax schedule in the hypothetical year t.

Corporate income tax brackets ($)	Tax rate ($t-1$)	Tax rate (t)	Size of tax cut
≤25000	20%	19%	5%
>25000	52%	50%	4%

Note: Tax rates are STRs that we use as a proxy for MTRs. Note that the numbers in this table are hypothetical, and for the sake of illustration, we use only two income tax brackets and rates. For our actual calculations in Table 3, we use IRS's Statistics of Income (SOI) Tax Stats - Historical Table 24.

Statistics of Income (SOI) Tax Stats - Historical Table 24, there were 12 shifts in corporate STRs over this period.[13] These shifts occurred in 1964, 1965, 1968, 1970, 1971, 1975, 1979, 1982, 1983, 1985, 1987, and 1994. We restrict our attention to a subset of these dates that are exogenous to the state of the economy, following the narrative identification strategy of Romer and Romer (2009).

This selection procedure revealed a total of six exogenous marginal tax cuts at 1964Q2, 1965Q1, 1979Q1, 1982Q1, 1983Q1, and 1987Q3.[14] We refer to all of these points as "tax dates." In Appendix S1, we test the predictability of the exogenous changes in MTRs and show that our constructed exogenous tax series are unforecastable based on past observations on the vector of observables. Needless to say, relying on a narrative approach to identify policy changes usually yields a small number of exogenous shocks.[15]

In addition, following the approach of Mertens and Ravn (2012), we distinguish anticipated and unanticipated reforms by introducing a timing convention. If a reform's announcement date and implementation date are fewer than 90 days apart, we classify the corresponding tax reform as unanticipated. The anticipated reforms are then those changes for which the two dates differ by more than 90 days.[16] After scoring the tax reforms in this manner, two of the six selected reforms were defined as unanticipated (1964Q2 and 1987Q3) and the other four as anticipated (1965Q1, 1979Q1, 1982Q1, and 1983Q1). In Appendix B, we describe our narrative analysis of all historical changes in federal corporate STRs and their sources in detail. This identification strategy eliminates some exogenous tax reforms that were not implemented through changes in statutory rates. For example, most of the investment incentive reforms, such as the 2002 and 2003 laws, are excluded. The following section provides full details of the way we measured the size of MTRs for both groups of firms.

4.2 | Measuring the size

In the previous section, we identified six episodes where changes in STRs took place for exogenous reasons. In this section, we measure the size of changes in MTRs for small and large firms at our identified "tax dates." Note that our small and large groups were constructed by aggregating eight QFR categories into two groups (see Section 3.2). To measure the average size of the MTR cuts for each group, we first measure the average size of the tax cut for each QFR bracket. The size of a tax cut for each small and large group is then the average cut in MTRs over the brackets belonging to that group. Measuring the size of tax cuts for the QFR brackets raises the difficulty that firms within each QFR bracket belong to multiple income tax brackets, and we do not know the distribution of income in the QFR brackets. To overcome this difficulty, we use US Compustat manufacturing firms. As an illustration, we execute the procedure for a sample of 16 hypothetical Compustat firms at a hypothetical tax date. These hypothetical firms are denoted by f1 to f16 in Table 2. For each firm, "total asset" and "pretax income" are reported in columns 2 and 3. This strategy was accomplished through the following steps:

(i) We sort the Compustat firms by total assets and then assign each firm to a QFR bracket based on its asset value. The result for the hypothetical sample appears in column 4 of Table 2.
(ii) Referring to the schedule of the tax reform at each tax date (Table 1 for a hypothetical date), we determine the size of the marginal tax cut for each firm (columns 6 and 7 of Table 2). As shown in Table 1, the size of the marginal tax cut, denoted by mtr, is the change in MTR divided by the initial level of MTR, that is, $mtr_t = \left(\frac{MTR_t}{MTR_{t-1}} - 1\right)$.

[13]Tax rates are available on the Internal Revenue Service (IRS) website: https://www.irs.gov/statistics/soi-tax-stats-historical-table-24

[14]Although our focus is on tax cuts, we identified two exogenous MTR increases in 1984Q3 and 1994Q1.

[15]See, for example, Gertler and Gilchrist (1994), Ramey (2011), Romer and Romer (2010), Barro and Redlick (2011), Favero and Giavazzi (2012), Alesina et al. (2015), Mertens and Ravn (2013), and Mertens and Montiel Olea (2018), among others.

[16]Following Mertens and Ravn (2012), the announcement date is the date the policy was legislated, and the implementation date is the date the changes were implemented.

TABLE 2 Measuring the size of tax cut for small and large firms: A hypothetical example.

Firm's index	Total asset ($mm)	Pretax income ($mm)	Corresp. QFR bracket	Size class	Corresp. income tax bracket ($)	Size of tax cut in tax date (%)	Asset weighted average tax cut for the QFR bracket	Weight of the bracket in small group	Weight of the bracket in large group	Size of tax cut for small and large groups (%)
f1	3.8	0.61	1	Small	>25000	4	4.55	0.78	0	
f2	4.61	0.005	1	Small	≤25000	5				3.86
f3	7.5	-0.57	2	Small	Exempted	0	2.22	0.14	0	(small firms)
f4	9.4	3.56	2	Small	>25000	4				
f5	16.72	-0.91	3	Small	Exempted	0	0.00	0.08	0	
f6	20.17	1.85	3	Small	>25000	4	4.00	0	0.05	
f7	32.17	0.02	4	Small	≤25000	5	4.42	0	0.08	
f8	45.1	1.1	4	Small	>25000	4				
f9	51.6	-4	5	Small	Exempted	0	2.50	0	0.09	3.73
f10	86.2	20	5	Small	>25000	4				(large firms)
f11	112.8	-15.6	6	Small	Exempted	0	2.89	0	0.15	
f12	294.3	65.7	6	Small	>25000	4				
f13	705.5	8.3	7	Small	>25000	4	4.00	0	0.29	
f14	912.1	140.5	7	Large	>25000	4				
f15	1497.8	104.9	8	Large	>25000	4	4.00	0	0.34	
f16	12611.3	133.9	8	Large	>25000	4				

Note: This table explains our procedure of estimating the size of changes in MTRs for the QFR small and large firms using Compustat firm-level data. For the sake of illustration, we execute the procedure for a sample of 16 hypothetical Compustat firms at a hypothetical tax date. These firms are denoted by f1 to f16 in column 1. For our actual calculations in Table 3, we use our identified "tax dates," IRS's Statistics of Income (SOI) income tax brackets and rates, and Compustat firm-level data.

TABLE 3 Marginal tax rates (MTRs).

Name	Signed	Effective	Type	Persistence	Size (*mtr*) %	
					Small firms	Large firms
1. Marginal Tax Cut of 1964 (Revenue Act of 1964)	February 1964	1964Q2	Surprise	Permanent	−3.63	−3.89
2. Marginal Tax Cut of 1965 (Revenue Act of 1964)	February 1964	1965Q1	Anticipated	Permanent	−3.62	−3.98
3. Marginal Tax Cut of 1979 (Revenue Act of 1978)	November 1978	1979Q1	Surprise	Permanent	−4.12	−4.09
4. Marginal Tax Cut of 1982 (Economic Recovery Tax Act of 1981)	August 1981	1982Q1	Anticipated	Permanent	−0.12	0
5. Marginal Tax Cut of 1983 (Economic Recovery Tax Act of 1981)	August 1981	1983Q1	Anticipated	Permanent	−0.14	0
6. Marginal Tax Cut of 1987 (Tax Reform Act of 1986)	October 1986	1987Q3	Anticipated	Permanent	−22.62	−25.4

Note: This table reports our constructed new narrative measures of exogenous variation in corporate MTRs for postwar legislated tax changes for the QFR small and large manufacturing firms in the United States.

(iii) For each QFR bracket, we calculate the weighted average of *mtr* for firms belonging to that bracket, where the weights are the firms' total assets. In our example, f1 and f2 belong to the first QFR bracket. In addition, f1 belongs to the income class "25000$ and over" while f2 belongs to the class "less than or equal to 25000$," and the size of their tax cuts are 4% and 5%, respectively. The weighted average of the marginal tax cut for the first QFR bracket at this tax date is therefore $mtr_{1,t} = [(4 \times 3.8) + (5 \times 4.61)]/[3.8 + 4.61] = 4.55\%$ ($mtr_{1,t}$ denotes the estimated tax cut for the i^{th} QFR bracket at date t).
The second QFR bracket comprises firms f3 and f4, with the former having negative income. Because firms with negative income are exempt from taxation, these firms receive no tax cuts after the reform. The weighted average decline in MTRs for this bracket is therefore estimated as $mtr_{2,t} = [(4 \times 9.4) + (0 \times 7.5)]/[9.4 + 7.5] = 2.22\%$. We repeat this procedure to estimate the average mtr_t for each QFR bracket at each tax date.

(iv) Finally, we measure the average decline in MTRs for each group of small and large firms by an average over all $mtr_{i,t}$ belonging to that group, weighted by the total assets of the corresponding brackets. The tax cut for the cut-off category is partially considered in both the small and large groups due to its weight in either group.[17] The size of *mtr* for small firms using our hypothetical sample is

$$mtr_{S,t} = \sum_{i=1}^{8} \left(mtr_i \times \varpi_{S,i} \right) = 3.86\%$$

where $\varpi_{S,i}$ is the share of the i^{th} bracket in the total assets of the small group. Assuming that the cut-off category is 3 (see Figure S1 in Appendix S1), the small group includes the whole first two QFR brackets and part of the third (then all $\varpi_{S,4} = \ldots = \varpi_{S,8} = 0$). These weights are presented in columns 9 and 10 in Table 2. Similarly, the corresponding *mtr* for large firms at this tax date is:

$$mtr_{L,t} = \sum_{i=0}^{8} \left(mtr_i \times \varpi_{L,i} \right) = 3.73\%$$

The calculated *mtr*s for both small and large firms in this example (taking 16 hypothetical firms) are reported in the last column of Table 2.

We therefore construct our narrative measures of declines in MTRs for small and large firms by using the whole Compustat manufacturing sample and proceeding through these steps at every tax date. The resulting series are presented in Table 3.

[17]The cut-off category straddles the threshold of small and large groups as discussed in Appendix S1 (Section 1).

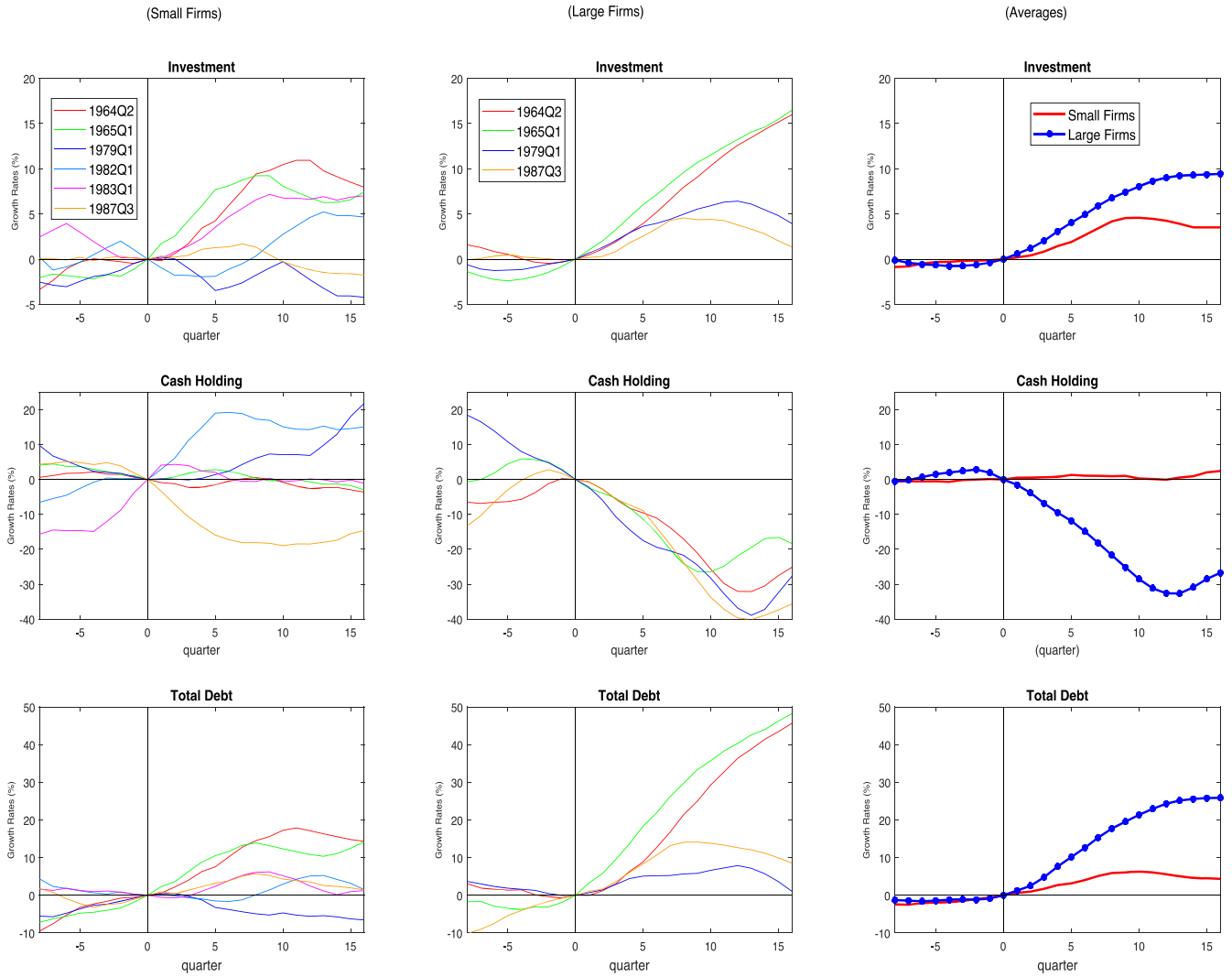

FIGURE 1 Analysis in the neighborhood of exogenous tax policy dates. *Note*: This figure shows a spaghetti chart displaying the behavior of the growth rates around each of the tax dates for small and large firms. It plots the cumulative growth rates of investment, cash holdings, and total debt for 8 quarters before and 16 quarters after each tax shock. The first and second columns present the deviations of small and large firms' cumulative growth rates from their respective values at each tax date. The cumulative growth rates in the tax cut quarter are normalized to 0. Starred lines in column three illustrate the average of the individual curves.

Our empirical analysis explores changes in the growth rates of the real and financial series around the tax dates for small and large firms. We study two sets of variables, capital investment as an indicator of real activity, and cash holdings and total debt as two indicators of financial decisions. In Appendix S1, we also present an extensive analysis for additional variables, including sales, inventories, dividend payout, and stockholder equity. Our empirical work proceeds in two main stages. First, in the next section, we present an informal descriptive analysis designed to illustrate the basic properties of the data. Second, in Section 6, we quantify the relative responses of small and large firms to tax policies using local projections (LPs) and structural vector autoregressive models (SVARs).

5 | DESCRIPTIVE ANALYSIS

We apply a simple statistical and graphical procedure for the descriptive analysis of the raw time series around the tax cut episodes. In the previous section, we identified six tax dates for small firms (1964Q2; 1965Q1; 1979Q1; 1982Q1; 1983Q1; 1987Q3) and four dates for large firms (1964Q2; 1965Q1; 1979Q1; 1987Q3).[18] Figure 1 shows a spaghetti chart displaying

[18]Note that there are six exogenous shifts in STRs in our sample period. However, the effects of two of these shocks are confined to the small firm brackets. We, therefore, have six shocks for small firms and only four shocks for large firms.

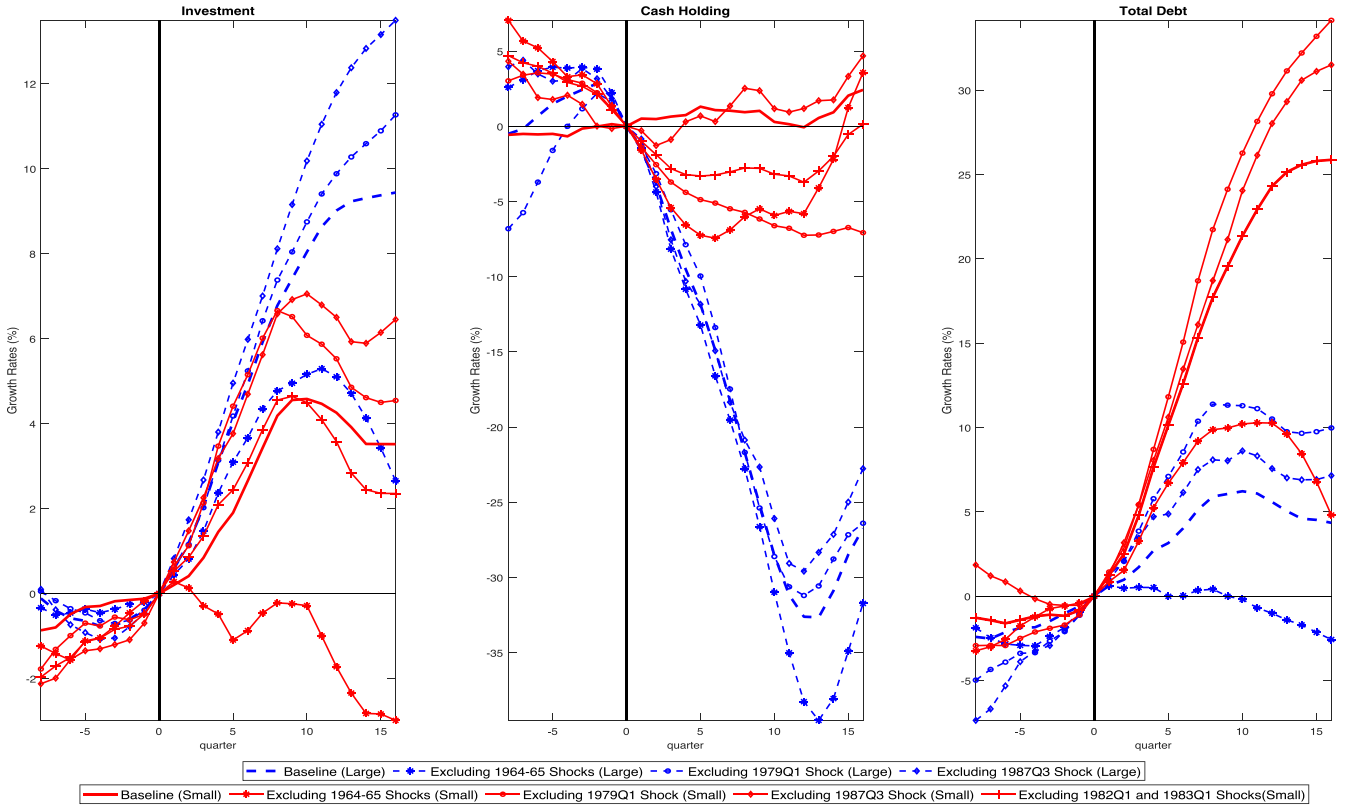

FIGURE 2 Analysis in the neighborhood of exogenous tax policy dates: Excluding single shocks. *Note*: This figure illustrates the average of the individual curves that present the deviations of small and large firms' cumulative growth rates from their respective values at the tax dates. The cumulative growth rates in the tax cut quarter are normalized to 0.

the growth rates around each tax date for small firms (column 1) and large firms (column 2) normalized to zero at the calendar quarter of the tax episodes.

The raw pictures indicate that after all of the tax cut episodes, investment rises smoothly for both small and large firms 4 years after the tax date—although the increases are slightly larger after 1964Q2 and 1965Q1 (the Revenue Act of 1964) than after the other dates. Column 3 compares the averages of the individual curves across all tax dates for small and large firms, illustrating that, on average, large firms raise investment substantially more than small firms. In particular, the average increase in the growth rate of investment by large firms 4 years after a tax cut is about six percentage points greater than that of small firms. Total debt growth exhibits a similar pattern of behavior as the bottom panel suggests. On average, the cash holdings of large firms drop substantially more than for small firms.

While Figure 1 makes it clear that the average results are not driven by a single tax date, it is plausible to address the possible importance of extreme observations. We repeat our spaghetti procedure for small and large firms by excluding every single tax shock to ensure that our baseline results are not driven by a single tax date. The main concern about the inclusion of two tax cuts from the Economic Recovery and Tax Cut Act of 1981 is the downward bias induced on the response of small firms, because these shocks follow the 1981–1982 recession. Although policymakers maintain that the Economic Recovery Tax Act of 1981 was taken for largely ideological or long-term reasons and not to return economic growth to normal (Romer & Romer, 2010), one worry is that the democratic process may cause these reforms to be correlated with economic performance. Moreover, even if these shocks are exogenous, the overlap between their dates and the recessionary episode might affect the response of small firms. To address these possibilities, we repeat our spaghetti charts by dropping the two tax dates from the Economic Recovery and Tax Cut Act of 1981: 1982Q1 and 1983Q1. In addition,

while the largest exogenous tax cut in 1987Q3 is surely a reasonable observation to consider, it is natural to ask whether it drives the average results. We therefore again repeat our spaghetti procedure for small and large firms by dropping this tax date to address this concern. Finally, we also exclude the 1964–1965 shocks and the 1979Q1 shock and calculate our spaghetti charts for small and large firms.

Figure 2 shows the results obtained by excluding the 1982Q1 and 1983Q1 tax cuts to obtain an "apples-to-apples" comparison of small and large firms.[19] We also exclude the largest exogenous tax cut in 1987Q3 to ensure the total effect was not generated by this extreme shock. We also drop the 1964–1965 shocks and the 1979Q1 shock. For comparison, the figure also repeats the baseline graphs. The results suggest that excluding the extreme observations has little impact on the averages, and hence our results are not driven by any one tax date.

In Appendix S1, we complement our descriptive analysis by providing additional spaghetti charts for the debt structure across small and large firms. We also present some additional information suggesting that our descriptive analysis is reasonable from the standpoint of the capital and debt structures of small and large firms.

Overall, the main impression from this descriptive analysis is that the response of large firms to a tax cut is stronger than the response of small firms. Moreover, while the increase in investment and total debt after a tax cut follow almost the same pattern across small and large firms, cash holdings drop considerably faster and more significantly for large firms. Small firms mainly rely on debt and on bank finance following a tax cut. Large firms, in contrast, use a combination of internal and external financing sources and issue more commercial paper.

6 | THE RESPONSE OF FIRMS TO MARGINAL TAX RATES

This section first presents our econometric framework and then reports and discusses our empirical results. We use both local projections (LPs) and structural vector autoregressive models (SVARs) to estimate the effect of a reduction in MTRs on firms' real and financial decisions. We perform our analysis separately for each model and then compare the main results.

6.1 | Econometric methodology

6.1.1 | LP model

To estimate the responses of small and large firms, we use the LP model developed by Jordà (2005) with data from 1956 to 2008.[20] The model is presented below for each firm size class ($i = S, L$) and horizon ($h = 0, 1, 2, \ldots, 16$).

Note that our baseline results rely on LP rather than on VAR because (a) as argued by Montiel Olea and Plagborg-Møller (2021), LP inference is arguably both simpler and more robust than standard autoregressive inference, whose validity is known to be sensitive to the persistence of the data and to the length of the horizon, and (b) because we follow the lag-augmented LP approach proposed by Montiel Olea and Plagborg-Møller (2021) and include lagged values of the variables of interest in the regression, we do not need to adjust for autocorrelation, which also simplifies inference.[21] The model is as follows for each firm size class ($i = S, L$) and horizon ($h = 0, 1, 2, \ldots, 16$):

$$\Delta g_{i,t+h} = \alpha_{\mathrm{i,h}} + A_{\mathrm{i,h}}(L)X_{i,t-1} + B_{\mathrm{i,h}} mtr_{i,t} + \epsilon_{i,t+h} \tag{1}$$

where g_i is the growth rate of the variable of interest for small and large firms, that is, $\Delta g_{i,t+h} = g_{i,t+h} - g_{i,t-1}$.[22] We estimate the series of regressions using quarterly data, where $A_{\mathrm{i,h}}(L)$ is a polynomial of order four. We include two groups of control variables: size-specific variables and macroeconomic conditions in the vector of controls $X_{i,t-1}$. The coefficient

[19] Note that 1982Q1 and 1983Q1 tax cuts are identified only for small firms.

[20] As noted by Jordà (2005), Stock and Watson (2007), Auerbach and Gorodnichenko (2013), Ramey and Zubairy (2018), and Zidar (2019), using direct projections of tax shocks on outcomes is attractive because it does not impose dynamic restrictions on the estimates at different horizons.

[21] As argued by Kilian and Lütkepohl (2017) and Plagborg-Møller and Wolf (2021), from an identification and estimation standpoint, both LPs and VARs rely on the same invertibility-robust identifying restrictions, and therefore neither LPs nor VARs dominate the other in terms of the mean squared error in finite samples and in population the two methods are equivalent.

[22] This definition of dependent variables allows us to compare the behavior of firms one quarter before a tax cut and at an h horizon after that. This transformation is the one used by Hall (2009), Barro and Redlick (2011), and Ramey and Zubairy (2018).

$B_{i,h}$ gives the response of Δg_i at time $t+h$ to the shock ($mtr_{i,t}$) at time t, for each variable of interest and each firm size class. TheNewey and West (1987) corrected standard errors control serial correlation in the error terms induced by the successive leading of the dependent variable.

Based on our identification strategy, our series of exogenous tax cuts are motivated by factors unrelated to the current or prospective state of the economy.[23] There is thus is no reason to expect a systematic correlation between these tax changes and other determinants of firms' real and financial variables. However, many other factors besides tax changes affect firms' real and financial decisions, and of firms that are all likely components of ϵ. To rule out the possibility of such correlations, we include a variety of control variables.

We include four lagged values of each of the dependent variables in the regression to capture any additional short-run dynamics. In particular, well-documented evidence from the empirical investment literature suggests that lagged investment is an economically important determinant of current investment spending (Eberly et al., 2012; Gilchrist & Himmelberg, 1995). In addition, we investigate the role of size-specific and macroeconomic variables in determining firms' real and financial decisions, as they can induce cross-sectional and time-series heterogeneity across small and large firms.[24] The choice of size-specific variables in determining a firm's financial policy has been widely discussed in the literature (see, e.g., Titman & Wessels, 1988). We follow the literature and control for size-specific variables, including cash flow, cash flow volatility, and sales, in our regression.

Moreover, recent studies emphasize that macroeconomic conditions have a profound impact on corporate decisions (Hackbarth et al., 2006). We therefore control for macroeconomic conditions by including four lags of the growth rates of real GDP, the real T-bill rate, the Economic Policy Uncertainty (EPU) index constructed by Baker et al. (2016), and two measures of the risk spread. We also include Moody's Seasoned BAA Corporate Bond minus Federal Funds Rate (BAAFFM) and Moody's Seasoned AAA Corporate Bond Minus Federal Funds Rate (AAAFFM) for small and large firms, respectively. See Appendix A for definitions of the variables.

6.1.2 | SVAR-IV model

We also estimate the impulse responses with a specific proxy VAR model and compare them with the LP method. In particular, we follow Mertens and Ravn ((2013), (2014)), Stock and Watson (2018), and Mertens and Montiel Olea (2018) and estimate an SVAR-IV model where IV is a proxy variable/external instrument for policy shocks, which is our narrative measure of the exogenous variation in MTRs. Consider the following VAR representation for investment/cash/debt and the MTR:

$$\begin{bmatrix} -ln(1-STR_t) \\ g_t \\ X_t \end{bmatrix} = \alpha + A(L) \begin{bmatrix} -ln(1-STR_{t-1}) \\ g_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} u_t^{STR} \\ u_t^{g} \\ u_t^{X} \end{bmatrix} \tag{2}$$

where statutory corporate tax rates (STR_t) is a proxy for MTRs, g_t is a vector of variables of interest for small and large firms of dimension b_g, $A(L)$ is a $p-1$ lag polynomial, p is the lag length, and X_t is a vector of control variables of dimension d_x. To obtain a comparison with the baseline results, we set the vector g_t as the growth rates of investment/cash/debt, $g_t = [g(investment_t) \;\; g(cash_t) \;\; g(debt_t)]'$, $p = 4$, and the same control variables (X_t) as we used in model (1). See Appendix S1 for a detailed description of the model.

6.2 | Results

6.2.1 | LP results

Figure 3 depicts the IRFs for the model (1) for small and large firms from 1956 to 2008. It shows the effect of a 1% decline in MTRs on the path of investment, cash holdings, and total debt. This figure makes clear that the impact of a tax cut on

[23]See Romer and Romer (2010), Cloyne (2013), and Mertens and Ravn (2012) for a detailed discussion. In addition, in Appendix S1, we test the predictability of our constructed exogenous tax series and show that they are unforecastable on the basis of past observations on the vector of observables.

[24]This specification is consistent with studies showing that the effect of taxation on investment depends strongly on cash flows and overall economic conditions (Abel & Blanchard, 1986; Fazzari et al., 1988; Oliner et al., 1995).

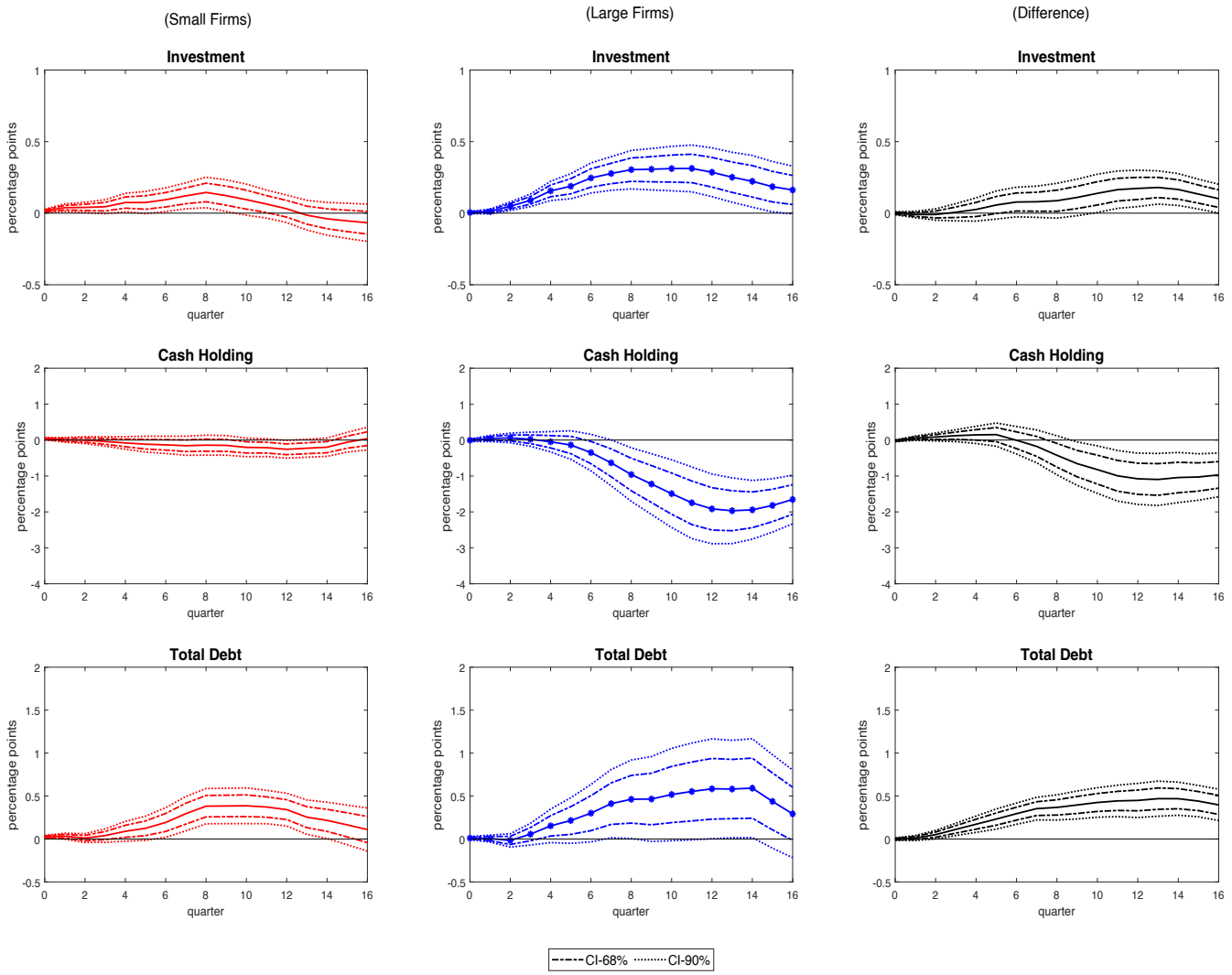

FIGURE 3 Responses to a 1% decline in MTRs: LP model. *Note*: This figure shows the IRFs for the model (1) for small and large firms from 1956 to 2008. It shows the effect of a 1% decline in MTRs on the path of investment, cash holdings, and total debt. Impulse responses are based on the LP model (1). The first and second columns plot the corresponding IRFs with associated error bands for small and large firms. The third column shows the difference in the IRFs of investment/cash/debt between small and large firms to an exogenous marginal tax cut of 1%. This figure confirms that the difference in the IRFs between small and large firms are significant.

corporate activity is size dependent. In this figure and all subsequent figures, the light and dark shaded bands around the IRFs are 90% and 68% confidence intervals. The first and second columns plot the corresponding IRFs with the associated error bands for small and large firms. The top panel of Figure 3 shows the response of investment response to a decline in MTRs. The second and third panels present IRFs for cash holdings and total debt across small and large firms.

Our estimates show that both small and large firms respond to exogenous tax cuts by boosting investment. A 1% cut in MTRs stimulates a persistent increase in investment, which is significant for large firms at every horizon but only significant for small firms for the first nine quarters after the tax cut. Large firms increase investment nearly twice as much as small firms at all horizons. A 1% cut in MTRs raises investment of large firms to a maximum of 0.31 percentage points ($t = 3.72$) and small firms to a maximum of 0.15 percentage points ($t = 2.23$) eight quarters after the shock. The figure shows that during the quarter of the tax change and the next three quarters, the effect on cash holdings is small and not significant. Cash holdings then steadily and rapidly decrease for large firms for the next 3 years before rebounding slightly in the final year. The maximum effect is a fall in the growth rate of cash holdings of 1.92 percentage points ($t = -3.25$) for large firms after 3 years. The small firm response is much smaller and smoother and not significantly different from zero at a 90% confidence band at every horizon. The relative patterns of total debt mirror the relative patterns of investment

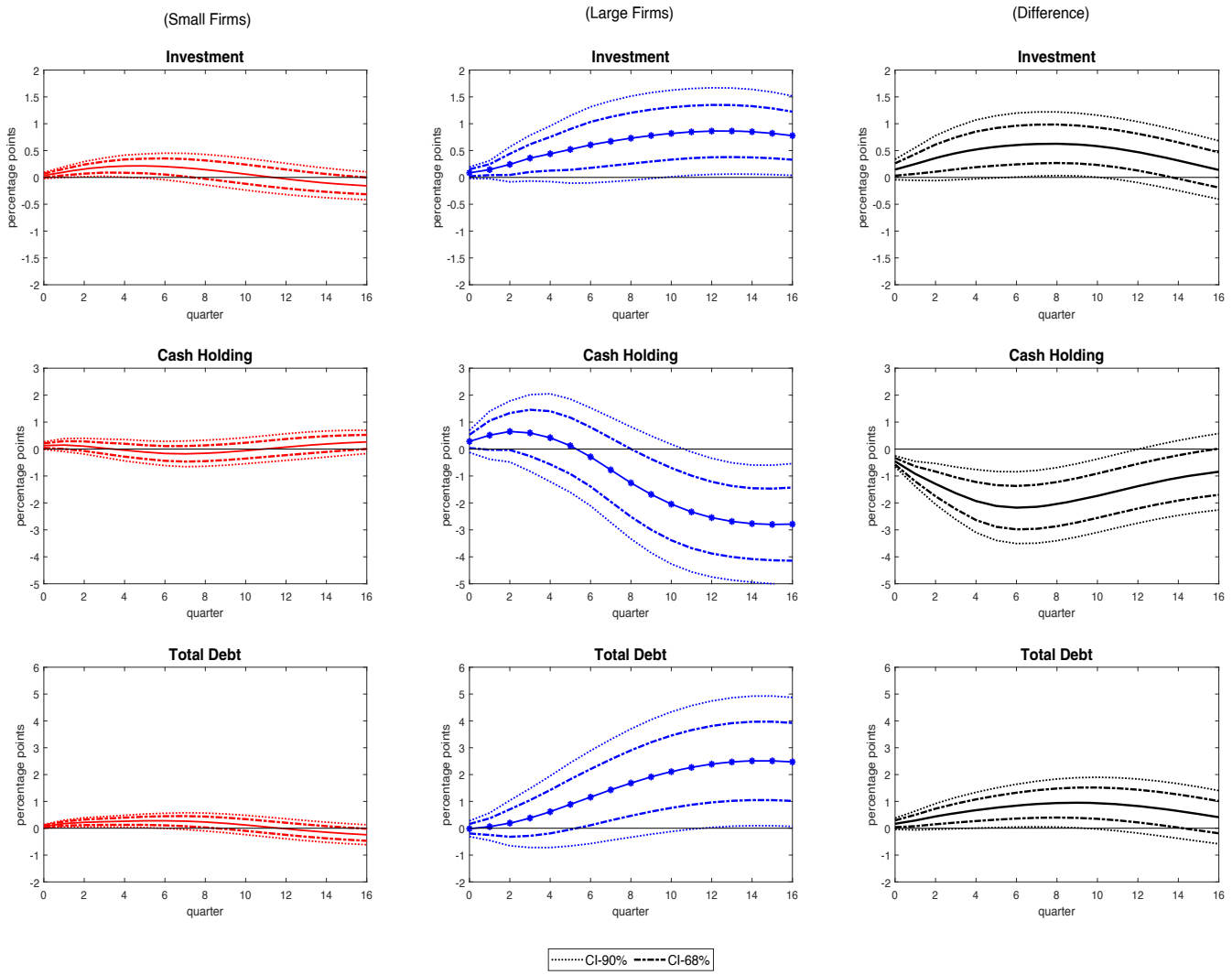

FIGURE 4 Responses to a 1% decline in MTR: SVAR-IV model. *Note*: This figure shows the IRFs of the growth rates of investment/cash/debt of small and large firms to an exogenous marginal tax cut of 1%. The third column shows the difference in the IRFs of investment/cash/debt between small and large firms to an exogenous marginal tax cut of 1%. Impulse responses are based on the SVAR-IV model in Equation (2) with four lags. This figure confirms that the difference in the IRFs between small and large firms are significant. We provide 68% and 90% confidence intervals that are computed using the delta-method.

for both size groups. The growth rate of debt for large and small firms rises by 0.58 percentage points ($t = 1.65$) and 0.34 percentage points ($t = 2.95$) 3 years after the shock.

Finally, we use the difference in investment/cash/debt between large and small firms (large-small) as the LHS variables in the LP model in Equation (1). The third column in Figure 3 presents our results and confirms that the difference in the IRFs between small and large firms are significant for all variables. The cumulative differences of investment, cash, and debt across size classes reach a maximum of 0.18, −1.10, and 0.47 percentage points, respectively, 3 years after the shock.

6.2.2 | SVAR results

Figure 4 reports the IRFs of the growth rates of investment/cash/debt of small and large firms to an exogenous marginal tax cut of 1%. Impulse responses are based on the SVAR-IV model in Equation (2) with four lags. We provide 68% and 90% confidence intervals computed using the standard delta-method.[25]

[25]Our results are robust to alternative interval methods such as the wild bootstrap used in Mertens and Ravn (2014) and the bootstrap procedures proposed by Olea et al. (2021). We report these results in Appendix S1.

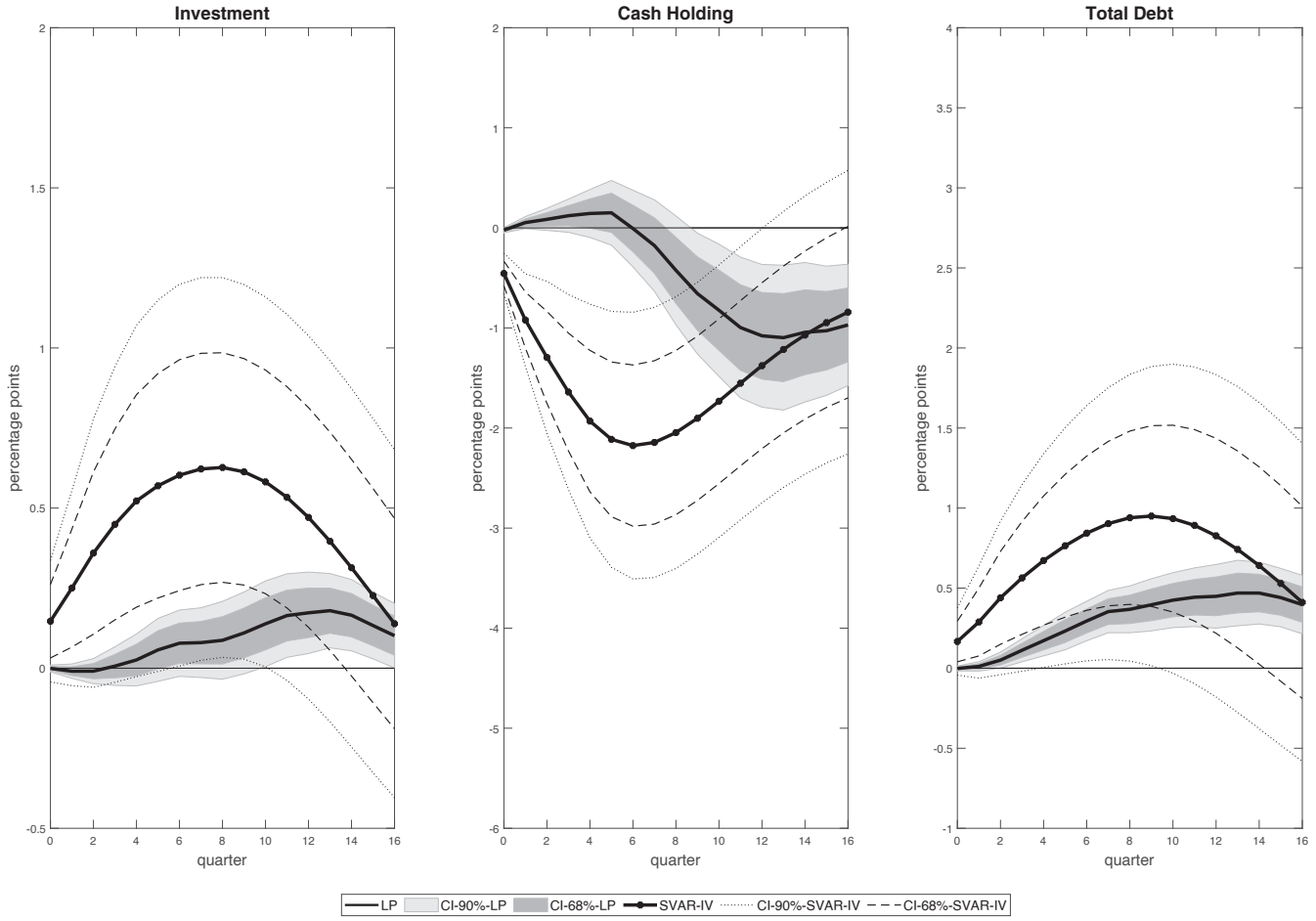

FIGURE 5 Responses to a 1% decline in MTR: LP and SVAR-IV model with difference. *Note*: This figure shows the difference in the IRFs of investment/cash/debt between small and large firms to an exogenous marginal tax cut of 1%. Impulse responses are based on LP (Equation 1) model and the SVAR-IV model (Equation 2) with four lags. This figure confirms that the difference in the IRFs between small and large firms are significant. We provide 68% and 90% confidence intervals that are computed using the delta-method.

Our results show that large firms respond to exogenous tax cuts by boosting investment. A 1% cut in MTRs stimulates an increase in the investment of large firms up to a maximum of 0.86 percentage points 3 years after the tax date. The investment response of small firms is slightly significant and reaches a maximum of 0.21 percentage points 1 year after the shock. However, the cash response of small firms is insignificant at all horizons, while the response of large firms becomes significant after eight quarters, with the maximum fall in the growth rate reaching 2.79 percentage points. The relative patterns of total debt mirror the relative patterns of investment for both size groups. The growth rate of debt for large and small firms rises by 2.51 percentage points and 0.28 percentage points, respectively.

The difference in investment/cash/debt between small and large firms (large-small) is shown in the third column in Figure 4. The cumulative differences of investment, cash, and debt across size classes reach a maximum of 0.63, −2.14, and 0.94 percentage points, respectively, 2 years after the shock.

As shown in Figure 5, both the SVAR-IV and LP approaches estimate relatively similar impulse responses. Although the confidence bands in the SVAR-IV results are wider than in the LP, the estimated responses in our SVAR-IV model for large firms are similar to that of the previous results with the LP method. The results from the SVAR-IV model, therefore, appear to imply that our results obtained using the local projection technique are robust to our econometric methodology.

6.3 | Discussion

Our findings suggest that a tax cut for large firms stimulates more investment growth than a similarly sized tax cut for small firms. To discuss the heterogeneous responses of small and large firms, we distinguish the income and substitution effects of tax cuts. These two effects also correspond to the role played by average as opposed to marginal tax rates.

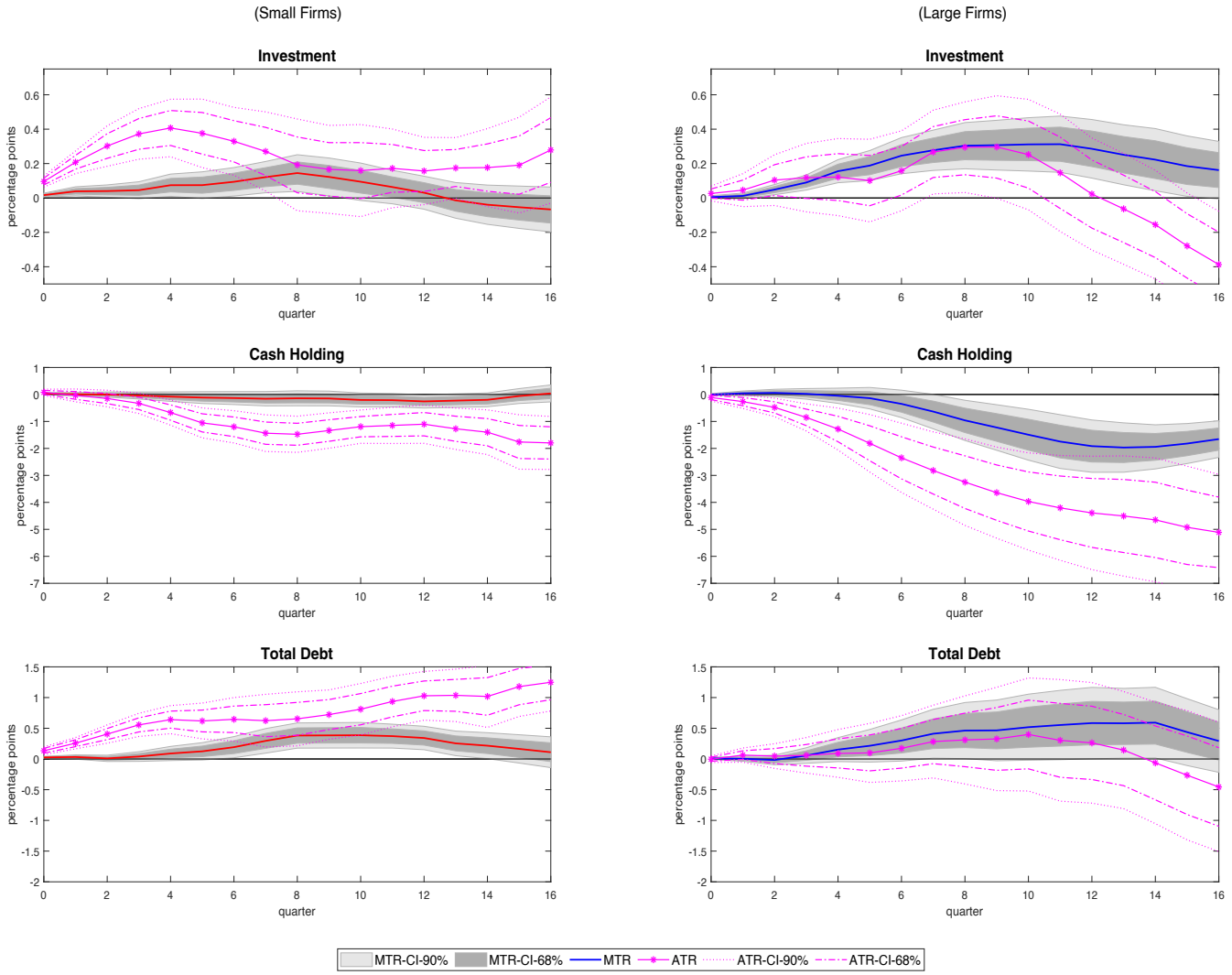

FIGURE 6 ACITRs versus MTRs. *Note*: This figure shows the IRFs of small and large firms to changes in average corporate income tax rates (ACITRs) constructed by Mertens and Ravn (2013) versus our MTRs.

First, tax decreases have an income effect. Because tax liability is a determinant of corporate investment, declines in tax rates act as retained earnings and increase the firm's available resources for investment.[26]

Second, we introduce the substitution effect. Following a tax cut, firms are induced to use cash instead of debt, given the tax deductibility of debt. Because the value of the tax shield depends on the tax rate and the amount of outstanding debt, a reduction in the tax rate decreases the value of holding debt. Firms therefore have an incentive to use cash instead of debt to finance investment as the advantage of debt financing declines. This substitution effect can help explain why large firms use relatively more cash than small firms—the tax deductibility of debt, valued at the MTR, encourages firms to use cash rather than debt to finance investment following a decline in tax rates. This effect is stronger for large firms as they are more leveraged and benefit more from the tax shield. When the MTR falls, they are thus more likely to substitute cash for debt to finance their investment. This higher tendency of large firms to use cash then becomes even stronger, because their investment is more responsive to the tax cut and requires a greater amount of funds.[27]

Therefore, at one end of the spectrum, we have an income effect that is related to reforms that reduce average tax liabilities without affecting marginal rates and primarily act as a retained earnings. At the other end is the substitution

[26] Our result that large firms are more sensitive to this channel is inline with the finding of Moyen (2004) that unconstrained firms are more likely to increase investment in the high income periods.

[27] Almeida et al. (2004) show that financially constrained firms display a systematic propensity to save cash out of cash flow, while unconstrained firms do not display this propensity.

effect, which alters financing incentives. Although the effect of changes in the ATR on corporate activities has been studied before (see, e.g., Mertens & Ravn, 2013), our contribution lies in isolating the distinct effect of changes in the MTR on firms' financing decisions.

6.4 | Comparison with broader measures

The main aim of this paper is to explore the impact of variation in MTRs on corporate activities. Examining variation in MTRs allows us to estimate the firms' responses to a similarly-sized tax shock. Our identification strategy excludes variation in corporate taxes that do not contain changes in marginal rates. However, it is useful to compare the results obtained via our series of changes in MTRs with existing conventional measures to determine whether any potential differences exist. We therefore consider two broader measures: (i) Exogenously identified average corporate income tax rates (ACITR) (Mertens & Ravn, 2013); and (ii) the statutory rate for the top tax bracket (TSTR).

Figure 6 shows the IRFs of small and large firms to changes in the average versus the marginal tax rate. The results show that the estimates based on the ACITRs are quite different from the MTRs for both groups of firms. In particular, the implied impact of a change in ACITRs on small firm investment is initially positive and larger than those found using MTRs and then falls slowly. For large firms, it is not significantly different from zero. In addition, while the responses of investment and total debt are quite different from our baseline results (Figure 3), the cash response is similar.

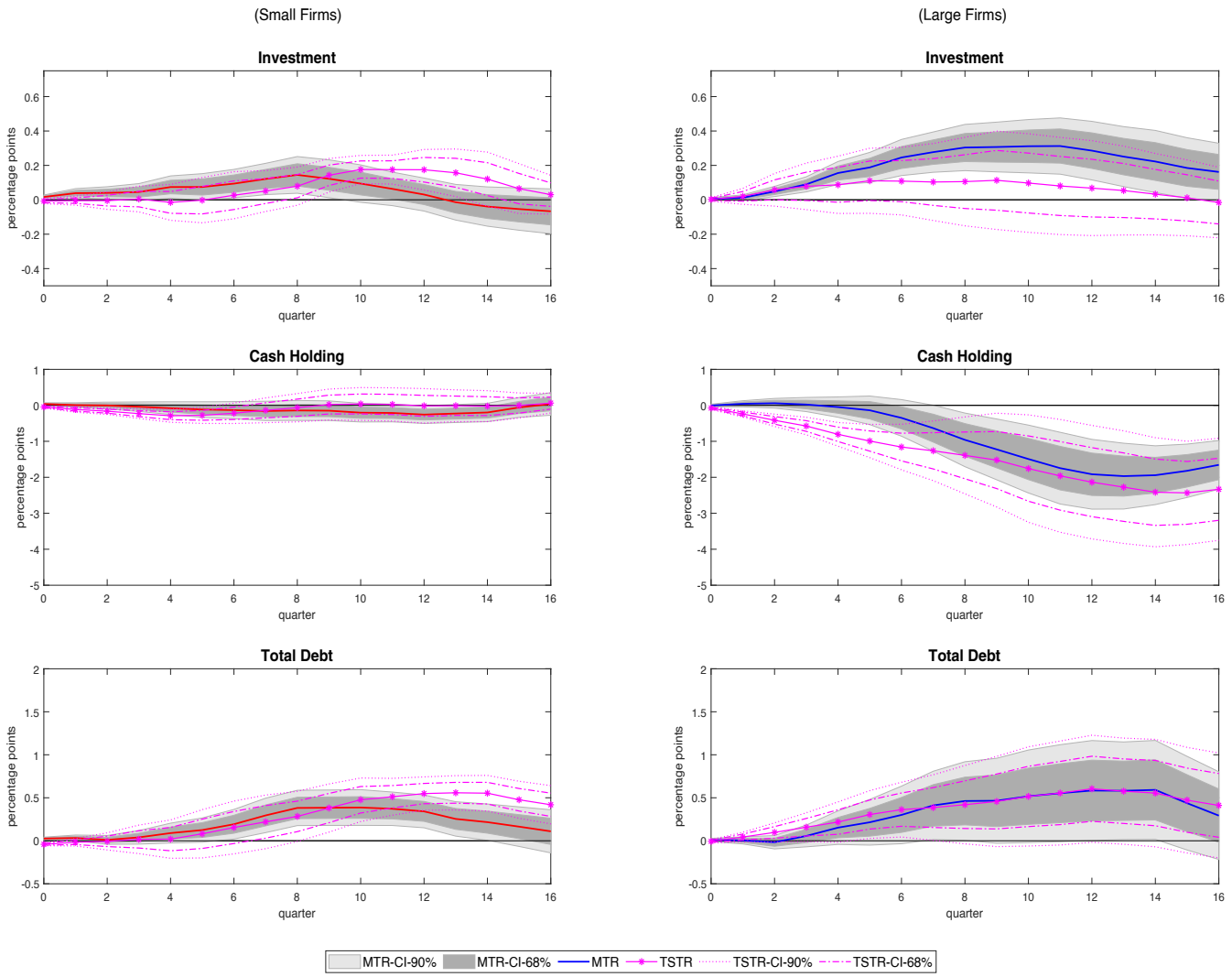

FIGURE 7 TSTRs versus MTRs. *Note*: This figure shows the IRFs of small and large firms to changes in the statutory rates for the top tax bracket (TSTRs) versus our MTRs.

These differing responses could occur for two reasons: (i) While ACITRs consider all exogenous policies affecting tax liabilities, including changes in deductions, exemptions, credits, and preferential rates, our identification strategy eliminates reforms that were not implemented through changes in statutory rates. For example, investment incentive reforms such as the 2002 and 2003 laws are excluded from our MTRs. Reforms that reduce tax liabilities without affecting statutory rates are therefore included in the ACITRs and excluded in our measures of MTRs; (ii) as discussed above, cutting the average tax rate has an income effect while cutting the marginal rate has a substitution effect. We therefore expect ACTIRs and MTRs to have different effects on small and large firms.

As shown in Figure 7 below, the implied impact of a decline in TSTRs of 1% is not significant for the investment of either group of firms. However, the impact on total debt and cash holdings is similar in size and timing to our baseline results. Note that the TSTR series include all variations in the top bracket statutory rates, covering both endogenous and exogenous reforms.

7 | FIRM-LEVEL EVIDENCE

In this section, we provide firm-level evidence on the effects of changes in the MTR. We verify our results for large firms by complementing our analysis with panel information from Compustat. To do so, we use a sample of all Compustat firm-year observations, with the exception of financial firms (SIC codes 6000–6999) and utilities (SIC codes 4900–4999), to eliminate the possible effects of regulation. We exclude firm-years with nonpositive values for total book assets, sales, and cash holdings, or with negative values for capital expenditures. We also perform a separate analysis for manufacturing firms (SIC codes 2000–3999). Following the existing literature (Bates et al., 2009), we winsorize the outliers in control variables as follows. Leverage is winsorized to fall between zero and one. R&D/sales, acquisitions/assets, cash flow volatility, and capital expenditures are winsorized at the 1% level. The bottom tails of net working capital/assets and cash flow/assets are winsorized at the 1% level, and the top tail of the market-to-book ratio is winsorized at the 1% level. These sample selection criteria result in 265,859 (139,067) firm-year observations corresponding to 20,973 (9802) unique firms (manufacturing). Table A2 shows summary statistics for nonfinancial and nonutility public US companies. See Appendix A for definitions of the variables.

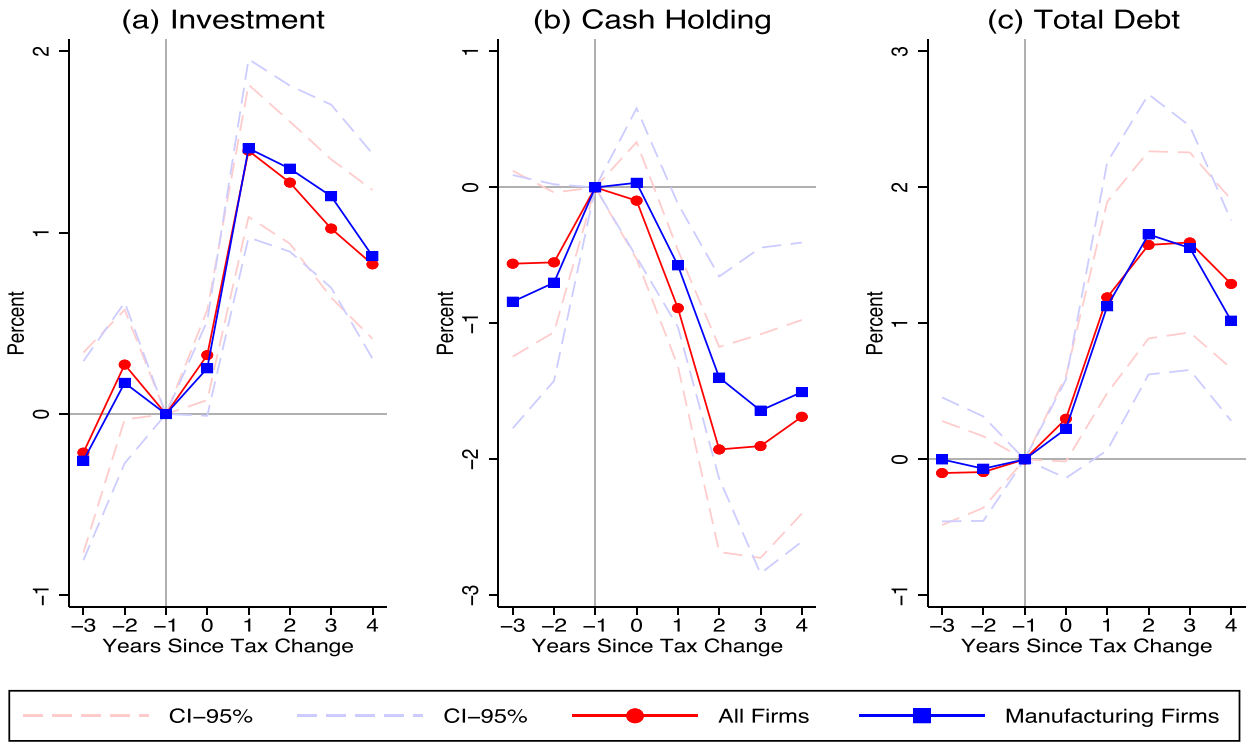

FIGURE 8 Firm-level effects of tax changes. *Note*: This figure shows the effect of a 1% decline in MTRs on the path of average corporate investment/cash/debt. The red and starred blue lines indicate responses of all and manufacturing Compustat firms. Standard errors are robust and clustered by firms; 95% confidence intervals are shown as dashed lines.

We estimate the relationship between changes in corporate MTRs and the investment, cash, and debt of public US companies. To examine how the path of firm-level activity evolves before and after MTRs shocks, we follow Zidar (2019) and run a series of direct projection regressions for different horizons ($h = -4, -3, \ldots, 5$) as follows:

$$y_{i,t+h} - y_{i,t-1} = \beta_h mtr^f_{i,t} + X'_{i,t}\Lambda_h + \mu_{i,h} + \delta_{t,h} + \epsilon_{i,t,h} \tag{3}$$

where y is the logarithm of the variable of interest, $y_{i,t+h} - y_{i,t-1}$ is the growth rate of the variables of interest, i and t are the index firm and year, $\epsilon_{i,t,h}$ is a residual component, and $\mu_{i,h}$ and $\delta_{t,h}$ are horizon-specific firm and year fixed effects. We estimate the series of regressions using yearly data. We include two groups of control variables: firm-specific variables and macroeconomic conditions in the vector of controls $X_{i,t}$.[28] $mtr^f_{i,t}$ are the exogenous changes in statutory corporate income tax rates faced by each firm in our sample. The coefficient β_h gives the response of y at time $t+h$ to the shock at time t, for each variable of interest. We use this direct projection approach to estimate average outcomes 3 years before and 4 years after the tax shocks.

Figure 8 presents the IRFs. It shows the evolution of the investment/cash/debt of all firms along with that of manufacturing firms. The general results of the firm-level analysis are remarkably similar to our semiaggregate QFR analysis. Panel (a) shows that investment exhibits little trend prior to the tax change, before increasing and reaching a peak of 1.5% after 1 year and falling to 1% 2 years after the shock, all significant at the 5% level for manufacturing and all firms. Panel (c) shows similar patterns for total debt. Panel (b) shows the evolution of cash relative to the year before the tax change. In addition, cash tends to be 2% lower 2 years after the shock and increases slightly to roughly 1.8% lower 4 years after the shock. Overall, our firm-level evidence corroborates our previous findings for the large QFR firms. Note that because the Compustat dataset is restricted to public firms, the results are comparable to those of the large group of QFR firms.

8 | CONCLUSION

This paper explores the impact of corporate income tax cuts on small and large manufacturing firms in the United States. We use a unique dataset of firms' balance sheets and income statements and construct new measures of variation in marginal tax rates to reveal the significant effects of tax changes on corporate investment. Because our study aims to compare the impact of taxes on small and large firms, we need to construct a measure that allows us to estimate the response of firms to a similarly sized tax shock. The narratively identified exogenous changes in the marginal tax rate is a suitable measure for this purpose.

Restricting our attention to the set of changes in the exogenous marginal tax rates in the United States between 1956 and 2008, we identify a total of six exogenous marginal tax cuts at 1964Q2, 1965Q1, 1979Q1, 1982Q1, 1983Q1, and 1987Q3. We then use local projections and structural vector autoregressive models to quantify the response of investment, cash, and total debt to a decline in marginal rates for small and large firms, and the difference between large and small firms. The responses of large firms are found to be more pronounced for all three variables. We also find that the investment response of large firms to a marginal tax cut is greater than the response of small firms. In addition, we show that small firms' new investments are financed almost entirely by issuing new debt, whereas large firms use both their internal cash holdings and debt. This finding supports the view that financing constraints play a key role in firms' responses to tax policy.

These heterogeneous responses to changes in marginal tax rates are very different from responses to broader measures of exogenous tax changes. For instance, we first show that unconstrained firms are more responsive to changes in marginal tax rates. We then find evidence consistent with the view that constrained firm investment is significantly more responsive to changes in average rather than marginal tax rates.

There are different avenues for future research. It would be interesting to extend our research methodology to other countries. Narratively identified tax changes are available for a broad set of countries (e.g., Alesina et al., 2015; Cloyne, 2013; Hayo & Uhl, 2013; Gil et al., 2018; Pescatori et al., 2014; Riera-Crichton et al., 2016), allowing the

[28] Firm-specific explanatory variables are acquisitions, cash flow volatility, cash flows, R&D, market-to-book ratio, net working capital, and log of real assets. Macroeconomic factors are real GDP growth, federal funds rate, unemployment rate, VXO, inflation, and economic policy uncertainty (EPU).

replication and comparison of our results across countries. Moreover, our empirical results could motivate theoretical work on a model of precautionary cash-holding with endogenous firm access to financial markets. This would allow for a deeper understanding of how large firms optimize their capital structure toward a more diversified credit portfolio.

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OPEN RESEARCH BADGES

This article has earned an Open Data Badge for making publicly available the digitally-shareable data necessary to reproduce the reported results. The data is available at DOI 10.15456/jae.2023169.1708641788.

DATA AVAILABILITY STATEMENT

Data have been provided to the journal, and it is available at Journal of Applied Econometrics Data Archive.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of the article.

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APPENDIX A: VARIABLE DEFINITIONS

QFR Analysis: All variables in brackets are the QFR data items. Note that in our regression analysis, we use the growth rate of the QFR variables (see Section 3.2).

- *AAA-FFM*: Moody's Seasoned AAA Corporate Bond Minus Federal Funds Rate (Source: FRED).
- *BAA-FFM*: Moody's Seasoned BAA Corporate Bond minus Federal Funds Rate (Source: FRED).
- *Cash*: Sum of total cash, US Government and other securities [*TOCASHSEC*].
- *CFL volatility*: For each group of the QFR firms, aggregate cash flow volatility is defined as the variance of *cash flow/assets* over the previous 4 years.
- *Cash flow/assets*: For each group of the QFR firms, operating cash flows is measured by: $(NIAT_t - \Delta TOCRASSET_t - \Delta TOCASHSEC_t + \Delta TOCRLIAB_t)$ over total assets [*TOTASSET*], where [*NIAT*], [*TOCRASSET*], [*TOCASHSEC*], and [*TOCRLIAB*] indicate, respectively, net income after tax, total current asset, cash-holding, and total current liabilities.
- *Econ policy uncertainty (EPU)*: Economic Policy Uncertainty index of Baker et al. (2016).
- *Investment*: Quarterly change in fixed assets [*TOTASSET-TOCRASSET*].
- *Long-term Debt (LTD)*: Sum of long-term loans from banks due in more than 1 year [*STBANK*], long-term bonds and debentures due in more than 1 year [*LTBNDDEBT*], other long-term loans due in more than 1 year [*LTOTHDEBT*], current portion of long-term loans from banks due in 1 year or less [*INSTBANKS*], current portion of long-term bonds and debentures due in 1 year or less [*INSTBONDS*], current portion of other long-term loans due in 1 year or less [*INSTOTHER*].
- *Real GDP growth*: Real GDP, percent change from year ago, quarterly, seasonally adjusted annual rate (chained 2012 $) (Source: FRED).

TABLE A1 Summary statistics.

	Small firms				Large firms				
Variable	**Mean**	**SD**	**Min.**	**Max.**	**Mean**	**SD**	**Min.**	**Max.**	**Observations**
Cash/assets (%)	9.618	1.161	7.477	12.65	5.879	2.28	3.18	14.573	247
Cash flow volatility	0.004	0.002	0.001	0.009	0.003	0.002	0.001	0.009	244
Cash flow/assets	0.023	0.006	0.011	0.044	0.02	0.008	0.002	0.044	246
Sales/assets (%)	44.356	8.293	27.651	55.214	25.035	5.566	12.846	33.745	247
STD/assets (%)	5.887	1.293	3.28	8.668	2.939	0.794	1.571	4.673	247
LTD/assets (%)	20.389	5.274	8.397	29.063	19.817	3.904	12.293	28.247	247
Investment/assets (%)	42.035	7.721	33.813	59.112	63.513	9.950	45.434	79.639	246
Capex/assets (%)	20.405	5.467	11.336	30.391	16.941	5.883	9.823	28.314	247
NWC/assets (%)	28.675	5.56	17.839	37.182	14.019	10.501	1.565	33.042	247

Note: The sample includes manufacturing firms drawn from the US Census Bureau, Quarterly Financial Report (QFR) from 1956 to 2008.

- *Real Treasury bill rate*: End-of-year secondary market rate on 3-month Treasury bills, minus inflation (Source: FRED).
- *Sales*: Net sales, receipts, and operating revenues [*SALES*].
- *Short-term Debt (STD)*: Sum of short-term loans from banks with original maturity 1 year or less [*STBANK*], short-term commercial paper with original maturity 1 year or less [*COMPAPER*], other short-term loans with original maturity 1 year or less [*STDEBTOTH*].
- *Leverage*: Sum of short-term debt (*STD*) and long-term debt (*LTD*) over total assets [*TOTASSET*].

Firm-Level Analysis: All variables in brackets are Compustat data items.

- *Acquisition activity*: Acquisitions [*aqc*] scaled by total book assets [*at*].
- *Cash*: Sum of cash and short-term investments [*che*].
- *Cash flow/assets*: Operating income before depreciation [*oibdp*], after interest [*xint*], dividends [*dvc*], and taxes [*txt*] over total book assets [*at*].
- *Industry sigma*: For each firm-year and two-digit SIC group, we calculate the standard deviation of *cash flow/assets* over the past 10 years. If fewer than 3 years of lagged data are available, the standard deviation is set to missing. Industry sigma for a two-digit SIC group is calculated as the average standard deviation of *cash flow/assets* across all firms in the group.
- *Investment*: Capital expenditures [*capx*].
- *Market to book*: The market value of assets [$at + prcc\_f \times csho - ceq$] over total book assets [*at*].
- *NWC/assets*: Net working capital [*wcap-che*] over total book assets [*at*].
- *Real assets*: The book value of assets [*at*] in year 2012 real dollars.

TABLE A2 Summary statistics for firm-level variables.

Variables		All firms	Manufacturing firms
Acquisition activity	Mean	0.0176	0.0156
	SD	0.0567	0.0529
Industry sigma	Mean	0.2528	0.2466
	SD	0.6594	0.7961
Cash/assets	Mean	0.1599	0.1675
	SD	0.2052	0.2100
Sales/assets	Mean	1.4347	1.3853
	SD	27.8790	35.4894
Cash flow/assets	Mean	−0.0573	−0.0543
	SD	2.9097	3.6535
Debt/assets	Mean	0.5000	0.4523
	SD	15.9007	15.9291
Capex/assets	Mean	0.0715	0.0579
	SD	0.1219	0.0622
R&D/sales	Mean	0.3431	0.5641
	SD	3.0903	4.1062
Market to book	Mean	1.8356	1.8077
	SD	5.0384	4.4725
NWC/assets	Mean	0.0156	0.0915
	SD	0.8362	0.7744
Ln(real book assets)	Mean	0.1906	0.1861
	SD	2.3233	2.2507
No. of firm-years		265,859	139,067
No. of unique firms		20,973	9,802

Note: This table reports summary statistics for variables used in our firm-level analysis. We use a sample of all Compustat firm-year observations, except financial firms (SIC codes 6000–6999) and utilities (SIC codes 4900–4999), to eliminate the possible effects of regulation. We exclude firm-year with nonpositive values for total book assets, sales, cash holdings, or negative values for capital expenditures. We also do a separate analysis for manufacturing firms (SIC codes 2000–3999). These sample selection criteria result in 265,859 (139,067) firm-year (manufacturing) observations corresponding to 20,973 (9802) unique firms (manufacturing).

- *R&D/sales*: R&D expenditures [*xrd*] over sales [*sale*]. R&D is set equal to zero when missing from Compustat.
- *Debt*: Sum of short-term debt [*dlc*] and long-term debt [*dltt*].

APPENDIX B: NARRATIVE TAX CHANGES

This appendix provides a narrative analysis of all historical legislated changes in federal corporate income tax rates in the United States over 1956–2008. It then uses the narrative analysis of Romer and Romer (2009), to determine the primary law and motivation of every piece of change and its consequent impact on statutory tax rates for firms in different income brackets. As shown in SOI Table 24, since 1956, the Internal Revenue Service (IRS) reports 12 changes in tax rates at 1964Q2, 1965Q1, 1968Q3, 1970Q1, 1971Q2, 1975, 1979Q1, 1982Q1, 1983Q1, 1984Q3, 1987Q3, and 1994. In the following, we detail each reform.

1 **The Tax Cut of 1964Q2.** During 1953–1963, the baseline tax rate was 30% for both low-income and high-income firms—segregated by the income threshold $25,000—with an additional surtax of 22% for high-income firms.[29] In 1964, following the Revenue Act of 1964, the baseline rate declines by 8 percentage points, and the surtax increases by 6 percentage points, resulting in the overall 22% and 50% for the two groups. The most significant impact of the Revenue Act of 1964 was reducing the rate of income taxes, where it was the single largest first-year tax cut of the post-WW II era, $11.5 billion, effective on both corporate and individual income (see Ahern, 2004). Consequent to this act, the baseline tax rate declined by 8 percentage points while the surtax for high-income firms increases from 22% to 28% in 1964 and 32% in 1965. Overall, the tax rate for low-income firms—with income less than $25000—declined by 8 percentage points from 30% to 22% and 2 percentage points for high-income firms from 52% to 50%. It clearly means that the reform is in favor of small corporations by a substantial rate reduction for this group—cutting 8 and 2 percentage points for low- and high-income firms are equal to decreasing the tax rates of 26.7% and 3.8% (see Lowndes, 1964, for a discussion on the Revenue Act of 1964). As discussed by Romer and Romer (2009), the motivation of this tax cut was to faster long-run growth and therefore is considered an exogenous reform. The Revenue Act of 1964 was a tax cut act proposed by President Kennedy in 1963 but signed into law by President Johnson on February 26, 1964 and planned to be implemented in two stages in 1964 and 1965. Since the first round of cuts implemented within 90 days of becoming law, we classify the tax cut of 1964Q2 as unanticipated (see Mertens & Ravn, 2012).
2 **The Tax Cut of 1965Q1.** On January 1, 1965, the second and final round of the bill went into effect and the tax rate for high-income firms declined from 50% to 48% by reducing the surtax from 28% to 26%. Therefore, this was restricted to high-income firms. Note that there is another tax cut in 1965 named the Excise Tax Reduction Act of 1965. As discussed by Romer and Romer (2009), this excise tax cut was imposed to stimulate long-run growth and improve the efficiency and fairness of the tax system and, thus, was an exogenous policy. However, because this reform does not impact the statutory tax rates at any bracket, it is excluded from our analysis. Therefore, the exogenous tax cut in 1965Q1 is the anticipated consequence of the Revenue Act of 1964 and not to the Excise Tax Reduction Act of 1965.
3 **The Tax Increase of 1968Q3.** The Revenue and Expenditure Control Act of 1968 created a temporary income tax surcharge at the annual rate of 10% on both individuals and corporations applied until July 1, 1969.[30] There were other tax measures incorporated in this particular bill (see Woodworth, 1968). However, the surcharge overshadowed the rest of them and alone was expected to bring in about $12 billion in revenue in 1 year. Following this act, the tax rates for low-income and high-income firms—segregated by the income threshold $25,000—increased from 24% and 48% to 24.2% and 52.8%, respectively. Because the motivation for this reform was to prevent the economy from overheating, we consider it an endogenous reform and exclude it from our analysis (see Romer & Romer, 2009).
4 **The Tax Increase of 1970Q1.** According to the prior law, the 10% surcharge introduced by the Revenue and Expenditure Control Act of 1968 expired in 1969 and the tax rates declined to 24% and 48%. The Tax Reform Act

[29]Surtax (Super-tax) is a tax levied on top of another tax and can be calculated as a percentage of the baseline tax rate. In the US tax system, the surtax is progressive and will be in larger amounts for higher income brackets. For example, if the surtax is 10%, the final tax rate when the initial rate is 20% would be an overall rate of 22%, while the same surtax imposed on a rate of 60% would result in an overall rate of 66%.

[30]A surcharge is added to the baseline tax as percentage point. For example, if the tax rates are 20% and 60% for two brackets, imposing a 10% surcharge results in the final rates of 30% and 70%. Therefore, it is not progressive in the sense that automatically a 10% imposes a larger amount on top brackets. In some episodes surcharge has imposed on high income firms to discriminate between low-income and high-income firms, what later has been done by introducing income brackets.

of 1969 extended the surcharge at a 5% rate from January 1, 1970, through June 1, 1970. Because this amount was adapted on a semiannual base, this surcharge would be 2.5% on an annualized base. However, considering the endogenous nature of this tax change, we exclude it in our analysis as discussed for the tax increase of 1968.

5 **The Tax Cut of 1971Q2.** There is a tax cut from 22.55% and 49.2% to 22% and 48% for low-income and high-income firms on June 1, 1970. However, this is not due to a tax policy and returns to the initial tax rate after finishing the surcharge introduced by the Tax Reform Act of 1969. Because the initial increase has been endogenous, we exclude this return as well from our analysis.

6 **The Tax Cut of 1975.** In 1975, US corporate income tax brackets widened, and tax rates declined. This happened by breaking the over $25,000 bracket into [$25,000 $50,000] and over $50,000. Before this reform, corporate income was subject to a normal tax at a rate of 22% and a surtax at a rate of 26% (for a total tax rate of 48%). However, the first $25,000 of corporate income was exempted from the surtax. This reform increased the surtax exemption from $25,000 to $50,000. Therefore, the first $50,000 of corporate taxable income was taxed at the 22% rate, while any additional corporate income was taxed at the 48% rate. In addition, it provided a reduction for 1975 in the corporate normal tax rate from 22% to 20% on the first $25,000 of net income (with the 22% rate applicable to the second $25,000 of net income). However, as discussed in Romer and Romer (2009), the aim of the Tax Reduction Act of 1975 was to return economic growth to normal. Hence, this tax cut is not exogenous to macroeconomic variations, and it is excluded from our analysis.

7 **The Tax Cut of 1979Q1.** The changes in the tax rate in 1979 are due to the Revenue Act of 1978. This Act includes widening tax brackets and cutting tax rates. The tax cut is very different over income brackets: 18 percentage points for the [$50,000 $75,000] bracket and 2 percentage points for the [$25,000 $50,000] bracket. As discussed by Romer and Romer (2009), the motivation of this policy was a desire to raise real growth from normal to above normal, and the administration was quite explicit that in the absence of a tax cut, growth would slow to relatively normal levels. Therefore, it is an exogenous policy that is included in our narrative series. The Revenue Act of 1978 was signed into law on November 6, 1978, and implemented in the first quarter of 1978. Because these dates are no longer than 90 days apart, we classify the marginal tax cut of 1979Q1 as unanticipated (see Mertens & Ravn, 2012).

8-9. **The Tax Cuts of 1982Q1 and 1983Q1.** The 1% tax cut for two subsequent years in 1982 and 1983 for the first two income brackets was due to the Economic Recovery Tax Act of 1981. The Subtitle D of this Act for Small Business Provisions was implemented by striking out 17% for the first income bracket and inserting in lieu thereof 15% at 1983 (16% for taxable years beginning in 1982) and by striking out 20% and inserting in lieu thereof 18% at 1983 (19% for taxable years beginning in 1982).[31] Because this act was taken mainly for ideological or long-term reasons and not to return economic growth to normal (see Romer & Romer, 2009), we consider it as an exogenous policy in our analysis. In addition, the Economic Recovery Tax Act of 1981 was signed into law by President Reagan on August 13, 1981, and was implemented in the first quarters of 1982 and 1983. Therefore we classify the tax cuts of 1982Q1 and 1983Q1 as anticipated (see Mertens & Ravn, 2012).

10 **The Tax Increase of 1984Q3.** The Deficit Reduction Act of 1984 placed an additional 5 percentage points to the tax rate to phase out the benefit of the lower graduated rates for corporations with taxable income between $1,000,000 and $1,405,000. Corporations with taxable income above $1,405,000, in effect, pay a marginal rate of 46%. The key motivation for this act was deficit reduction and it was an exogenous reform.

11 **The Tax Cut of 1987Q3.** Following the Tax Reform Act of 1986, the tax rate revised to 15% for taxable income less than $50,000, to 25% for taxable income between $50,000 and $75,000; and to 34% for taxable income in excess of $75,000. The tax increase for corporations with a taxable income in excess of $100,000 was 5% or $11,750, whichever was less. Such rates became effective for tax years beginning on or after July 1, 1987. Before July 1, 1987, taxable income was subject to a two-tax rate schedule or a blended tax rate. At this date, an additional 5% tax, not exceeding $11,750, is imposed on taxable income between $100,000 and $335,000 to phase out the benefits of the lower graduated rates. Note that this change is not associated with the Omnibus Budget Reconciliation Act of 1987, adapted for deficit reduction in early 1987. As discussed by Romer and Romer (2009), because the reform Act of 1986 was motivated by a desire to make the tax system fairer, simpler, and more conducive to long-run growth and not by a desire to return growth to normal, we classify it as an exogenous action. The Tax Reform Act of 1986 was signed into law by President Reagan on October 22, 1986, and implemented in the third quarter of 1987. We classify the tax cut of 1987Q3 as anticipated (see Mertens & Ravn, 2012).

[31] See PUBLIC LAW 97-34–AUG. 13, 1981, available at https://history.nih.gov/research/downloads/PL97-35.pdf.

12 **Marginal Tax increase of 1994.** An additional 5% tax, not exceeding $11,750, was imposed on taxable income between $100,000 and $335,000 to phase out the benefits of the lower graduated rates. Moreover, an additional 3%, not exceeding $100,000, was imposed on taxable income between $15,000,000 and $18,333,333 to phase out the benefits of the lower graduated rates. We also exclude this reform because tax increases are not the interest of this study.

In all, we can see that among all variations in corporate statutory tax rates, the ones implemented in 1964Q2, 1965Q1, 1979Q1, 1982Q1, and 1983Q1 and 1987Q3 correspond to exogenous tax cuts.

APPENDIX C: ROBUSTNESS

Our baseline results are potentially sensitive to the numerous specification choices not guided by theory. In this appendix, we explore the sensitivity of our findings to these choices. We conduct robustness checks with respect to outliers (excluding the largest exogenous tax cut and excluding every single tax shock) and sample period, control for various tax reform provisions (personal income tax changes, capital gains taxes, and changes in corporate effective tax rates), and different data transformation (logarithm of the variables (in levels) with quarterly dummies and 4-quarter growth rates). In Appendix S1, other robustness checks are available with respect to our measures of firm size (different thresholds and excluding firms in the bottom and top asset brackets of the QFR sample), tax increases versus decreases, unanticipated versus anticipated tax changes, "apples-to-apples" comparison, the measurement error in our narrative shocks, and the responses of eight asset size brackets and all QFR firms. Finally, we extend our results by examining the effects of tax changes on various real and financial variables.

C.1 | Outliers and sample period

As discussed in the descriptive analysis, it is natural to question whether the largest exogenous tax cut (in 1987Q3: 22.62% for small firms and 25.4% for large firms) is driving the average results. We therefore re-estimate model (1), dropping the

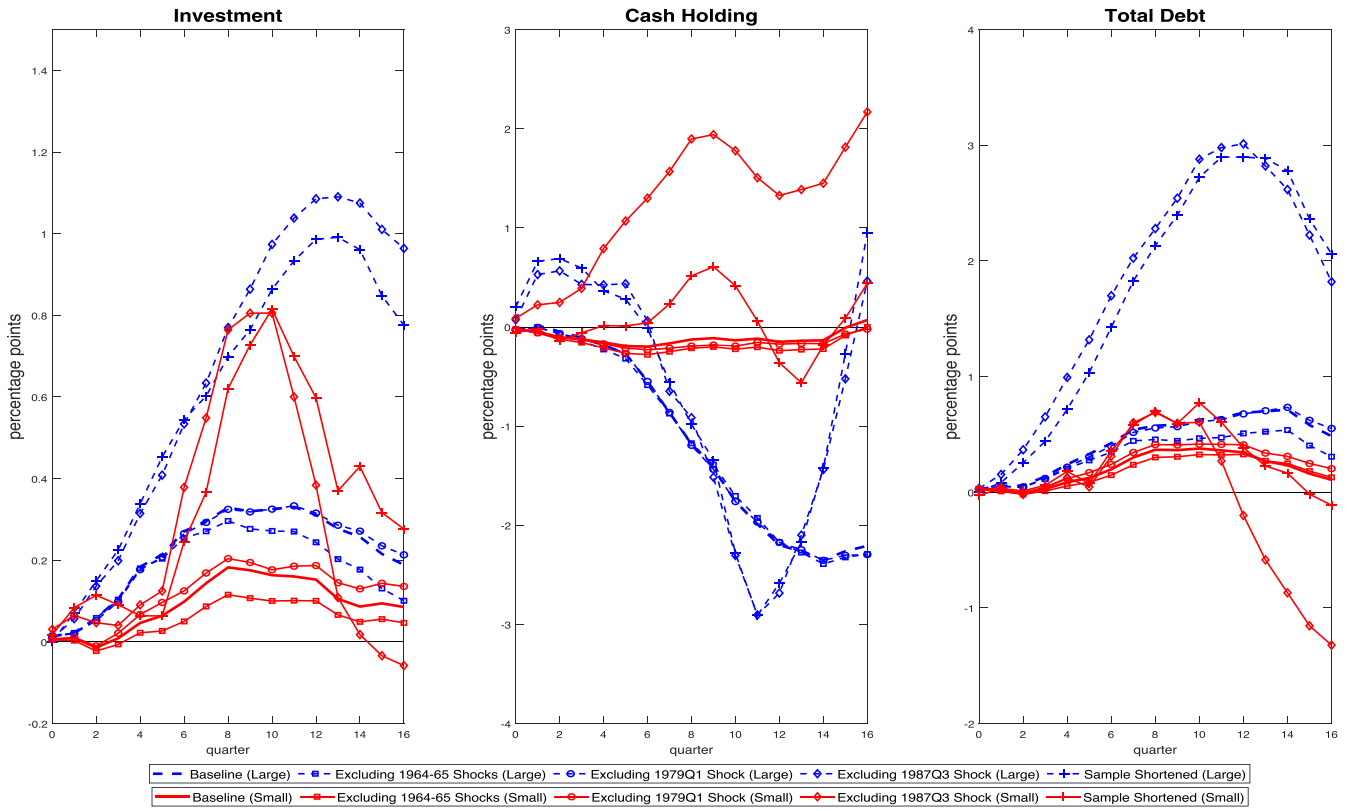

FIGURE C1 Sensitivity of the baseline results to excluding single shocks. *Note*: This figure plots the results of the model (1) dropping every single tax shock to ensure that any one tax date is not driving our baseline results.

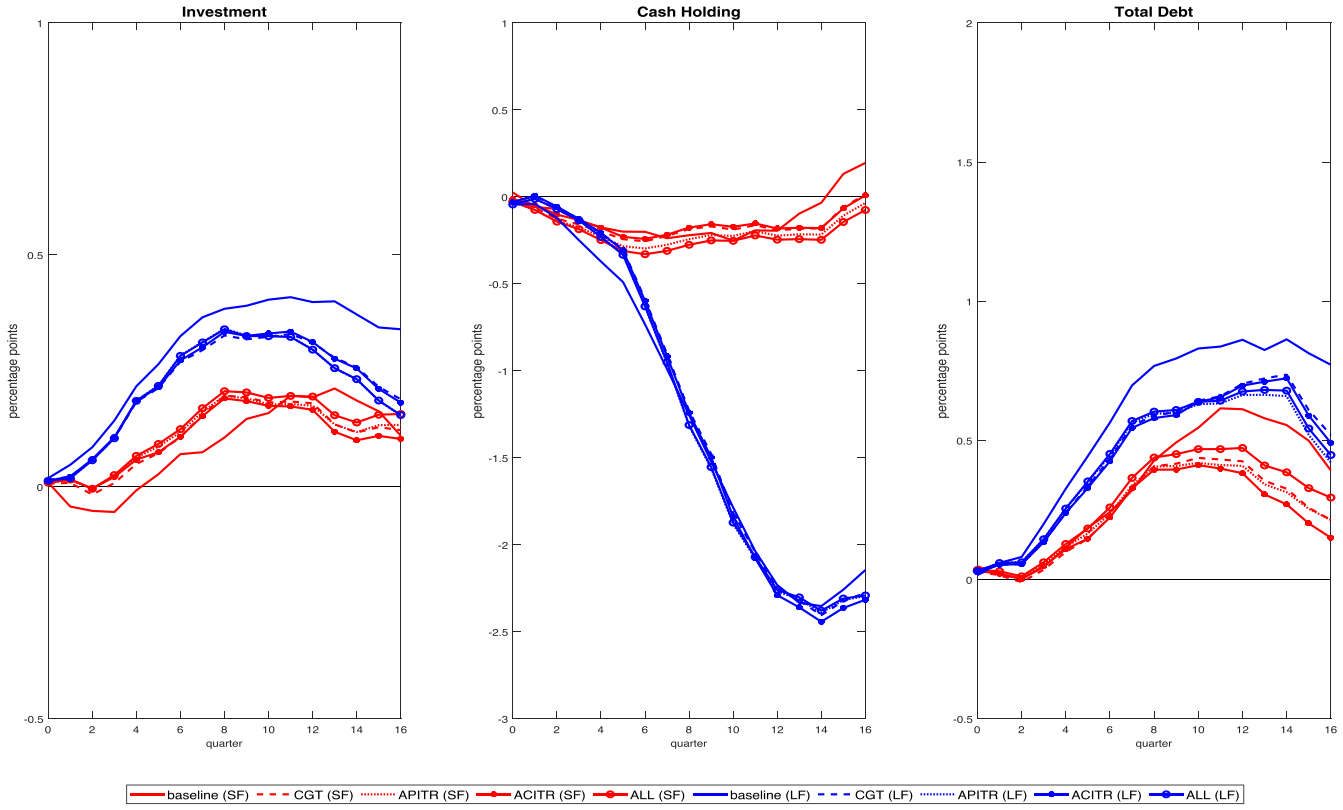

FIGURE C2 Sensitivity of the baseline results to other types of tax shocks. *Note*: This figure shows the results when we include three provisions of tax reforms (CGT, APITR, and ACITR) along with our measure of changes in MTRs in the model (1). Including changes of these tax reforms in the model has minimal effects on the responses of both small and large firms. This indicates that potential measurement error due to the correlation between these tax policies is not a serious concern in our analysis.

TABLE C1 Pairwise correlation coefficients.

Variable	MTR (small firms)	MTR (large firms)	CGT	APITR	ACITR
MTR (small firms)	1.0000				
MTR (large firms)	0.9997*	1.0000			
CGT	0.0943	0.0821	1.0000		
APITR	0.1405	0.1312	0.1689	1.0000	
ACITR	0.0565	0.0518	0.0735	0.3837*	1.0000

Note: This table reports the pairwise correlation coefficients between various provisions of tax reform.

1987Q3 tax date (the Tax Reform Act of 1986). Another way to address the possible importance of this extreme observation would be to end the sample in 1986Q1.[32] We also exclude every single tax shock to ensure that no particular tax date is driving our baseline results (see Section 5 for a detailed discussion).

Figure C1 suggests that our baseline result on the heterogeneous responses of small and large firms to a tax cut is robust. For both actions, excluding the extreme observation substantially increases the impact of a tax cut on investment. In addition, while it has a similar effect on the debt response of large firms, the effect on the response of small firms is small. However, while the investment response is significant at every horizon for large firms, it is only significant for small firms in multiple quarters after a tax cut. As shown in Figure C1, the results obtained by shortening the sample are very similar to excluding the largest shock. In addition, Figure C1 suggests that excluding extreme observations scarcely affects the averages, meaning that our results are not driven by any particular tax date.

[32]Shortening the sample period also allows us to deal with changes in tax provisions other than corporate tax rates at this date. Corporate MTRs and depreciation provisions changed simultaneously in some episodes, for example, in 1986.

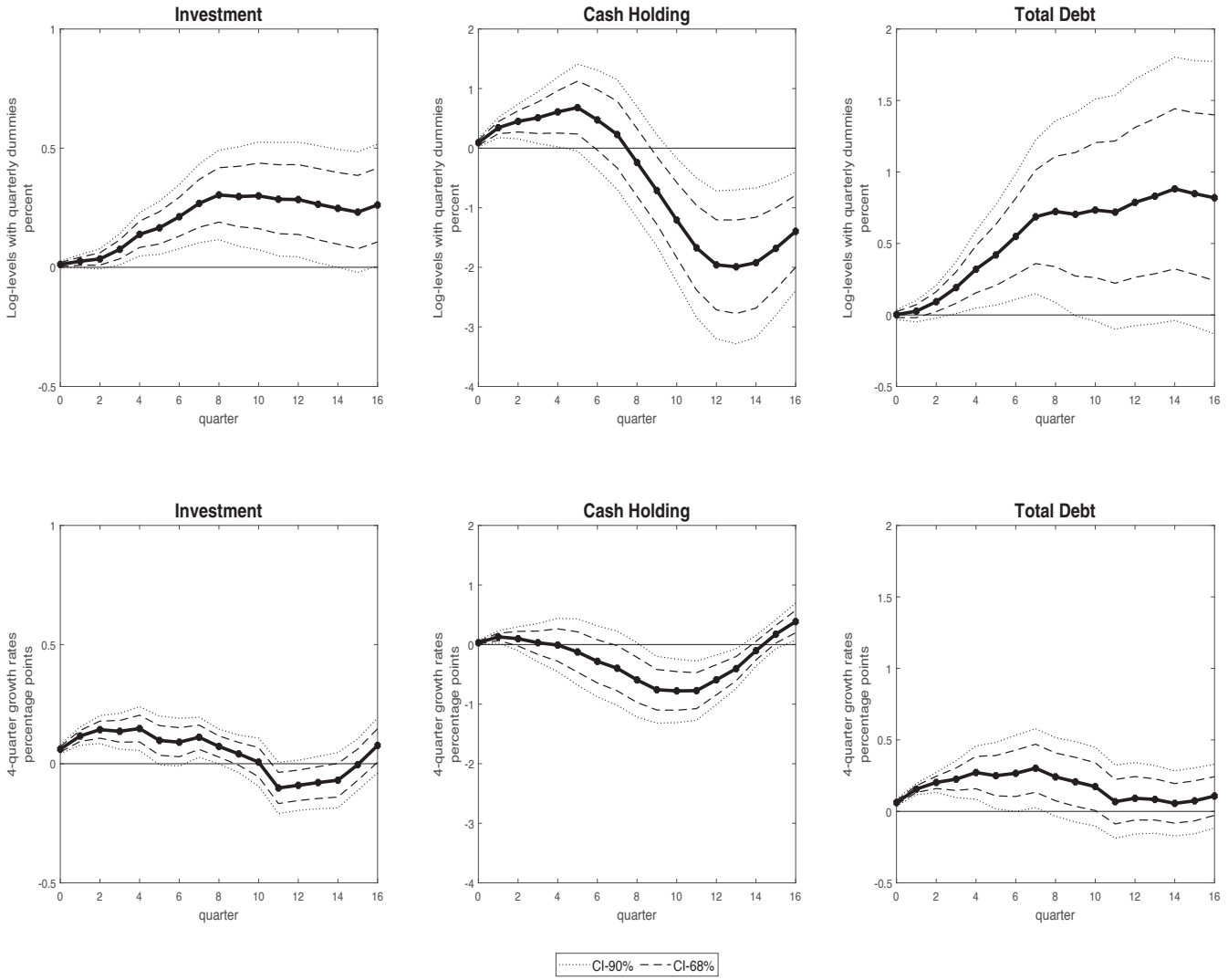

FIGURE C3 Responses to a 1% decline in MTR: Large/small difference with variables in 4-quarter growth rates and log-levels with quarterly dummies. *Note*: This figure shows the IRFs for the difference between large and small firms with the logarithm of the variables (in levels) with quarterly dummies, and 4-quarter growth rates.

C.2 | Controlling various provisions of tax reforms

Although our shocks are narratively identified and are less likely to be affected by an omitted variable, endogeneity is always a possibility and we, therefore, control for some potentially omitted variables to make sure that our estimations are not biased. We consider three possible sources of omitted variable bias by controlling capital gains taxes (CGT), personal income taxes, and average corporate income taxes. CGT is the first potential omitted variable to consider. We, therefore, estimate model (1) by including changes in the top statutory CGT rate along with MTRs to deal with this potential bias. Figure C2 shows that our baseline results are robust to this modification.

Personal income tax policy is perhaps the most important omitted variable to consider. Mertens and Ravn (2013) show that both personal and corporate income taxes are adjusted simultaneously, and the correlation between them is 0.42. Previous studies have addressed the effect of personal taxation on firms via its impact on the corporate bond spread (Elton et al., 2001).[33] To address this concern, we include the exogenous shocks in the personal income tax rate (APITR) constructed by Mertens and Ravn (2013) along with our measure of changes in MTRs in model (1). As Figure C2 makes

[33]Corporations can switch from C- to S-corporation status and back again if they meet the legal requirements, but as documented in Yagan (2015), switching is rare empirically because consecutively switching back and forth is restricted by law.

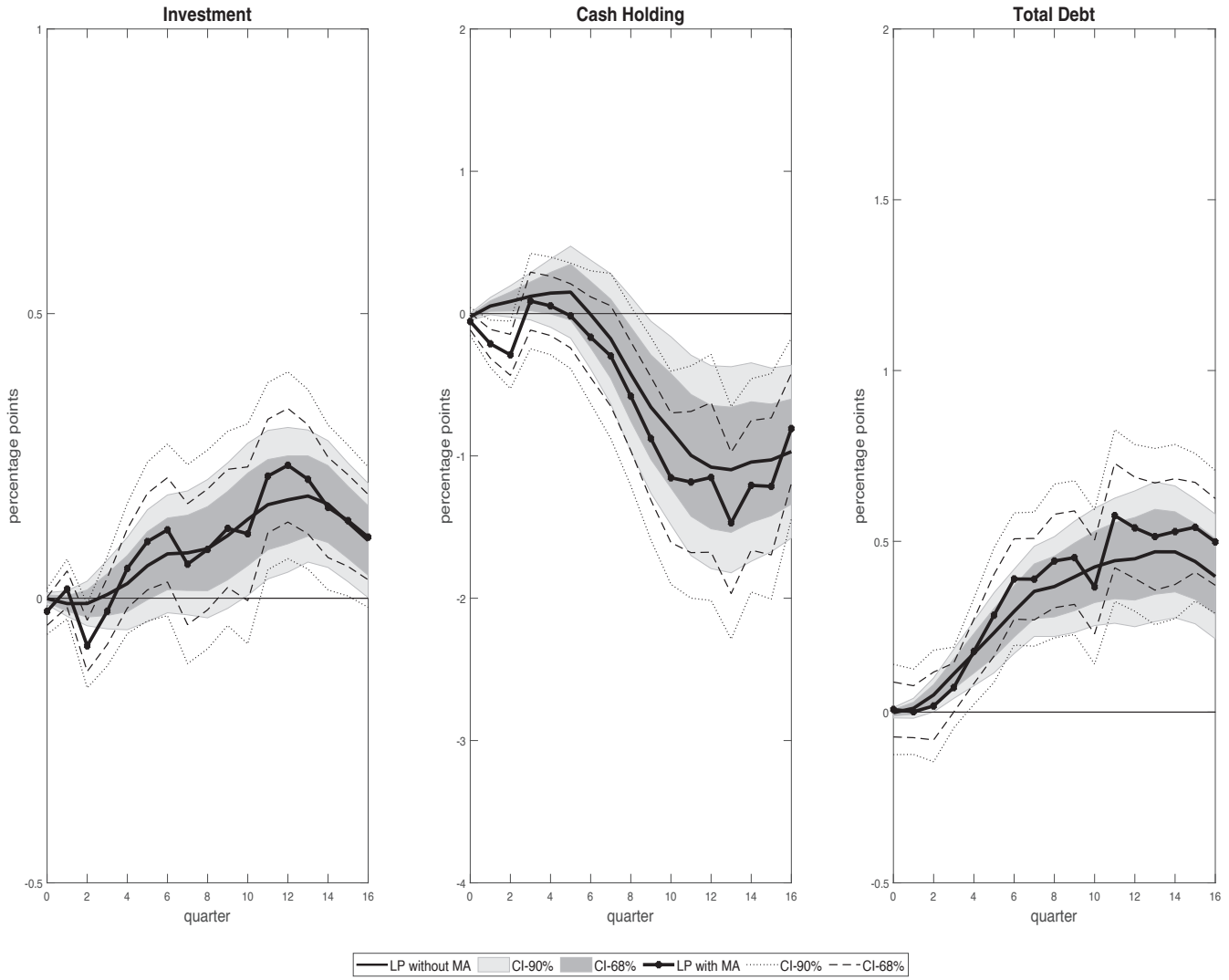

FIGURE C4 Responses to a 1% decline in MTR: Large/small difference with smoothed and unsmoothed data.

clear, including personal income tax shocks in the model has a minimal effect on the responses of both small and large firms.

In addition, controlling for average tax rates allows us to disentangle the effect of marginal taxation. We, therefore, include changes in the exogenous corporate income tax rate (ACITR) constructed by Mertens and Ravn (2013) along with our measure of changes in MTRs in model (1) to deal with this potential measurement error. Figure C2 shows that our findings are robust to this specification.

Finally, because the correlation between various types of tax reforms and their interaction effects is potentially a problem, we include all three of the tax reform provisions (CGT, APITR, and ACITR) along with our measure of changes in MTRs in model (1). Figure C2 makes clear that the estimated responses to changes in corporate MTRs are robust to controlling for the various tax reforms and their interaction effects. Additionally, Table C1 presents simple pairwise correlation coefficients among the four tax reforms and confirms that their correlation is not a serious concern.

C.3 | Data transformations

Our baseline results are based on the growth rates of the variables of interest because the responses of small and large firms might be impacted by the different scales of the variables in these two groups. In addition, to see relative performance over a number of quarters around each tax date, we cumulate and linearly detrend these growth rates. This adjustment is particularly useful when seeking to understand the cyclical components.

However, to show how this transformation impacts the results, we re-estimate the local projection model (1) for the difference between small and large firms with two alternative approaches: the logarithm of the variables (in levels) with quarterly dummies, and 4-quarter growth rates instead of the growth rates discussed in Section 3.2. As shown in Figure C3, the results are robust to the use of the log-levels and 4-quarter growth rates. These findings would imply that such concerns about data transformations are not crucial.

In addition, as discussed in the manuscript, we use the X-13ARIMA-SEATS program (Win X-13) to adjust for seasonality. However, even after seasonal adjustment eliminates the predictable patterns, considerable volatility remains in our time series because seasonal adjustment does not account for irregular factors in the data. Therefore, we use the simple 4-quarter moving average to smooth the data and determine the underlying trend. Note that the results of smoothed or unsmoothed data are materially the same (Figure C4).