Firm Tax Uncertainty, Cash Holdings, and the Timing of Large Investment

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WORKING PAPER – CONTACT AUTHORS BEFORE CITING

October 30, 2014

ABSTRACT

Firms accumulate cash holdings for a variety of reasons, including as a buffer against uncertainty and to finance large investments. This paper explores whether there is a trade-off between two competing uses of cash holdings: precautionary savings that result from increased tax uncertainty and savings devoted to large investments. Specifically, we test whether firm-specific tax uncertainty affects the timing and incidence of large investments (or investment spikes) made by firms. In our baseline analysis, we find that firms with higher tax uncertainty have higher cash holdings and lower investment, and that this adverse impact is more pronounced at higher levels of investment where we expect the trade-off effect to be larger. We then focus on the timing of large investments using a hazard framework and find that greater tax uncertainty delays large capital investments. This trade-off between tax uncertainty and investment implies that, from a policy standpoint, a reduction in tax uncertainty could free up valuable financial capital for firm investment, which may currently be tied up as a cash buffer for firms that are highly uncertain about their future tax incidence.

Keywords: tax, uncertainty, investment, timing, cash, corporate saving
JEL Codes: D81, D92, G11, H25, M49

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We thank John Gallemore, Margot Howard, Edward Maydew, Jeremy Moulton, Marcel Gérard, and seminar participants at WHU – Otto Beisheim School of Management for helpful comments and suggestions.

1. Introduction

Corporations save in the form of cash holdings or other liquid assets for a multitude of reasons. To name a few, firms accrue savings or additional precautionary cash balances when external financing is costly, income uncertainty is high, and when their optimal capital investment is "lumpy" or relatively large (Riddick and Whited 2009). Empirically, Riddick and Whited (2009) find that these factors, and uncertainty in particular, have dramatic effects on a corporation's propensity to save. In this study, we set out to examine a specific source of uncertainty, tax uncertainty, in the context of a firm's savings and investment decision-making. When firms are uncertain about their future tax positions or tax policy, a portion of their savings may serve as a precautionary buffer against potentially high tax costs. And, as firms save more in response to tax uncertainty, this may imply that less savings is being directed toward other purposes, e.g. large capital investment.

The central purpose of this study is to explore this potential trade-off empirically, examining whether firms with greater tax uncertainty are more likely to delay the types of projects for which savings are alternatively used, namely large investments. This trade-off may be critical for understanding important microeconomic decision-making at the firm level, given that 25 to 40 percent of a typical plant's total investment over a given 17 year period comes from a single, large investment spike (Doms and Dunne (1997)). In the United States and other economies, most of the variation in aggregate investment comes from large investment spikes within firms (Gourio and Kashyap (2007)). Recent macroeconomic research by Bachmann et al. (2013) has emphasized that lumpy investment at the firm level plays an important role in the business cycle. Furthermore, Gourio and Kashyap (2007) argue that, "for the purposes of modeling investment fluctuations it is critical to understand the timing of investment spikes," (Gourio and Kashyap, pp. 4) underscoring the importance of examining this empirically.

Firms face idiosyncratic tax environments depending on their specific type and location of operations, corresponding tax positions, and different levels of enforcement. As a result, even firms with similar overall firm risk differ substantially in their effective tax rates from year to year (see, for example McGuire et al. (2011) and Jacob and Schütt (2014)). Following McGuire et al. (2011), we use the firm's specific standard deviation of annual effective tax rates (ETRs) over its absolute average ETR as a measure of firm-specific tax uncertainty.[1] The intuition is that a higher standard deviation of past tax rates translates into greater uncertainty about future tax rates (Jacob and Schütt (2014)). It is our goal to explore how this type of uncertainty impacts a firm's real decisions, namely, its saving and investment outcomes.[2]

In the proceeding analysis, we first use this measure of tax uncertainty to examine its relation to changes in cash holdings in the same vein as Hanlon et al. (2014), using a sample of all firms in Compustat from 1978–2012. Second, we derive a measure of a tax-induced cash buffer, as a portion of firm savings may serve as a precautionary buffer against potentially high tax costs. We use this measure, called the tax induced cash buffer, and the variation in ETR as two alternative measures of tax uncertainty. We then examine the effect of tax uncertainty on levels of investment using standard OLS and quantile regression models. We find that as a firm's tax induced cash buffer increases by one standard deviation (i.e. if 4 cents per dollar of cash flows are retained as a buffer for uncertain future tax payments), then a firm's level of

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1 Tax uncertainty may come from a combination of a variety of factors, including tax policy, a firm's tax positions, operational uncertainty, and other factors. We leave a more granular examination of the individual components of tax uncertainty to future research.

2 In Appendix A, we provide a hypothetical example that illustrates how this measure is calculated and how a firm with greater volatility in its past ETRs compares to a firm with stable past ETRs. The comparison also shows what a one standard deviation increase in this tax uncertain measure would look like, making the subsequent coefficient estimate interpretations more transparent.

investment to assets decreases by approximately 11.8 percent. While we find that tax uncertainty generally reduces firm investment, tax uncertainty has a dramatically larger negative effect on the upper quantile of investment. In fact, the effect at the 90th percentile is more than twice as large as the effect of tax uncertainty on investment at the median. Not surprisingly, this difference in the effect of tax uncertainty on incremental versus large investments provides evidence that the cash buffer set aside because of tax uncertainty is more of a binding constraint for larger investments in particular.

The traditional OLS framework for examining incremental investments may not be appropriate for studying large investments because large investments have an inherently lumpy function over time (Whited (2006)). A hazard analysis allows for lumpy investments and varied adjustment costs, unlike the OLS approaches used by a number of studies of incremental investment. We therefore use our measures of tax uncertainty within a hazard framework, following the approach of Whited (2006), to examine the effect of tax uncertainty on the timing of large investments specifically. The hazard results are consistent with the hypothesis that tax uncertainty and the tax-induced cash buffer delay large investment, or reduce the probability of a large investment at a given point in time. We find that one-standard deviation increase in the tax uncertainty delays an investment spike by 17-20 percent. For the average firm that has an investment spike each 4.23 years, this increase in tax uncertainty effectively extends the length of time until a firm's next investment spike to 5.07 years, or by about 10 months.[3]

This paper contributes to the literature in several ways. First, our study fills a critical gap in the investment literature by investigating a mechanism through which tax uncertainty affects investment, and large investments in particular. Tax uncertainty is distinct from general firm risk

[3] Given the macroeconomic importance of large investments, it is worth noting that the average recession length in the US from 1945 to 2001 was approximately 10 months, according to the NBER. http://www.nber.org/cycles.html

as variation in this component of uncertainty is, to a greater extent, controllable either through tax policy or by the firm reactions to tax policy. We offer insight into the nature of trade-offs involved in corporate savings or cash holdings, where greater precautionary savings due to tax uncertainty may directly lead to smaller savings devoted to large investments, thereby delaying their implementation. Second, our paper responds to the call for more research on the real effects of tax, in particular for investment, in Hanlon and Heitzman (2010). Tax uncertainty not only affects firm valuation (Jacob and Schütt (2014)) and persistence of earnings (McGuire et al. (2011)), but it also affects cash holdings (Hanlon et al. (2014)) and, as a consequence, large investments. This implies that tax uncertainty is a significant cost to firms and has real consequences for firm resource allocations.

Third, we extend the empirical literature on large investments specifically (Whited (2006) and Billett et al. (2011)) and show that uncertainty about future tax positions delays investments, highlighting a natural mechanism (i.e. precautionary cash holdings) through which these two variables interact. Fourth, our study contributes to the literature on uncertainty and investment effects more broadly (Blouin et al. (2012), Baker et al. (2013), Stein and Stone (2012)). These studies have not considered the mechanism of interest in our study (cash holdings) and the corresponding implications that this channel has for large versus incremental investments. Methodologically, the hazard analysis framework used in the present paper allows for such lumpy investments and varied adjustment costs, which fundamentally departs from the traditional incremental investment studies in an OLS framework. Finally, this paper extends the literature on the role of tax uncertainty and firm decision-making. Blouin et al. (2012) focus on the effect of tax uncertainty on incremental investment from aggressive tax avoidance which uses a measure available only after 2006. This study utilizes more general measures of tax uncertainty and a sample form 1978-2012 to allow for more general inferences.

2. Prior Research and Motivating Hypotheses

The present study builds on strands of literature within financial economics and taxation. In this section, we first want to provide a brief survey of a relatively broad literature on the determinants of corporate savings and why exactly firms hold cash and other liquid assets. As noted in the introduction, this study examines two competing factors for which firms accumulate cash holdings, tax uncertainty and large investment, with the purpose of extending our understanding of potential trade-offs within savings allocations. Second, we use the corporate savings literature to motivate our specific research questions and hypotheses. And finally, we highlight the existing gaps in the taxation and investment literature that this study intends to fill, showing where we extend the literature more specifically.

At first glance, it may not be obvious why firms hold large sums of cash and other liquid assets, when this financial capital has an opportunity cost of being deployed within the firm to generate future cash flows. This is especially the case if firms are easily able to tap external capital markets for needed financing when they fall short of liquid assets. However, given a host of information asymmetries, agency issues, and other capital market imperfections, the financial economics literature has proceeded to explore firm cash savings that exist in the real world, along with a host of corresponding determinants.[4] Specifically, Opler et al. (1999) find that firms with riskier cash flows, strong growth ratios, and higher costs of external capital tend to have higher cash holdings. More recent empirical literature reinforces and extends these findings by examining alternative settings, different measures of these firm characteristics, and introducing

[4] For a good summary of the early theoretical and empirical literature on cash holdings, see Opler et al. (1999).

additional determinants of cash holdings (Faulkender and Wang (2006), D'Mello et al. (2008), Bates et al. (2009), Dasgupta et al. (2011), Palazzo (2012), and Lins et al. (2010)). In contrast, Han and Qui (2007) find evidence that riskier (more volatile) cash flows play less of a role than previously thought. Another set of studies instead focuses on the importance of agency issues in determining cash holdings (Pinkowitz et al (2006), Dittmar and Mahrt-Smith (2007), Kalcheva and Lins (2007), Harford et al. (2008), Bates et al. (2009), and Gao et al. (2013)). Finally, two recent studies investigate the implications of tax planning, specifically through tax repatriations, for firm cash accounts (Foley et al. (2007) and Blouin and Krull (2009)).

Related to the setting in our study, Riddick and Whited (2009) conducted a detailed theoretical and empirical analysis of corporate savings, finding that, in addition to external financing constraints, firms save more in order to (fully or partially) finance large investments and to respond to uncertainty. In fact, they find that the effect of uncertainty "dwarfs the effect of the cost of external finance," underlining the critical role that uncertainty plays in corporations' propensity to save (Riddick and Whited 2009). To this end, we view the examination of tax uncertainty as a special case of uncertainty that extends naturally from Riddick and Whited's (2009) analysis. However, one important reason that tax uncertainty is distinct from overall uncertainty is that, to a greater extent, variation in this component of uncertainty is controllable (either through policy or by the firm reactions to policy), which have more direct policy implications. For example, for a given level of overall risk in a firm, (tax) managers have some discretion over the risk they take in avoiding taxes. Moreover, tax policy can contribute to the degree of tax uncertainty firms experience directly, whereas other forms of firm uncertainty tend to be influenced more indirectly (or more bluntly) by policy.

One implication of the analysis in Riddick and Whited (2009) is that firms may ramp up their precautionary savings as a result of tax uncertainty in the same way as they would for other forms of income uncertainty. Consequently, firms with higher tax uncertainty may devote greater savings toward a corresponding buffer, thereby channeling relatively less financial capital toward savings for large investments. Intuitively, this suggests that there may be a trade-off between savings devoted to act as a tax buffer and savings devoted to investment. Because savings plays a more critical role in financing large, lumpy investment as compared to smaller, incremental investment, we expect this effect to be particularly pronounced for large investments. Further, for a given period, this also suggests that firms with greater tax uncertainty would be less likely to make a large investment, or that such an investment would be delayed as a result of having less financial capital allocated for that purpose. Overall, this literature and its implications motivate the following hypotheses:

H1: Firms accumulate cash (or have higher savings) as a buffer against tax uncertainty.

H2$_a$: By tying up cash resources for a buffer, tax uncertainty adversely impacts the level of firm investment, holding other relevant factors constant.

H2$_b$: The effect of tax uncertainty is more pronounced for large investments as compared to smaller, more incremental investments.

H3: All else equal, firms with greater tax uncertainty will delay large investments.

Taken together, these specific hypotheses imply a broader hypothesis that there may be a tradeoff between cash holdings held as a buffer against tax uncertainty and cash holdings held for investment purposes.

The three most closely related studies to this paper are concurrent working papers by Blouin et al. (2012), Baker et al. (2013), and Stein and Stone (2012), which show that uncertainty affects firm-level incremental capital investment. Blouin et al. (2012) is the only study out of these three which focuses directly on a type of firm-specific tax uncertainty, based on the firm-level Uncertain Tax Positions reporting requirements from FASB Interpretation No. (FIN) 48. The authors predict and find results consistent with increases in tax uncertainty from aggressive tax avoidance resulting in decreases in investment. Baker et al. (2013) investigates whether a macro level measure of economic policy uncertainty (EPU) relates to firm-level incremental capital investment and employment. EPU is an index based on three components of policy uncertainty, one of which is a measure of macro level tax uncertainty (the rest relate to news media and economic forecasting discussion of overall policy uncertainty). The study finds that periods with higher EPU relate to incremental decreases in capital investment and employment. Stein and Stone (2012) use a firm-level measure of overall market uncertainty based on the implied volatility of stock options and examine whether market uncertainty decreases incremental capital investment and employment. They find that market uncertainty decreases both capital investment and employment. However, none of these studies have considered the mechanism of interest in our study (cash holdings) and the corresponding differential implications that this channel has for large versus incremental investments.

3. Sample Requirements, Descriptive Statistics, and the Correlation Matrix

3.1. Sample requirements

The initial sample includes all firm-year observations from Compustat for the years 1978-2012. With our focus on larger (and potentially longer-term investments), we wanted to capture at least 30 years (i.e. a longer horizon) of investment decisions. In addition, we did not want to start the sample in the middle of a sequence of major tax changes, which occurred in the 1980s (e.g. the Economic Recovery Tax Act of 1981 and the Tax Reform Act of 1986). For this reason, we started our sample further back in the 1970s. We chose 1978 to allow several years after the 1975 Tax Rebate and before the Economic Recovery Tax Act of 1981.

Most of our sample restrictions follow from Whited (2006) and Billett et al. (2011). We delete firm-years with duplicate observations (e.g. when firms change their fiscal year and report two sets of financial statements for a fiscal year). We then exclude a firm from the sample if there is evidence of a large merger.[5] Next, we remove utilities and financial industry firms.[6] Further, we require that firm-years have a non-missing SIC, non-missing values of the components of all regression variables that are defined in Appendix B, and non-missing values of the instrumental variables from Almeida et al. (2004). In addition, we remove observations in the extreme (1st and 99th) percentiles of investment, cash flow, sales growth, leverage, pre-tax income, tax uncertainty, and return volatility. After applying these restrictions, we have a sample of 55,214 firm-years, which we use for our initial analysis of the effect of tax uncertainty on cash holdings and the *level* of investment.

3.2. Descriptive Statistics and the correlation matrix

A complete account of the variables used in this study is summarized in Appendix B. Table 1, Panels A and B, reports the descriptive statistics and correlation matrix for the variables relevant to our analysis. The negative significant Pearson and Spearman correlations between $\textit{Tax Uncertainty}_{i,t}$ and $\textit{Investment}_{i,t}$ provide an initial indication that tax uncertainty is negatively

5 We define a firm as having a large merger if it has costs related to the acquisition of a company in the current year or effects of an acquisition in a prior year carried over to the current year (Compustat variable AQC) greater than 25 percent of the firm's total assets.

6 Utilities and financial industry firms are identified as having Standard Industrial Classifications (SICs) 4900-4999 and 6000-6999, respectively

associated with firms' investment levels. Further, our proxies for investment opportunities and innovation, *Cash Flow*$_{i,t}$ and *Sales Growth*$_{i,t}$ (following Whited (2006)), have significant positive correlations with investment as we would expect.[7] Finally, other control variables correlate with investment in ways that we would expect based on prior literature, e.g., the negative correlation between investments and *Financial Constraint*$_{i,t}$ as well as *Return Volatility*$_{i,t}$ consistent with the delay effect of financial constraints on investment found in Whited (2006) and the negative relation between underlying overall firm uncertainty and investment in Stein and Stone (2012).[8]

4. Research Design and Empirical Results

4.1 Research design overview

Our study focuses on the role of tax uncertainty in firm decisions regarding large investments with the expectation that savings for large investment is a likely opportunity cost of precautionary savings for taxes. Traditional studies on factors that influence (incremental) investment typically use an OLS regression of investment on other factors.[9] To explore the most basic relationship between tax uncertainty, cash holdings, and investment, we start by estimating a standard cash holdings model (section 4.2) and traditional OLS regression for incremental investment as a baseline analysis (section 4.3). We then use quantile regression analysis (section 4.4) to assess the shape of the relation between tax uncertainty and investment activity at different levels of investment. The initial results are used to help us assess a baseline relation

7 The correlations in Table 1 indicate that there may be a degree of multicollinearity that contributes to larger standard errors in the proceeding regression analysis. However, the standard textbook response is that this issue is of lesser concern than potential omitted variables bias resulting from dropping a meaningful control variable from our analysis.

8 We recognize that Whited (2006) was focused on the effect of financial constraints on the *timing* rather than level of investment and that levels versus timing effects have different tests and implications for investment.

9 These regressions typically include a proxy for investment opportunities and innovation, a characteristic of interest, and controls for other determinants of investment (e.g. Fazzari et al. (1988) and a series of papers that follow their methodology, Blouin et al. (2012), and Stein and Stone (2012)).

between tax uncertainty and cash, H1, and the relation between tax uncertainty and investment as predicted in $H2_a$, and whether tax uncertainty has a larger impact on higher levels of investment as predicted by our $H2_b$.

However, as we explained above, two recent studies that have focused instead on *large* investment provide evidence that linear regressions estimation may not appropriate in this setting (Whited (2006) and Billett et al. (2011)). The primary arguments for this are articulated in detail in Whited (2006) and are demonstrated both through a theoretical model and simulations. Specifically, in contrast to incremental investments, large investments are lumpy rather than smooth because of significant adjustments costs. Whited describes the adjustment costs driving the "lumpiness" in the form of a fixed (nonconvex) cost specific to large investments. This inherent lumpiness requires a framework that accounts for non-linearity and adjustment costs in the relation between the factor of interest (in our case, tax uncertainty) and large investment decisions. Thus, the remainder of the design and results sections (section 4.5 and section 5) focus on our tests of H3, namely the effect of tax uncertainty on the timing of large investment, and applies the methodology suggested in Whited (2006).

4.2. Tax Uncertainty and Cash Holdings

We begin by testing the underlying premise that a portion of firms' savings may serve as a precautionary buffer against potentially high tax costs (i.e. H1). That is, when uncertainty about future taxation is high, cash holdings should increase as a precautionary buffer for uncertain future taxes.[10] We follow Almeida et al. (2004) and estimate the following OLS model:

$$\Delta Cash\ Holdings_{i,t} = \alpha_1 + \alpha_2 \cdot Cash\ Flow_{i,t} + \alpha_3 \cdot Q_{i,t} + \alpha_4 \cdot Size_{i,t} + \alpha_5 \cdot Tax\ Uncertainty_{i,t} + \beta_i + \beta_t + \mu_{i,t} \quad (1)$$

[10] Hanlon et al. (2014) show empirically that firms hold larger cash balances when they face tax uncertainty.

where Δ*Cash Holdings*$_{i,t}$ is the change in the firm's cash holdings to asset ratio. We start with the baseline empirical model from Almeida et al. (2004) by including controls for cash flow, q, and size. β_i and β_t are included to account for firm and year fixed effects. *Tax Uncertainty*$_{i,t}$ follows the measure used in McGuire et al. (2011), which is the standard deviation of a firm's effective tax rates (ETRs) from the current year and four lagged years divided by the absolute average of the firm's ETR over these same years (see Appendix B for a complete description of all the variables above). This measure represents the ratio of a firm's ETR volatility to the firm's average ETR level over the most recent five years. Intuitively, firms with consistent effective tax rates over time are associated with low tax uncertainty, while firms with more volatile taxes from year to year are associated with higher tax uncertainty.

Table 2 presents regression results from estimating equation (1) without tax uncertainty (Column (1)) and with tax uncertainty (Column (2)). In Column (3), we add a measure for a firm's uncertainty about overall firm risk (*Return Volatility*$_{i,t}$) and the effective tax rate (*GAAP ETR*$_{i,t}$) to control for the current level of tax planning. In Column (4), we control for expenditures, acquisitions, changes in net working capital, and changes in short-term debt using an instrumental variable approach as in Almeida et al. (2004). Throughout our study, variables are in standardized form (with a mean of zero and standard deviation of one) for ease of coefficient interpretation.

We consistently find that tax uncertainty is associated with an increase in cash holdings (Column (2) to (4)). This indicates that a portion of cash savings is due to uncertainty about the future tax positions and that firms increase cash holdings as a precautionary buffer against potentially high tax costs, consistent with Hanlon et al. (2014). The coefficient estimates indicate that if a firm goes from the 25^{th} to the 75^{th} percentile of *Tax Uncertainty*$_{i,t}$, cash holdings increase by 0.46 percent of total assets.[11] This is equivalent to 7 percent of the average annual cash flow to assets ratio of 6.19 percent of our sample firms. In other words, if tax uncertainty increases from the 25th to the 75th percentile, firms retain 7 cents of a dollar in cash flows as a buffer for uncertain future taxes.

As a proxy for cash savings for future uncertain tax costs, we define the *Tax Induced Cash Buffer*$_{i,t}$ as the difference between the predicted change in cash holdings from Column (2) and the predicted change in cash holdings from Column (1) of Table 2:

$$Tax\ Induced\ Cash\ Buffer_{i,t} = Predicted\ \Delta Cash\ Holding\ (\text{with}\ Tax\ Uncertainty)_{i,t} - Predicted\ \Delta Cash\ Holding\ (without\ Tax\ Uncertainty)_{i,t} \quad (2)$$

The proxy *Tax Induced Cash Buffer*$_{i,t}$ thus captures the specific portion of the change in cash holdings that is due to the inclusion of Tax Uncertainty in equation (1). Table 1 also presents summary statistics for *Tax Induced Cash Buffer*$_{i,t}$, which averages zero and varies considerably. Some firms have negative values, indicating that they actually save less cash, which may be a result of a more certain tax position, while others save a considerable amount of cash to buffer for tax uncertainty.

Throughout the remainder of the paper, we use *Tax Uncertainty*$_{i,t}$ and *Tax Induced Cash Buffer*$_{i,t}$ as alternative proxies for tax uncertainty. Another advantage of using *Tax Induced Cash Buffer*$_{i,t}$ as alternative independent variable is that its Pearson correlation with general firm risk (*Return Volatility*$_{i,t}$) is insignificant while it is highly positively correlated with tax uncertainty. This supports our underlying assumption that tax uncertainty is a type of uncertainty that is

[11] This effect is calculated as follows. An increase from the 25th to the 75th percentile increases tax uncertainty by 0.8850 (=1.0139 – 0.1289), or by 1.4095 times the standard deviation (=0.8850/0.6279). Using the coefficient in Column (3), the change in cash holding increases by 0.0548 (=1.4095 × 0.0389). This is equivalent to a change in actual cash holdings of 0.0046 (=0.0548 × 0.0839), where 0.0839 is the standard deviation of changes in cash holdings. As the change in cash holdings is expressed relative to total assets, an increase by 0.0046 is equivalent to 0.46 percent of total assets.

distinct from overall firm risk and using *Tax Induced Cash Buffer*$_{i,t}$ addresses concerns that *Tax Uncertainty*$_{i,t}$ is correlated with *Return Volatility*$_{i,t}$.

4.3. Traditional investment levels approach through OLS regression analysis

Our next series of tests focus on a specific real cost of this precautionary savings, the effect on firm investments. If financial resources are tied up in cash holdings as a result of tax uncertainty, then we would expect less capital to be devoted to investment more generally. Following traditional studies on incremental investment, we define our initial OLS regression equation as:

$$Investment_{i,t} = \beta_1 + \beta_2 \cdot Cash\ Flow_{i,t} + \beta_3 \cdot Q_{i,t} + \beta_4 \cdot Sales\ Growth_{i,t} + \beta_5 \cdot Tax\ Uncertainty_{i,t} + \boldsymbol{\gamma}\boldsymbol{\Pi}_{\boldsymbol{i,t}} + \beta_i + \beta_t + \epsilon_{i,t} \quad (3)$$

where *Investment*$_{i,t}$ is the ratio of investments to total assets; *Cash Flow*$_{i,t}$ is income before extraordinary items, with depreciation and amortization added back, scaled by total assets; $Q_{i,t}$ is Tobin's q; *Sales Growth*$_{i,t}$ is the difference between current and prior year sales over prior year sales; and *Tax Uncertainty*$_{i,t}$ is defined as above. As an alternative proxy for tax uncertainty, we use *Tax Induced Cash Buffer*$_{i,t}$ as defined in equation (2).

Following Whited (2006), we use *Cash Flow*$_{i,t}$ and *Sales Growth*$_{i,t}$ as proxies for investment opportunities and innovation, respectively. Further, we include $Q_{i,t}$ as an additional proxy for investment opportunities consistent with much of the prior investment literature.[12] Our control variables ($\boldsymbol{\Pi}_{\boldsymbol{i,t}}$) come from prior and concurrent literature. We include whether a firm is financially constrained between periods of spikes in investment (*Financial Constraint*$_{i,t}$) based

[12] One concern about including $Q_{i,t}$ in investment regressions, as noted in Whited (2006), is that the measurement error in investment opportunities through $Q_{i,t}$ can bias results (e.g., Almeida, Campello, and Galvao (2010), Erickson and Whited, (2000, 2012)). We, therefore, rerun all regressions excluding $Q_{i,t}$. Results for our tax uncertainty measures remain unchanged. Tables A.I through A.IV of our online table appendix replicate our main results when excluding $Q_{i,t}$ and show that our results are robust to the exclusion of $Q_{i,t}$. The online table appendix is available at https://www.dropbox.com/s/63ayj532hwmp7am/JWW%20-%2010-29-14%20Online%20Table%20Appendix.pdf?dl=0.

on the findings in Whited (2006) that financially constrained firms delay investment.[13] We control for a firm's degree of leverage and total assets in the current year (*Leverage*$_{i,t}$ and *Total Assets*$_{i,t}$) following Billett et al. (2011). We include a measure for a firm's overall firm uncertainty (*Return Volatility*$_{i,t}$) based on the finding in Stein and Stone (2012) that increases in firm uncertainty about the payoff of investment can decrease investment activity. Finally, we include a firm's current year pre-tax income and effective tax rate (ETR) (*Pre-Tax Income*$_{i,t}$ and *GAAP ETR*$_{i,t}$) to control for the effect of current levels of underlying income and tax planning. β_i and β_t are included to account for firm and year fixed effects.

We report our estimates of equation (3) in Table 3 with t-stats presented in parentheses. The negative significant coefficient on *Tax Uncertainty*$_{i,t}$ reflects an increase in tax uncertainty decreasing incremental investment, consistent with $H2_a$. We obtain very similar results when we use *Tax Induced Cash Buffer*$_{i,t}$ as our measure of tax uncertainty. Most importantly, the effects are economically significant. A substantial increase in *Tax Uncertainty* (i.e. going from the 25^{th} to the 75^{th} percentile), is associated with a decrease in *Investment*$_{i,t}$ (i.e. investments to total assets) by 1.05 percentage points, or 17.3 percent of the sample average. Using our *Tax Induced Cash Buffer*$_{i,t}$, we also find substantial effects. If the *Tax Induced Cash Buffer*$_{i,t}$ increases by one standard deviation, that is, if 0.25 percent of total assets or 4 cents a dollar of cash flows are retained as a buffer for uncertain future tax payments, investments to assets decrease by 11.8 percent. To put the tax effect into perspective, we compare the effect of tax uncertainty to the effect of return volatility. If a firm goes from the 25^{th} to the 75^{th} percentile of *Return Volatility*$_{i,t}$, investments decrease by 8.6 percent of the sample average.

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[13] Our results are not sensitive to using a different proxy for financial constraints. When using the the size-age index from Hadlock and Pierce (2010), results remain unchanged. We present β_5 coefficient estimates from these tests in Tables A.V to A.VIII of the online table appendix.

4.4. Testing for heterogeneity in the effect at different levels of investment through quantile regression analysis

If a linear functional form captures the true relation between tax uncertainty and investment for *all levels* of investment, then this result for the effect of tax uncertainty on incremental investment should carry over directly to infer the effect of tax uncertainty on large investment. Our next step, therefore, is to test whether the assumption of a linear functional form is appropriate for large investment in our setting and whether large investments are somehow different. To assess whether the design concerns (for non-linearity) from recent studies on large investment are relevant for our research question, we use a quantile regression to examine whether there are differences in the effect of tax uncertainty on different levels of investment. Specifically, we estimate the following equation for each quantile q of the investment distribution:

$$Investment_{i,t}^{q} = \beta_1^q + \beta_2^q \cdot Cash\ flow_{i,t} + \beta_3^q \cdot Q_{i,t} + \beta_4^q \cdot Sales\ growth_{i,t} + \beta_5^q \cdot Tax\ uncertainty_{i,t} + \boldsymbol{\gamma^q \Pi_{i,t}} + \beta_i^q + \beta_t^q + \epsilon_{i,t}^q \quad (4)$$

where all variables are defined as above in equation (3), except that the equation is estimated from the 1st to the 99th percentile yielding 99 β_5^q coefficients to compare across different levels (percentiles) of investment. If the effect of tax uncertainty on investment was linear, we would observe unchanged β_5^q coefficients across quantiles and an essentially flat distribution of the β_5^q coefficients across different levels (quantiles) of investment. To help us assess this shape, we generate Figure 1 to provide a visual representation of the β_5^q coefficients over the 99 different percentiles along with the upper and lower 95 percent confidence interval. Coefficients are estimated using robust standard errors two-way clustered at the year and firm level.

Figure 1 suggests a non-linear relation between tax uncertainty and certain levels of investments. Specifically, the shape of the distribution of coefficient estimates is concave. Coefficient estimates are statistically significant for each quantile and become less negative from the 1st to about the 20th percentile. For example, the coefficient on *Tax Uncertainty*$_{i,t}$ is about -0.14 at the 10th percentile of investment. At the median, the coefficient is about -0.08 (a little less than 60 percent of the coefficient at the 10th quantile). Above about the 80th percentile, the β_5^q coefficients become more negative again. This provides initial evidence that the effect of tax uncertainty is more pronounced as the size of firm investment becomes larger.

While the concave shape of the distribution may be surprising at first glance, there is a very practical explanation for the finding that tax uncertainty has a larger impact at very small investment levels. Being in the bottom decile of the investment distribution is positively correlated with having an investment spike one or two years later. In contrast, being the 2nd to 9th decile of investment is negatively correlated with having an investment spike one or two years later. Hence, as tax uncertainty increases, very small investments are also more affected by tax uncertainty as these very small investments typically precede very large investments, or investment spikes. In effect, these very small investments can be thought of as simply "leading large investments," thereby making the nearly symmetrical impact of tax uncertainty more intuitive.

Because our above assessment that the distribution of β_5^q coefficients is concave is based primarily on observing the shape in Figure 1, we include an additional more formal test of how well a concave functional form explains the distribution of coefficients observed. Specifically, we test how well a quadratic function explains the distribution of β_5^q coefficients. To do this, we simply treat obtained coefficients $\hat{\beta}_5^q$ as data points and regress them on the quantile rank (q) and the squared percentile rank (q^2).[14] The linear regression yields a point estimate of 0.486 and a very high t-statistic (32.23) for the linear term (q). The coefficient on the quadratic term (q^2) is negative (-0.511) and significant (t-stat = 32.89), suggesting a concave shape of the distribution of coefficients. The R-squared of the 99-data-point regression is 95 percent. This indicates that the quadratic function $\hat{\beta}_5^q = \alpha_1 + \alpha_2 \cdot q + \alpha_3 \cdot q^2$ explains the distribution of $\hat{\beta}_5^q$ coefficients estimates from the quantile regressions very well.

We repeat the analysis and use *Tax Induced Cash Buffer*$_{i,t}$ instead of *Tax Uncertainty*$_{i,t}$ when estimating equation (3). In Figure 2, we plot the distribution of β_5^q coefficients. We again obtain a concave distribution. We then use obtained coefficients $\hat{\beta}_5^q$ as data points and regress them on the quantile rank (q) and the squared percentile rank (q^2). The linear regression yields a point estimate of 0.444 and a very high t-statistic (31.88) for the linear term (q). The coefficient on the quadratic term (q^2) is negative (-0.478) and significant (t-stat = 32.91). The R-squared of the 99-data-point regression is 95 percent. Thus, the results using the tax induced cash buffer are qualitatively similar.

Overall, the primary implication of the quantile regression results is that the effect of tax uncertainty on larger investments, that is, for higher quantiles of investments, is patently different from the effect of tax uncertainty at median or average investment. The flat region near the median is consistent with a linear regression being more reasonable for examining incremental investment around the median. However, the steep downward sloping curve for the 80th percentile and above has two implications relevant to our setting (i.e. large investments). First, it suggests that tax uncertainty has a greater negative association with large investments, which is consistent with the $H2_b$. The increase in the economic magnitude is economically and

[14] The resulting estimation equation is $\hat{\beta}_5^q = \alpha_1 + \alpha_2 \cdot q + \alpha_3 \cdot q^2 + \varepsilon$ where $\hat{\beta}_5^q$ is the estimated coefficient on *Tax Uncertainty*$_{i,t}$ and q denotes the n-th quantile. We cluster standard errors by firm.

statistically significant. The β_5^q coefficient estimate more than doubles if we compare the effect at the median (-0.08) to the effect at the 90th percentile of investment (-0.17). As the 95 percent confidence intervals do not overlap, the increase is also statistically significant. Second, it provides evidence that a linear functional form is not appropriate for examining the way the tax uncertainty influences large investments. If we want to understand firm decision-making regarding large investments, we cannot simply extrapolate from estimates of linear models that capture incremental investment.

4.5. Examining large investment spikes through binary choice regression analysis

We next focus our attention specifically on the role of tax uncertainty in a firm's decision to make large investments. We start our analysis of H3 using simpler logit and linear probability regression equations for ease of interpretation and then apply the more compelling hazard analysis from Whited (2006) to account for potential nonlinearity and adjustment costs in the next section. We estimate the following regression equation:

$$Investment\ Spike_{i,t} = \varphi_1 \cdot Cash\ Flow_{i,t} + \varphi_2 \cdot Sales\ Growth_{i,t} + \varphi_3 \cdot Q_{i,t}$$
$$+\varphi_4 \cdot Tax\ Uncertainty_{i,t} + \boldsymbol{\delta}\ \boldsymbol{\Pi_{i,t}} + \varphi_i + \varphi_t + \mu_{i,t} \qquad (5)$$

where *Investment Spike*$_{i,t}$ is defined following Whited (2006). It equals one if a firm's ratio of investment to total assets in year t is two times greater than the firm's median ratio of investment to total assets over the sample period. All other variables are defined as before for the OLS regression equation (3).

We report our estimates of equation (5) in Table 4. Columns (1) and (2) present the logit estimation of equation (5). Columns (3) and (4) use a linear probability model. Our statistical inference is based on robust standard errors clustered by firm and year. Of primary interest, the coefficient on tax uncertainty in Columns (1) and (3) is both negative and significant. Likewise, the coefficient on *Tax Induced Cash Buffer*$_{i,t}$ is negative and significant in Columns (2) and (4), providing evidence that firms are less likely to have an investment spike in year t if tax uncertainty has increased. Again, the effects are economically significant. Going from the 25th percentile to the 75th percentile of tax uncertainty is associated with a decrease in the likelihood of an investment spike by 26.3 percent from the sample mean likelihood using the OLS model results. A one standard deviation increase in *Tax Induced Cash Buffer*$_{i,t}$, or retaining 4 cents of a dollar in cash flows to buffer tax uncertainty, is associated with a decrease in the likelihood of an investment spike of 18 percent from the sample mean likelihood in a given time period. To put this into perspective, going from the 25th to the 75th percentile of return volatility is associated with a decrease in the likelihood of an investment spike of 12.8 percent (14.7 percent) using the results in Column (4) (Column (2)) Overall, the signs on the right-hand side variables representing the effect in terms of increases or decreases in the probability of an investment spike are consistent with the signs on the coefficients from the initial OLS regression.

The logit and linear probability specifications provide initial evidence that tax uncertainty is associated with a decrease in the probability of an investment spike (H3); however, in the next section we explore a different methodology to address two concerns. First, these models make assumptions about specific functional form (namely assuming a logistic or linear functional form) and the results could be sensitive to this arbitrary choice. Second, neither of these models provides an explicit way to incorporate unobservable adjustment costs into the estimation (leaving a potentially important omitted variable). Instead, our final set of analyses, where we perform the primary tests for our study, uses a hazard analysis approach from Whited (2006) to address both of these concerns.

5. Hazard Analysis and Results

5.1 Hazard analysis estimation versus a traditional OLS estimation

The traditional framework for examining incremental investments is likely inappropriate for studying large investments because large investments have an inherently lumpy function over time (Whited (2006)). This idea of "lumpiness" comes from adjustment costs necessary for large investments that may not be as relevant for incremental investments. Indeed, a hazard analysis framework as used by Whited (2006) allows for lumpy investments and varied adjustment costs, unlike the traditional incremental investment studies in an OLS framework. We provide a brief discussion of the benefits of hazard analysis for examining large investments here. However, for a more detailed discussion of these benefits, we refer readers to Whited (2006). The specific technique used originally comes from Meyer (1990), which uses a semi-parametric hazard analysis that accounts for both observable sources of heterogeneity (like tax uncertainty and other observable control variables in our study) and unobservable heterogeneity (like adjustment costs) while using a non-parametric baseline function. The related mixed proportional hazard equation from Whited (2006) is:

$$\lambda_i(t) = \omega_i \lambda_0(t) \exp(x_i(t)'\beta) \tag{6}$$

where t represents the spell length or the number of years since a firm's last investment spike (where a spike is defined in the previous section) and $\lambda_i(t)$ is the hazard function, which in our case is the probability that an investment spike occurs in year t given that it has not occurred in a previous year since the last spike; $\lambda_0(t)$ is called the baseline hazard, which represents how investment spikes behave simply as a function of time. In our model, following Whited (2006), this function is non-parametric, restricted only to the extent that it must be a step function of the spell length. $x_i(t)$ represents our right-hand side covariates from the OLS equation (3), which are allowed to vary cross-sectionally across firms *and* across time.[15] The ω_i is a random disturbance term referencing unobserved heterogeneity that is used to account for unobservable adjustment costs. This variable is assumed to be independent of the observable covariates ($x_i(t)$) and follows a gamma distribution.

5.2 Additional sample restrictions and descriptive statistics for the primary analysis sample

To estimate the hazard equation, we place four additional restrictions on our initial sample, following Billett et al. (2011) and Whited (2006). First, following Billett et al. (2011), we exclude firms that have only one uncensored spell and one censored spell if the censored spell is shorter than the uncensored spell. An uncensored spell occurs when a spell includes all years leading up to the spike, while a censored spell occurs when the firm leaves the sample before it reaches the next spike year (i.e. the period of years since the last spike does not lead to another spike in the sample). Second, for firms with more than one spike, we drop the first spell and spike years in our sample period. If a firm does not enter the sample exactly in the first year after it completes its previous spike in investment (the first year of its next spell), estimates of the spell length up to the next investment spike would be incorrect, which is why these are dropped from the sample. For example, suppose a firm's actual first investment spike was in 1973, the firm enters the sample in 1978 (the first year of our sample period), and its second spike in investment is not until 1982. If the years 1978 through 1982 are left in the sample for the firm, then the hazard analysis would incorrectly classify the time leading up to the second investment spike as five years (from when the firm enters the sample in the beginning of 1978 to the end of 1982) whereas it should actually be nine years (from the beginning of 1974 to the end of 1982).

[15] We stress the variation across time here as hazard analysis is frequently estimated using time invariant control variables.

Our third restriction is to drop firms that never had a spike over our sample period, which allowed us to have similar spell and spike characteristics to Whited (2006) and Billett et al. (2011). Finally, our fourth restriction comes from the ability to identify the baseline hazard. In order for the baseline to be properly identified, the sample must have both observations with and without spikes for each spell length included in the estimation. If a specific spell length has either only spikes or no spikes, then it will perfectly explain the spike outcome for that spell length. Thus, as all spell lengths up to 22 years include both censored and uncensored observations and several spell lengths of 23 years or higher have only either censored or uncensored observations, we limit our sample to observations with only up to 22 years in spell length.

Recall that our initial analysis sample had 55,214 firm-year observations. The restriction from Billett et al. (2011) reduces the sample by 3,508 observations. Dropping the first spell/spike firm-years reduces the sample another 4,321 observations. Excluding firms that never have a spike reduces the sample by 22,211 observations.[16] Finally, eliminating observations with spell lengths greater than 22 reduces the sample an additional 356 observations, which results in the primary hazard analysis sample of 24,818 firm-years. The variable and investment spell descriptive statistics for our primary hazard analysis sample are reported in Table 5 Panels A and B.

The descriptive statistics in Table 5 Panel A are included for comparison with the initial sample summary statistics in Table 1 Panel A. Overall, the descriptive statistics do not appear to change very much except that the hazard sample has lower average pre-tax income and total assets. Table 5 Panel B reports investment spell descriptive statistics similar to those reported in

[16] Our primary results are not sensitive to the exclusion of firms that never have a spike.

Whited (2006) and Billett et al. (2011). When comparing our investment spell characteristics, we note that our statistics are in line with those provided in Whited (2006) and Billett et al. (2011).[17]

5.3 Primary analysis of the effect of tax uncertainty on the timing of large investment spikes

Tables 6 and 7 report our primary hazard analysis results for the effect of tax uncertainty on the timing of large investment. The main difference between Tables 6 and 7 is the form of coefficient reported, where Table 6 reports the hazard rate coefficients and Table 7 reports the accelerated failure-time form coefficients. We include Table 6 to be consistent with both the methodology and reporting of Whited (2006) and Billett et al. (2011) (i.e. using hazard rates). However, the more intuitive interpretations for the magnitude of the effect of tax uncertainty on the timing of large investment can be found in Table 7.

Table 6 Panel A (Panel B) presents the hazard rate estimates when $Tax\ Uncertainty_{i,t}$ ($Tax\ Induced\ Cash\ Buffer_{i,t}$) is included as our variable of interest. Column (1) in both panels reports the hazard rate estimates when a mixed proportional hazard model based on Meyer (1990) (similar to Whited (2006)).[18] Columns (2)-(4) in both panels present estimates from three other common hazard models, the Cox proportional hazard, Weibull, and exponential hazard models, respectively. We include these additional columns to consider the sensitivity of our results to the assumptions of different distributions of the model.

Roughly speaking, a hazard rate coefficient that is less than (greater than) one and statistically significant demonstrates an incrementally lower (higher) conditional probability of

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17 For instance, the proportion censored/uncensored is similar to both Whited (2006) and Billett et al. (2011). In addition, the spell lengths are consistent with the spell lengths reported in Billett et al. (2011) and with what Whited (2006) shows, that as multisegment and larger firms are included in the sample the average spell lengths increase. In a later test, we examine a small firm only sample to address concerns that including larger firms can create an aggregation bias in hazard rates.

18 Our estimation of equation (6) accounting for unobserved heterogeneity utilizes a Stata program provided in Jenkins (1997) labelled "pgmhaz8" and follows guidance on hazard analysis from the author, Stephen Jenkins's, website: https://www.iser.essex.ac.uk/ resources/survival-analysis-with-stata. We are grateful to the author for use of these resources that were instrumental in our tests for the paper.

an investment spike associated with increases in the right-hand side variables. Thus, as the coefficients on *Tax Uncertainty*$_{i,t}$ (*Tax Induced Cash Buffer*$_{i,t}$) in Table 6 Panel A (Panel B) are all statistically significant different from one and range from 0.8172 to 0.8867 (0.8457 to 0.8987), our results indicate that an increase in tax uncertainty relates to a lower conditional probability of an investment spike. This result is consistent with H3, which predicts that firms with greater tax uncertainty delay large investment spikes. Further, the consistency of this result across the columns indicates this finding is not sensitive to the use of alternative, common hazard models.

We next examine our primary control variables for reasonableness. We compare our coefficients on *Cash Flow*$_{i,t}$ and *Sales Growth*$_{i,t}$ with the coefficients reported in Whited (2006) and find the reported estimates are in line with those in her study. Our proxy for overall firm risk, *Return Volatility*$_{i,t}$ has a statistically significant negative effect on the hazard rate, consistent with our initial expectation for a proxy for overall firm uncertainty. This initial expectation, however, may be somewhat naïve given the literature on uncertainty. In fact, in a survey of the literature on uncertainty and investment, Leahy and Whited (1996) provide evidence that the effect of uncertainty on investment may be ambiguous.[19] Not all types of uncertainty are predicted to have a negative or delay effect on investment, and in some cases, uncertainty may accelerate investment.[20] Hence, some offsetting factors that contribute to investment acceleration may be contributing to the somewhat smaller coefficient estimate for overall return volatility.

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[19] See Leahy and Whited (1996) for a thorough review of different predictions for the relation between uncertainty and investment and the different underlying assumptions of each prediction. In general, the key distinguishing feature of the direction of the prediction is the assumed functional form of the marginal revenue product of investment (capital). If the form is expected to be convex, uncertainty may actually increase investment. However, if it is assumed to be concave, uncertainty is predicted to decrease investment.

[20] While Leahy and Whited (1996) give a more extensive review of the literature. We provide two examples of alternative predictions for different types of uncertainty and their effect on investment for illustration. Specifically, Cushman (1985) finds that exchange rate risk raises direct investment using a theoretical model and related empirical tests. Further, Bar-Ilan and Strange (1996) find that price uncertainty can accelerate

While the results in Table 6 provide evidence of the delay effect based on the hazard rate, we turn to the estimates in Table 7 for a more intuitive interpretation of the results. Table 7 reports the accelerated failure-time form coefficients for the hazard analysis using two of the four distributions from Table 6, the Weibull model in columns (1) and (2) and the exponential model in columns (3) and (4). Columns (1) and (3) (Columns (2) and (4)) include *Tax Uncertainty*$_{i,t}$ (*Tax Induced Cash Buffer*$_{i,t}$) as right-hand-side variables. For accelerated failure-time form estimation, significant, positive (negative) coefficients in Table 7 indicate an increase (decrease) in the time it takes or a delay (acceleration) effect on investment spikes. Based on the coefficients of interest in columns (1)-(4), we find that it takes approximately 17-20 percent longer, all else equal, for a firm to make its next investment spike if tax uncertainty is one standard deviation higher. [21] [22] [23] More concretely, for a firm with an average spell length of 4.23, 20 percent corresponds to a delay of approximately 10 months. To put this delay effect into perspective, the average recession length in the US from 1945 to 2001 was approximately 10 months (see http://www.nber.org/cycles.html). Overall, our results from Tables 6 and 7 support our third hypothesis (H3) that firms with greater tax uncertainty delay large investments.

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investment that has high "investment lags" (a longer period between when the investment is made and when the payoff is expected) using a theoretical model and simulation. Bar-Ilan and Strange also give anecdotes of where this is observed in the real world through overbuilding in commercial real estate and electricity generation.

[21] Because of the concern that there can be measurement error in regressions including Q to estimate investment opportunities (Almeida, Campello, and Galvao (2010), Erickson and Whited, (2000, 2012)), we re-estimate our analysis for Table 7 without Q and find the same (approximately 17-20 percent) delay effect.

[22] To obtain the 20 (17) semielasticity magnitudes requires exponentiating the accelerated failure-time form coefficients reported in the Table 7. For small values of these coefficients, interpretations of magnitudes can be determined by multiplying the table coefficients by 100. However, for larger values of the coefficients, the conversion is done by exponentiating the coefficient and subtracting unity. For instance, the semielasticity or percent delay/acceleration estimate for the Weibull coefficient estimate in column (1) for *Tax Uncertainty*$_{i,t}$ is estimated with the following calculation: 100(exp(0.1815)-1) = 19.90 percent.

[23] Our results are robust to using an alternative measure of financial constraints, the size-age index from Hadlock and Pierce (2010). We report our re-estimated tax uncertainty coefficients from the accelerated failure-time form tests in Tables A.VII and A.VIII of our online table appendix. The online table appendix is available at: https://www.dropbox.com/s/63ayj532hwmp7am/JWW%20-%2010-29-14%20Online%20Table%20Appendix.pdf?dl=0.

5.4 Robustness and additional sensitivity tests

In our primary analysis, we do not make any restrictions on the size of the firm included in the sample to offer more generalizable magnitude interpretations. However, Whited (2006) discusses a potential issue with including larger firms in the hazard analysis of large investment spikes. The issue is aggregation of asynchronous actions within a firm. Specifically, small firms tend to have single decision making units whereas larger firms are expected to have multiple decision making units. Thus, unless all of the units in larger firms behave in the same way, fluctuation in investment within the individual units of the larger firm will make the overall firm investment appear smoother, preventing identification of the different investment spikes occurring across the units and reducing the hazard rates for these firms. Whited provides support for this assertion by examining whether the baseline hazard is flatter for larger firms. An upward sloping baseline hazard indicates an increasing likelihood of having a large investment spike over time (consistent with nonconvex adjustment costs or lumpy investment) whereas a flatter baseline hazard indicates that the likelihood of a large investment spike is essentially unaffected by time (implying adjustment costs are not captured as they are smoothed within the firm's different units). Consistent with these predictions, Whited finds that while her small firm partition has an upward sloping baseline hazard, the large firm partition has an essentially flat baseline hazard. Whited and Billett et al. (2011) address the aggregation issue in their studies of large investment by limiting their analysis to small firms.

To address this issue in our paper, we first examine whether there is evidence of the aggregation issue in our overall sample by comparing the baseline hazards of a small firm partition to the baseline hazard of our overall sample. We define small firms similar to Whited (2006) and Billett et al. (2011) where a firm is classified as small if its total assets are below the

33rd percentile of the total assets of firms in the first year that the test firm appears in the sample. In addition, for the analysis, we limit the observations to spell lengths of 17 years or less (down from 22 years or less in the primary hazard sample). We do this to ensure there are both observations with and without spikes at each spell length for each partition.[24] We then re-estimate equation (6) using the mixed proportional hazard model based on Meyer (1990) (re-estimating Table 6 column (1) of Panels A and B) for the small firm only sample and the overall sample and plot the resulting baseline hazards in Figures 3 and 4. Columns (1) and (2) (Columns (3) and (4)) of Table 8 presents the re-estimated hazard rate form for the full hazard versus small firm only samples respectively, and Figure 3 (Figure 4) plots the related baseline hazards when $\textit{Tax Uncertainty}_{i,t}$ ($\textit{Tax Induced Cash Buffer}_{i,t}$) is used to proxy for tax uncertainty. Note that the coefficients in columns (1) and (3) of Table 8 differ from column (1) Panels A and B of Table 6 slightly, which is due to the reduction in sample size from limiting observations up to spell lengths of 17 years.

The first point to note when examining Table 8 and Figures 3 and 4 is that the coefficients on the variable of interest (the tax uncertainty proxies) indicate a statistically significant delay effect regardless of whether the full or the small firm sample is used. Specifically, the coefficients on $\textit{Tax Uncertainty}_{i,t}$ ($\textit{Tax Induced Cash Buffer}_{i,t}$) for our full primary hazard analysis sample and the small sample are 0.8099 and 0.8166 (0.8396 and 8433) respectively, both of which are less than one and significant (consistent with a delay effect). However, when we examine the baseline hazards plotted in Figures 3 and 4, we do find evidence of an aggregation effect on the baseline hazard. As the figures are very similar, we focus on

[24] This limitation comes from the small firm sample having different spell lengths greater than 17 years that either only have observations without spikes or observations with spikes. This restriction reduces the sample by 2.4 percent (608 observations dropped divided by the 24,818 observations in the original analysis sample from Table 6).

Figure 3 for our interpretation. Based on Figure 3, it appears that asynchronous aggregation does exist if larger firms are included in the sample. This finding is implied by the upward sloping baseline hazard for the small firm only sample and the essentially flat baseline hazard for the overall firm (primary hazard analysis) sample. We include trend lines to help make this distinction clearer.

Because of the evidence of potential aggregation issues in Figure 3 and 4, we re-estimate the accelerated failure-time form analysis from Table 7 to determine if the aggregation issue alters the magnitudes of the timing effect interpretations. The re-estimation is reported in Table 9 and indicates a similar delay effect range as our primary results in Table 7. Based on the coefficients of interest in Table 9 columns (1)-(4), it takes small firms approximately 15-19 percent longer, all else equal, to make its next large investment spike if tax uncertainty is one standard deviation higher (versus 17-20 percent longer shown for our overall sample in Table 7). While small firms differ from large firms in a number of important ways, it is clear from our results that both small and large firms respond similarly to tax uncertainty, holding other relevant factors constant.

In addition to the small firm sample tests above, we perform a set of additional sensitivity tests in our online appendix related to how our design addresses potential unobserved heterogeneity. In our initial hazard rate analysis test, we follow Whited (2006) and Billett et al. (2011) by including industry and year fixed effects and including a gamma distribution unobserved heterogeneity term. Importantly, if we re-estimate Tables 7 and 9 (where we draw our magnitude interpretations) with *firm* and year fixed effects, the delay effect is somewhat larger for the overall sample but about the same for the small firm sample. Specifically, the firm and year fixed specification reports a delay effect of approximately 20-22 percent for our overall sample and 15-17 for small firms.[25]

However, prior research indicates there may be econometric issues with including fixed effects in hazard and other nonlinear models. Specifically, Greene (2004) examines this issue for the Weibull model and Allison (2002) studies this issue for the Cox model. Because of this concern with the use of fixed effects, we re-estimate Tables 7 and 9 without fixed effects to determine if our results are sensitive to this design choice. We find larger delay effects for both the full and small firm samples (estimates the effect is 22-25 percent for the full sample and 21-24 percent for the small firm sample) when fixed effects are excluded.[26] Overall, the small sample and additional sensitivity tests support H3 (the delay effect) both in terms of statistical significance and economic magnitude.

6. Conclusion

The primary purpose in this paper is to examine the relationship between firm tax uncertainty and large investments. Overall, our findings suggest tax uncertainty prompts firms to sideline financial resources in the form of cash holdings, which 1) decreases the amount (or level) of firm investment in absolute terms and 2) delays large investments that may require a buildup of cash holdings. Our initial OLS results were consistent with prior literature, as higher tax uncertainty was associated higher cashing holdings and lower investment. However, the quantile regression results indicated a more nuanced story: Tax uncertainty has a more

[25] These results are presented in Tables A.IX and A.X of our online table appendix. The online table appendix is available at: https://www.dropbox.com/s/63ayj532hwmp7am/JWW%20-%2010-29-14%20Online%20Table%20Appendix.pdf?dl=0.

[26] These results are presented in Tables A.XI and A.XII of our online table appendix. The online table appendix is available at: https://www.dropbox.com/s/63ayj532hwmp7am/JWW%20-%2010-29-14%20Online%20Table%20Appendix.pdf?dl=0.

pronounced impact on larger investments as compared to incremental or more "normal" levels of investment closer to the median. As the traditional framework for examining incremental investments is likely inappropriate for studying large investments, we use a hazard analysis framework because large investments have an inherently lumpy function over time (Whited (2006)). Indeed, the hazard models confirms that firms are less likely to make large investments in a given year when they are more uncertain about taxes, and investments are delayed by as much as 20 percent (or 10 months for the average firm) due to higher tax uncertainty. These results are consistent with our motivating hypotheses, that tax uncertainty lead firms to use precautionary savings as a buffer, in lieu of investment, thus delaying large investment projects to future periods.

This study extends our understanding of real firm decision-making with respect to large investments, a critical part of our economy. From a policy standpoint, this study provides additional motivation for policymakers to focus on reducing tax uncertainty that firms face. The results of our study imply that a reduction in tax uncertainty may free up precautionary savings capital that firms may set aside for tax-related purposes. A potentially revenue neutral reduction in tax uncertainty may, in effect, mirror a tax cut, in that firms can deploy additional financial capital toward investments and speed up plans for large projects; yet, unlike a tax cut, this type of policy would not necessarily impact the government's budget. This may be particularly relevant for time periods where policymakers aim to accelerate large investment activity (when, for example, other factors may be working in the opposite direction, delaying investment).

However, it should be noted, that this free lunch is not exactly free. There are many open questions in the literature about reforms to the tax code that may (or may not) reduce tax uncertainty, and there is substantial debate among experts and policymakers about the best ways to achieve this end. In fact, Dixit and Pindyck (1994) argue that in the case where a tax reform process is drawn out for an excessive amount of time, the cure may be worse than the disease. Thus, more optimal corporate tax policy that reduces tax uncertainty ought to balance swift enactment and policy efficacy.

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Appendix A – Tax Uncertainty Coefficient of Variation (Volatility) Measure Example

Year	**Firm A**	**Firm B**
2001	0.25	0.38
2002	0.25	0.06
2003	0.25	0.43
2004	0.25	0.13
2005	0.25	0.25
Standard Deviation of ETRs calculated for 2005 (1)	**0.00**	**0.158**
Average ETR calculated for 2005 (2)	**0.25**	**0.25**
Tax Uncertainty value for 2005 = (1)/(2)	**0.00**	**0.63**

Notes: In this table we provide a simple example of two firms that have the same ETR but different ETR volatilities in the current year (2005 in our example). Specifically, both Firms A and B have a 25 percent ETR in the current year (2005) and averaged over the five year period. However, the principal difference between the two is that Firm B has greater volatility in its tax rates, which is easy to see by just glancing at the series. This is also reflected in the tax uncertainty measure, as Firm B has higher tax uncertainty for 2005 than Firm A (valued as 0.63 and 0.00, respectively). The difference in tax uncertainty between these two hypothetical firms is also equal to one standard deviation in our sample, which is illustrative of the magnitude that is used in our regression coefficient interpretations later in the paper.

Appendix B – Variable Descriptions

Variable	Description
$Acquisitions_{i,t}$	Acquisitions (AQC) divided by total assets (AT). If AQC was missing, the variable is set equal to zero.
$Cash\ Flow_{i,t}$	Following Billett et al. (2011): The sum of income before extraordinary items (IB) and depreciation and amortization (DP) all divided by total assets (AT). If DP was missing, the variable is set equal to IB/AT.
$\Delta Cash\ Holdings_{i,t}$	The current year ratio of cash and marketable securities to total assets (CHE/AT) less the prior year ratio of cash and marketable securities to total assets
$Expenditures_{i,t}$	Capital expenditures (CAPXV) divided by total assets (AT)
$Financial\ Constraint_{i,t}$	Similar to Whited (2006): An indicator variable for whether there were any distributions over the period since last investment spike and through the current year. A distribution is defined as common/ordinary dividends (DVC) plus the change in common treasure stock (TSTKC) from prior year. If missing the current or prior year TSTKC, then distributions were set equal to DVC. Missing values of DVC were set equal to zero.
$GAAP\ ETR_{i,t}$	Total tax expense (TXT) divided by pre-tax income (PI) adjusted for (less) special items (SPI). If SPI was missing, the variable is set equal to TXT/PI. If the numerator is positive and the denominator is negative (having tax expense when in a loss), then the variable is set equal to 100 percent. If the numerator is negative and the denominator is negative (having a tax refund when in a loss), then the variable is set equal to zero percent. The remaining cases when the variable would be less than zero (greater than 100) percent are set equal to zero (100) percent.
$Investment_{i,t}$	Following Billett et al. (2011): Capital expenditures (CAPXV) less sales of PP&E (SPPE) all divided by total assets (AT)
$Investment\ Spike_{i,t}$	Following Whited (2006): A spike is defined as two times the firm's own median $Investment_{i,t}$ over the sample period. It equals one if there was spike in the current year and is set equal to zero otherwise.
$Leverage_{i,t}$	Following Billett et al. (2011): The sum of long-term debt (DLTT) and debt in current liabilities – total (DLC) all divided by total assets (AT)
$\Delta NWC_{i,t}$	The current assets (ACT) less cash and marketable securities (CHE) and current liabilities (LCT) all divided by total assets (AT) less the same ratio from the prior year
$Pre-Tax\ Income_{i,t}$	Pre-tax income (PI)
$Q_{i,t}$	The market value of equity (PRCC_F x CSHO) divided by total assets (AT)
$Return\ Volatility_{i,t}$	The natural log of daily returns (CRSP.dsf variable retx) over the 12 months leading up to the firm-year end date. Following Bushee and Noe (2000), we require at least 125 observations of daily returns per firm-year.
$Sales\ Growth_{i,t}$	Following Billett et al. (2011): The difference in current and prior year sales (SALE) divided by prior year sales.
$\Delta Short\text{-}Term\ Debt_{i,t}$	The difference in the current and prior year ratios of debt in current liabilities (DLC) to total assets (AT)
$Size_{i,t}$	The natural log of total assets (AT)
$Size\text{-}Age\ Index_{i,t}$	The size-age index is defined similar to Hadlock and Pierce (2010) ("HP"). The index is the sum of -0.737 multiplied with size, 0.043 multiplied with the square of size, and -0.040 multiplied by age. The size used in the index equals $Size_{i,t}$ above but is set equal to $4.5 billion if it is greater than $4.5 billion (following HP). Our definition for the age differs from HP. We use the number of years a firm has been on Compustat (the current year less YEAR1) whereas HP uses the number of years a firm has a stock price available on Compustat. Following HP, age is set equal to 37 if age is greater than 37.
$Tax\ Uncertainty_{i,t}$	Following McGuire et al. (2011): Uses five years of GAAP ETRs (the current year and four lag years). It equals the standard deviation of $GAAP\ ETR_{i,t}$ over the five years divided by the absolute value of the average $GAAP\ ETR_{i,t}$ over the five years where $GAAP\ ETR_{i,t}$ is in decimal form (not percent).
Note: All components of variables that are in units of currency are adjusted to 2006 dollars before computing variables. Variable name references in parentheses are from Compustat.	

Figure 1
Distribution of Tax Uncertainty Coefficient Estimated at Different Quantiles

This figure plots coefficient estimates on *Tax Uncertainty*$_{it}$. We estimate the *Tax Uncertainty*$_{it}$ coefficient separately for each quantile using equation (2). Upper confidence 95 percent bounds (dotted line) and lower 95 percent confidence bounds (solid line) are also presented.

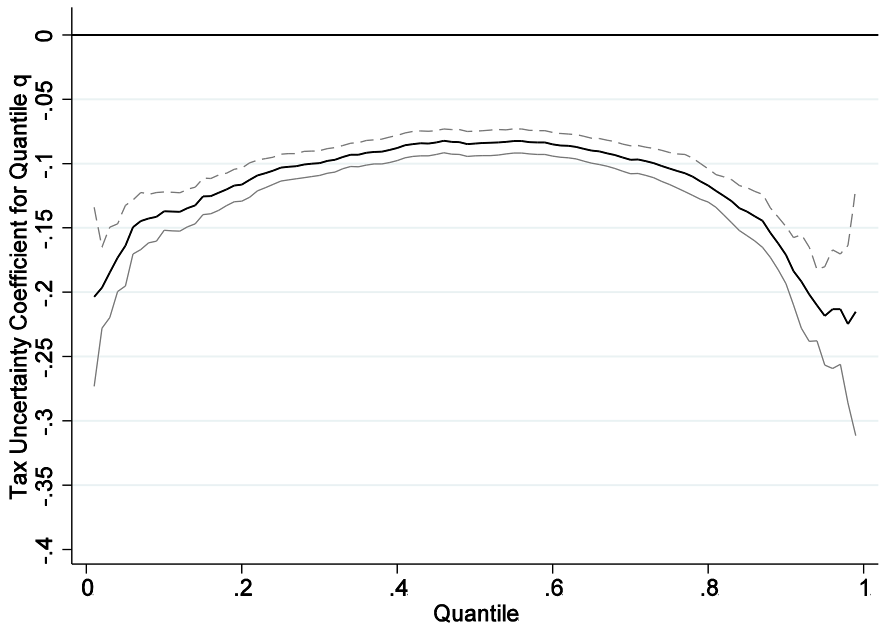

Figure 2
Distribution of Tax Induced Cash Buffer Coefficient Estimated at Different Quantiles

This figure plots coefficient estimates on *Tax Induced Cash Buffer*$_{it}$. We estimate the *Tax Induced Cash Buffer*$_{it}$ coefficient separately for each quantile using equation (2). Upper confidence 95% bounds (dotted line) and lower 95% confidence bounds (solid line) are also presented.

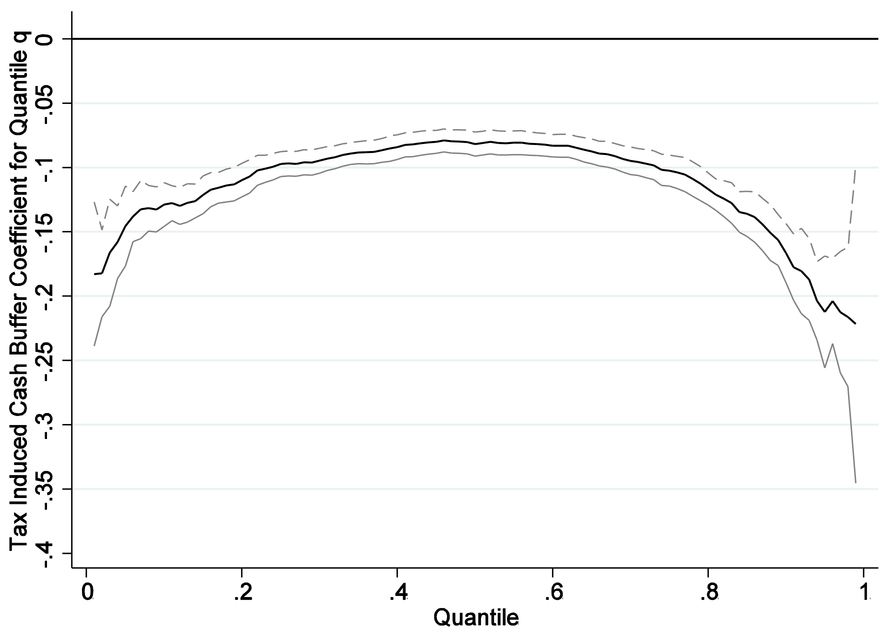

Figure 3
Estimated baseline hazard for the full sample versus small firm sample when controlling for tax uncertainty.

This figure plots the baseline hazard for the full sample versus the small firm sample when including *Tax Uncertainty*$_{i,t}$ in the hazard analysis. The horizontal axis measures the years since the last investment spike. The vertical axis measures the hazard rate coefficient, which is intuitively the probability of a spike, given that the firm has not had a spike up to that time. The estimates and figure show an upward sloping hazard for the small firm sample and an approximately flat hazard for the full sample.

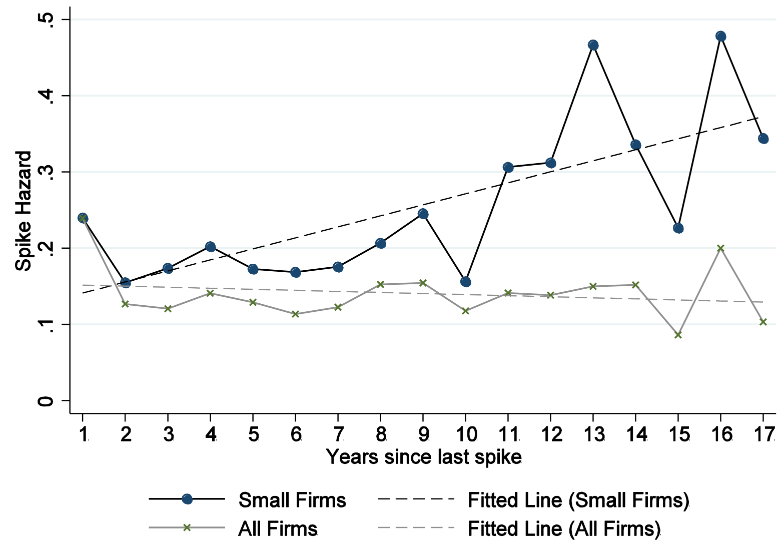

Figure 4
Estimated baseline hazard for the full sample versus small firm sample when controlling for the tax induced cash buffer.

This figure plots the baseline hazard for the full sample versus the small firm sample when including *Tax Induced Cash Buffer*$_{i,t}$ in the hazard analysis. The horizontal axis measures the years since the last investment spike. The vertical axis measures the hazard rate coefficient, which is intuitively the probability of a spike, given that the firm has not had a spike up to that time. The estimates and figure also show a nearly identical upward sloping hazard for the small firm sample and an approximately flat hazard for the full sample.

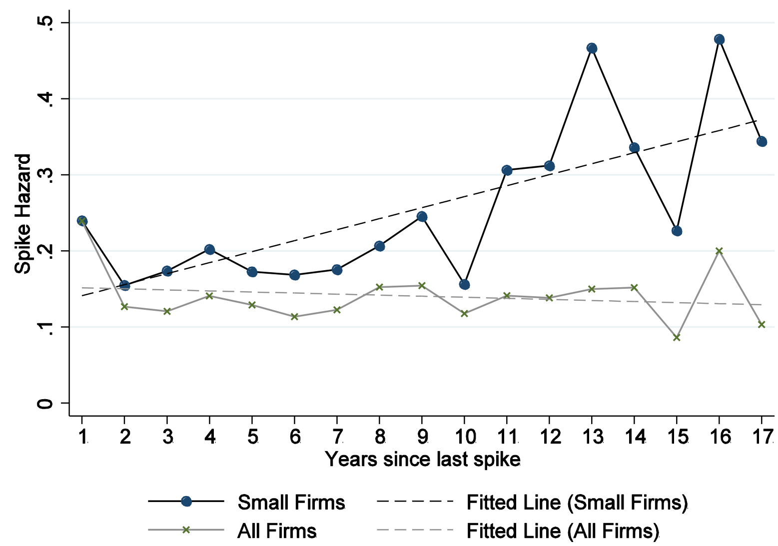

Table 1
Descriptive Statistics and Correlation Matrix

Panel A Descriptive Statistics

Variables	N	Mean	Std Dev	25th Pctl	50th Pctl	75th Pctl
$Investment_{it}$	55,214	0.0606	0.0580	0.0207	0.0439	0.0825
$\Delta Cash\ Holdings_{it}$	55,214	-0.0020	0.0839	-0.0291	-0.0007	0.0256
$Cash\ Flow_{it}$	55,214	0.0619	0.1281	0.0386	0.0851	0.1274
$Sales\ Growth_{it}$	55,214	0.0870	0.2522	-0.0403	0.0606	0.1766
Q_{it}	55,214	1.1771	1.3882	0.4259	0.7830	1.4218
$Tax\ Uncertainty_{it}$	55,214	0.6916	0.6279	0.1289	0.5675	1.0139
$Tax\ Induced\ Cash\ Buffer_{it}$	55,214	0.0000	0.0025	-0.0029	-0.0001	0.0011
$Return\ Volatility_{it}$	55,214	0.0352	0.0190	0.0215	0.0304	0.0433
$GAAP\ ETR_{it}$	55,214	0.3300	0.2715	0.0932	0.3460	0.4266
$Pre\text{-}Tax\ Income_{it}$	55,214	90.6381	310.4936	0.0094	6.1688	45.1307
$Financial\ Constraint_{it}$	55,214	0.2816	0.4498	0.0000	0.0000	1.0000
$Leverage_{it}$	55,214	0.2065	0.1802	0.0385	0.1820	0.3241
$Total\ Assets_{it}$	55,214	1110.0000	3280.0000	38.9204	143.9943	609.5691

Table 1 - Continued

Panel B Pearson (above) Spearman (below) Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) *Investment* $_{it}$		0.23 ***	0.14 ***	0.04 ***	-0.16 ***	-0.05 ***	-0.14 ***	-0.01 ***	0.06 ***	-0.02 ***	0.11 ***	0.03 ***
(2) *Cash Flow* $_{it}$	0.37 ***		0.21 ***	0.08 ***	-0.42 ***	0.00 ***	-0.39 ***	-0.02 ***	0.19 ***	-0.24 ***	-0.11 ***	0.10 ***
(3) *Sales Growth* $_{it}$	0.18 ***	0.30 ***		0.27 ***	0.00	0.07 ***	-0.03 ***	0.00	0.04 ***	0.06 ***	-0.05 ***	0.01
(4) *Q* $_{it}$	0.09 ***	0.39 ***	0.32 ***		0.01 ***	0.00	0.02 ***	-0.02 ***	0.08 ***	0.09 ***	-0.33 ***	-0.02 ***
(5) *Tax Uncertainty* $_{it}$	-0.24 ***	-0.48 ***	-0.09 ***	-0.15 ***		0.85 ***	0.43 ***	-0.24 ***	-0.20 ***	0.30 ***	0.09 ***	-0.14 ***
(6) *Tax Induced Cash Buffer* $_{i}$	-0.08 ***	-0.15 ***	0.01 ***	-0.05 ***	0.81 ***		0.00	-0.28 ***	-0.03 ***	0.12 ***	0.08 ***	0.03 ***
(7) *Return Volatility* $_{it}$	-0.19 ***	-0.33 ***	-0.03 ***	-0.05 ***	0.47 ***	0.04 ***		-0.04 ***	-0.22 ***	0.32 ***	0.03 ***	-0.21 ***
(8) *GAAP ETR* $_{it}$	0.06 ***	0.18 ***	0.07 ***	0.00	-0.40 ***	-0.36 ***	-0.16 ***		0.01	-0.02 ***	-0.03 ***	-0.01 ***
(9) *Pre-Tax Income* $_{it}$	0.24 ***	0.67 ***	0.26 ***	0.26 ***	-0.57 ***	-0.18 ***	-0.54 ***	0.22 ***		-0.16 ***	0.00	0.81 ***
(10) *Financial Constraint* $_{it}$	-0.07 ***	-0.22 ***	0.03 ***	0.04 ***	0.30 ***	0.11 ***	0.36 ***	-0.09 ***	-0.33 ***		0.03 ***	-0.16 ***
(11) *Leverage* $_{it}$	0.13 ***	-0.19 ***	-0.06 ***	-0.50 ***	0.08 ***	0.08 ***	-0.03 ***	-0.03 ***	-0.06 ***	0.00		0.08 ***
(12) *Total Assets* $_{it}$	0.17 ***	0.21 ***	0.09 ***	0.04 ***	-0.31 ***	0.03 ***	-0.47 ***	0.04 ***	0.65 ***	-0.32 ***	0.11 ***	

Table 1 presents the descriptive statistics for our initial analysis sample in Panel A and the Pearson (above) and Spearman (below) correlation matrix in Panel B. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 2
OLS Regressions of Cash Holdings on Tax Uncertainty

	Dependent Variable: $\Delta Cash\ Holdings_{it}$			
	(1)	(2)	(3)	(4)
$Cash\ flow_{it}$	0.0624***	0.0678***	0.0766***	0.1313***
	(7.139)	(7.426)	(8.283)	(11.058)
Q_{it}	0.0388***	0.0415***	0.0427***	0.0338**
	(4.356)	(4.662)	(4.799)	(3.210)
$Size_{it}$	-0.0077	0.0019	0.0127**	0.0809***
	(-1.679)	(0.378)	(2.403)	(5.179)
$\boldsymbol{Tax\ Uncertainty_{it}}$		**0.0411*** **	**0.0389*** **	**0.0208** **
		(6.523)	**(5.998)**	**(2.891)**
GAAP ETR			0.0221***	0.0109
			(3.743)	(1.832)
$Return\ Volatility_{it}$			0.0518***	0.0192**
			(8.406)	(2.181)
Additional Controls	No	No	No	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.127	0.129	0.131	–
N	55,214	55,214	55,214	55,214

Table 2 presents the estimates for equation (1) using ordinary least squares (OLS). Column (4) uses an IV approach where IVs come from Almeida et al. (2004). Standard errors are clustered by firm and year, and t-statistics are in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 3
OLS Regressions of Investment on Tax Uncertainty

	Dependent Variable: ***Investment***$_{it}$	
	(1)	(2)
Tax Uncertainty$_{it}$	**-0.1287***** **(11.316)**	
Tax Induced Cash Buffer$_{it}$		**-0.1234***** **(11.287)**
Cash Flow$_{it}$	0.0068 (1.025)	0.0233*** (3.302)
Sales Growth$_{it}$	0.0980*** (8.698)	0.0991*** (8.800)
Q_{it}	0.0596*** (4.552)	0.0654*** (5.118)
Return Volatility$_{it}$	-0.0564*** (7.790)	-0.0785*** (9.940)
GAAP ETR$_{it}$	-0.0228** (3.076)	-0.0234** (3.141)
Additional Controls	Yes	Yes
Firm Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
R-squared	0.564	0.564
N	55,214	55,214

Table 3 presents the estimates for equation (3) using ordinary least squares (OLS) regression with standard errors clustered by firm and year. T-statistics are in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 4
Logit and Linear Probability Regression of Investment Spikes on Tax Uncertainty

	Dependent Variable: *Investment Spike$_{it}$* *Sample Average: 0.1111*			
	Logit (1)	Logit (2)	OLS (3)	OLS (4)
Tax Uncertainty$_{it}$	**-0.2319*****		**-0.0207*****	
	(9.134)		**(7.325)**	
Tax Induced Cash Buffer$_{it}$		**-0.2206*****		**-0.0197*****
		(8.718)		**(7.077)**
Cash Flow$_{it}$	-0.0210	0.0087	-0.0025	0.0002
	(0.867)	(0.357)	(1.118)	(0.082)
Sales Growth$_{it}$	0.1880***	0.1902***	0.0194***	0.0196***
	(9.412)	(9.525)	(7.669)	(7.728)
Q$_{it}$	0.1217***	0.1325***	0.0155***	0.0165***
	(3.904)	(4.347)	(5.113)	(5.419)
Return Volatility$_{it}$	-0.0987***	-0.1388***	-0.0089***	-0.0124***
	(4.632)	(6.292)	(4.418)	(5.796)
GAAP ETR$_{it}$	-0.0569**	-0.0578**	-0.0051**	-0.0052**
	(2.951)	(2.979)	(2.930)	(2.963)
Additional Controls	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.059	0.059	0.207	0.207
N	55,214	55,214	55,214	55,214

Table 4 presents the estimates for equation (5) using logit regression and a linear probability regression. Columns (1) and (2) present the results for the logit regression. Columns (3) and (4) report the results for the linear probability regression. Standard errors are clustered by firm and year, and t-statistics are in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 5
Hazard Analysis Descriptive Statistics and Investment Spikes and Spells Summary Statistics – Full Sample

Panel A Variable Descriptive Statistics

Variables	N	Mean	Std Dev	25th Pctl	50th Pctl	75th Pctl
$Investment_{it}$	24818	0.0501	0.0523	0.0158	0.0350	0.0682
$Cash\ Flow_{it}$	24818	0.0564	0.1258	0.0326	0.0788	0.1212
$Sales\ Growth_{it}$	24818	0.0722	0.2440	-0.0524	0.0517	0.1639
Q_{it}	24818	1.1498	1.3281	0.4294	0.7745	1.3936
$Tax\ Uncertainty_{it}$	24818	0.7212	0.6245	0.1502	0.5850	1.0586
$Tax\ Induced\ Cash\ Buffer_{it}$	24818	0.0000	0.0010	-0.0007	-0.0002	0.0006
$Return\ Volatility_{it}$	24818	0.0357	0.0191	0.0220	0.0309	0.0439
$GAAP\ ETR_{it}$	24818	0.3220	0.2771	0.0534	0.3370	0.4130
$Pre\text{-}Tax\ Income_{it}$	24818	57.3912	208.0291	-0.2875	4.6708	33.6638
$Financial\ Constraint_{it}$	24818	0.2769	0.4475	0.0000	0.0000	1.0000
$Leverage_{it}$	24818	0.2035	0.1821	0.0316	0.1755	0.3251
$Total\ Assets_{it}$	24818	782.5306	2340.0000	35.9679	127.5098	498.8679

Panel B Investment Spell Descriptive Statistics

Average spell length	4.23
Fraction of spells censored	0.34
Average length censored	6.97
Fraction of spells uncensored	0.66
Average length uncensored	2.89
Number of spells	6373

Table 5 presents the descriptive statistics for the full hazard analysis sample in Panel A and investment spell summary statistics for the sample in Panel B. We define the variables in Appendix B.

Table 6
Hazard Rate Analysis of Investment Spikes under Tax Uncertainty

Panel A Hazard Rate Analysis Using Tax Uncertainty and Different Models

	Dependent Variable: ***Investment Spike***$_{it}$			
	Mixed proportional hazard (1)	Cox proportional hazard (2)	Weibull hazard (3)	Exponential hazard (4)
Tax Uncertainty$_{it}$	**0.8172*****	**0.8867*****	**0.8298*****	**0.8321*****
	(-6.986)	**(-7.555)**	**(-9.114)**	**(-9.124)**
Cash Flow$_{it}$	0.9344**	0.9656**	0.9391***	0.9400***
	(-3.228)	(-2.390)	(-3.644)	(-3.622)
Sales Growth$_{it}$	1.1356***	1.0977***	1.1415***	1.1391***
	(7.413)	(8.009)	(9.888)	(9.861)
Q_{it}	1.0675***	1.0373**	1.0549***	1.0539***
	(3.484)	(3.252)	(4.067)	(4.031)
Return Volatility$_{it}$	0.8945***	0.9481***	0.9533**	0.9521**
	(-4.290)	(-3.437)	(-2.371)	(-2.455)
GAAP ETR$_{it}$	0.9645**	0.9740**	0.9651**	0.9658**
	(-1.975)	(-1.970)	(-2.241)	(-2.218)
Additional Controls	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-9888.6463	-34697.7480	-8662.3726	-8664.7223
Number of Spells	6,373	6,373	6,373	6,373
N	24,818	24,818	24,818	24,818

Panel B Hazard Rate Analysis Using Tax Uncertainty and Different Models

	Dependent Variable: ***Investment Spike***$_{it}$			
	Mixed proportional hazard (1)	Cox proportional hazard (2)	Weibull hazard (3)	Exponential hazard (4)
Tax Induced Cash Buffer$_{it}$	**0.8457*****	**0.8987*****	**0.8503*****	**0.8523*****
	(-6.960)	**(-7.737)**	**(-9.202)**	**(-9.207)**
Cash Flow$_{it}$	0.9900	1.0009	0.9914	0.9915
	(-0.501)	(0.065)	(-0.513)	(-0.509)
Sales Growth$_{it}$	1.1361***	1.0984***	1.1424***	1.1400***
	(7.513)	(8.061)	(9.938)	(9.911)
Q_{it}	1.0610**	1.0340**	1.0498***	1.0488***
	(3.224)	(2.969)	(3.697)	(3.662)
Return Volatility$_{it}$	0.8460***	0.9156***	0.9008***	0.9003***
	(-6.195)	(-5.859)	(-5.330)	(-5.401)
GAAP ETR$_{it}$	0.9656	0.9733**	0.9648**	0.9655**
	(-1.931)	(-2.019)	(-2.258)	(-2.235)
Additional Controls	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-9,888.6463	-34,696.6820	-8661.7117	-8664.0726
Number of Spells	6,373	6,373	6,373	6,373
N	24,818	24,818	24,818	24,818

Table 6 presents the hazard rate analysis estimates from equation (6) using four different models. Panel A (Panel B) uses *Tax Uncertainty*$_{it}$ (*Tax Induced Cash Buffer*$_{it}$) to proxy for a firm's uncertainty about future tax incidence. Column (1) provides estimates using the Meyer (1990) mixed proportional hazard model design that incorporates a gamma distribution for unobservable heterogeneity. Column (2) uses a Cox proportional hazard model. Columns (3) and (4) use a Weibull and exponential hazard model, respectively. Z-statistics are reported in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 7
Accelerated Failure-Time Form Analysis of Investment Spikes under Tax Uncertainty: Full Sample

	Dependent Variable: ***Investment Spike***$_{it}$			
	Weibull (1)	Weibull (2)	Exponential (3)	Exponential (4)
Tax Uncertainty$_{it}$	**0.1815*** **		**0.1838*** **	
	(9.178)		**(9.124)**	
Tax Induced Cash Buffer$_{it}$		**0.1578*** **		**0.1599*** **
		(9.258)		**(9.207)**
Cash Flow$_{it}$	0.0612***	0.0084	0.0619***	0.0085
	(-3.646)	(0.513)	(3.622)	(0.509)
Sales Growth$_{it}$	-0.1288***	-0.1295***	-0.1303***	-0.1310***
	(-9.935)	(-9.985)	(-9.861)	(-9.911)
Q_{it}	-0.0520***	-0.0473***	-0.0525***	-0.0477***
	(-4.072)	(-3.701)	(-4.031)	(-3.662)
Return Volatility$_{it}$	0.0465**	0.1017***	0.0491**	0.1050***
	(2.372)	(5.342)	(2.455)	(5.401)
GAAP ETR$_{it}$	0.0345**	0.0348**	0.0348**	0.0351**
	(2.242)	(2.259)	(2.218)	(2.235)
Additional Controls	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-8,662.3726	-8,661.7117	-8,664.7223	-8,664.0726
Number of Spells	6,373	6,373	6,373	6,373
N	24,818	24,818	24,818	24,818

Table 7 presents the accelerated failure-time form estimates for the full sample using two different distributions. Columns (1) and (2) use a Weibull hazard model, and Columns (3) and (4) use an exponential hazard model. Columns (1) and (3) (Columns (2) and (4)) use *Tax Uncertainty*$_{it}$ (*Tax Induced Cash Buffer*$_{it}$) to proxy for a firm's uncertainty about future tax incidence. Z-statistics are reported in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 8
Estimating the Baseline Hazard for the Full Sample versus the Small Firm Sample

	Dependent Variable: ***Investment Spike***$_{it}$			
	Full Sample (1)	Small Firms Only (2)	Full Sample (3)	Small Firms Only (4)
Tax Uncertainty$_{it}$	**0.8099***** **(-7.131)**	**0.8166***** **(-4.979)**		
Tax Induced Cash Buffer$_{it}$			**0.8396***** **(-7.096)**	**0.8433***** **(-4.946)**
Cash Flow$_{it}$	0.9325** (-3.261)	0.8924*** (-3.935)	0.9906 (-0.466)	0.9462** (-2.000)
Sales Growth$_{it}$	1.1358*** (7.291)	1.1517*** (5.718)	1.1364*** (7.395)	1.1524*** (5.768)
Q_{it}	1.0672*** (3.355)	1.0714** (2.451)	1.0605** (3.092)	1.0652** (2.267)
Return Volatility$_{it}$	0.8885*** (-4.458)	0.8446*** (-4.752)	0.8382*** (-6.396)	0.7992*** (-6.000)
GAAP ETR$_{it}$	0.9654 (-1.900)	0.9735 (-1.055)	0.9665 (-1.854)	0.9739 (-1.042)
Additional Controls	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-9,799.6339	-4,396.1816	-9,800.5620	-4,396.5296
Number of Spells	6,373	2,871	6,373	2,871
N	24,210	10,110	24,210	10,110

Table 8 presents the accelerated failure-time form estimates for the full and small firm only samples using the Meyer (1990) mixed proportional hazard model design that incorporates a gamma distribution for unobservable heterogeneity. Columns (1) and (3) (Columns (2) and (4)) are estimated using the full sample (small firm only sample). Columns (1) and (2) (Columns (3) and (4)) use *Tax Uncertainty*$_{it}$ (*Tax Induced Cash Buffer*$_{it}$) to proxy for a firm's uncertainty about future tax incidence. Z-statistics are reported in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Table 9
Accelerated Failure-Time Form Analysis of Investment Spikes under Tax Uncertainty: Small Firm Sample

	Dependent Variable: *Investment Spike$_{it}$*			
	Weibull	Weibull	Exponential	Exponential
	(1)	(2)	(3)	(4)
Tax Uncertainty$_{it}$	**0.1655*** **		**0.1733*** **	
	(6.465)		**(6.333)**	
Tax Induced Cash Buffer$_{it}$		**0.1422*** **		**0.1489*** **
		(6.474)		**(6.346)**
Cash Flow$_{it}$	0.0857***	0.0379	0.0912***	0.0410
	(4.071)	(1.812)	(4.040)	(1.839)
Sales Growth$_{it}$	-0.1139***	-0.1146***	-0.1215***	-0.1222***
	(-6.425)	(-6.465)	(-6.393)	(-6.433)
Q$_{it}$	-0.0516**	-0.0471**	-0.0516**	-0.0468**
	(-2.589)	(-2.357)	(-2.420)	(-2.196)
Return Volatility$_{it}$	0.0919***	0.1391***	0.1046***	0.1540***
	(3.731)	(5.719)	(3.951)	(5.886)
GAAP ETR$_{it}$	0.0229	0.0229	0.0229	0.0230
	(1.157)	(1.158)	(1.076)	(1.078)
Additional Controls	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-3,714.2814	-3,714.3705	-3,729.6750	-3,729.7359
Number of Spells	2,871	2,871	2,871	2,871
N	10,110	10,110	10,110	10,110

Table 9 presents the accelerated failure-time form estimates for the small firm only sample using two different models. Columns (1) and (2) use a Weibull hazard model. Columns (3) and (4) use an exponential hazard model. Columns (1) and (3) (Columns (2) and (4)) use *Tax Uncertainty$_{it}$* (*Tax Induced Cash Buffer$_{it}$*) to proxy for a firm's uncertainty about future tax incidence. Z-statistics are reported in parentheses. We define the variables in Appendix B. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% levels (two-tailed), respectively.