Net Operating Loss Carryforwards and Corporate Financial Policies

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Abstract

We examine the relation between the tax benefits from net operating loss (NOL) carryforwards and external financing and liquidity decisions using hand-collected data that more precisely measure the cash value of these tax shields. NOLs are a key input into common measures of corporate tax status such as simulated tax rates, yet it is widely recognized that the readily-available proxy for NOLs from Compustat suffers from considerable measurement error. We first show that our measure can better predict cash tax shields on future profits relative to the traditional measure. We then show that our measure of NOL benefits is positively associated with equity financing, consistent with NOL firms substituting to equity from debt when the tax loss reduces the present value of interest tax deductions. We also demonstrate that this substitution of equity-for-debt does not hold for all firms, particularly those subject to statutory limitations on future utilization of the tax loss following significant equity transactions. NOL benefits are also associated with larger corporate cash balances, consistent with NOLs lowering the tax cost of holding cash and liquid investments, and investors place a higher value on these NOL-induced cash holdings. Moreover, NOL benefits appear to mitigate the frictions on cash holdings arising from repatriation taxes and aggressive tax planning. These results inform the academic literature and policy makers by documenting important firm decisions affected by statutory tax loss rules.

Keywords: Net Operating Losses, Taxes, Debt, Equity, Cash

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1. Introduction

Central questions in corporate finance concern whether and to what extent taxes influence the firm's financial policies, including the choice of capital (internal vs. external, debt vs. equity) to fund firm operations. Prior literature motivates the predictions that firms facing high tax rates should issue more debt and hold less cash (see Graham, 2003 for a review). Specifically, the corporate tax deductibility of interest payments, but not of dividends, provides a tax advantage to issuing debt that is increasing in the firm's marginal tax rate. Similarly, the corporate taxation of investment income earned on a firm's financial assets is an important cost associated with accumulating and holding liquid assets in the firm (Riddick and Whited, 2009). Despite compelling ex ante predictions, the empirical literature has confronted criticism that taxes are no more than a third-order consideration in financing decisions (Myers, 1984). This has led to empirical refinements addressing the proxies for tax status (Shevlin, 1990; Graham, 1996; Blouin, Core and Guay, 2010, Faulkender and Smith, 2016) and the use of unique experimental settings to address the identification of tax status (Barclay, Heitzman and Smith, 2013, Heider and Ljungqvist, 2015). However, the literature has done relatively little to address the mismeasurement of a core determinant of tax status: the firm's tax net operating loss (NOL) carryforwards. In this paper, we re-examine the relation between a firm's NOL carryforwards, measured with more precise hand-collected data, and a firm's financing and savings policies.

Net operating loss carryforwards are options to reduce future cash tax obligations otherwise owed to taxing authorities in profitable years that arise from prior economic losses incurred by the firm. Although multiple factors can affect a firm's tax status, an explicit focus on NOL carryforwards is important for several reasons. First, they are economically significant to both the

government and firms; in 2012, aggregate unused NOL carryforwards for U.S. corporations approached $2 *trillion* at the Federal level alone (Treasury Inspector General for Tax Administration, 2015), providing firms with the ability to reduce future corporate tax payments by up to $700 billion. By comparison, Federal corporate income tax revenues averaged $240 billion per year between 2009 and 2015.[1] Second, our data reveal that nearly 90% of large U.S. public firms report NOL carryforwards. The prevalence of tax losses means that NOL carryforwards potentially have wide-ranging and significant effects on many firm decisions. However, despite the economic importance of NOLs and their role in investment decisions (Auerbach and Poterba, 1987; Edgerton, 2010; Dobridge, 2016; Langenmayr and Lester, 2017), evidence documenting the direct relation between financing decisions and NOLs specifically is limited (MacKie-Mason, 1990). Finally, the literature has either used inaccurate NOL data as a key input in estimating a firm's marginal tax rate to study a firm's debt financing decisions (Graham, 1996; Blouin, Core, and Guay, 2010), or it has ignored the relation between tax losses and equity issuances, despite the fact that technical tax rules draw an explicit link between the value of NOL benefits and equity transactions.[2] Understanding the effect of an NOL carryforward, if any, is therefore central to estimating the impact of government policies on a firm's financing decisions and in evaluating how management responds to tax loss incentives.

We conjecture that the lack of consistent evidence linking NOLs carryforwards to corporate financing decisions begins with a traditional reliance on a readily-available, but highly imperfect, proxy from Compustat. With a few notable exceptions (Auerbach and Poterba, 1987; Graham and Mills, 2008; Cooper and Knittel, 2010), prior research relies almost exclusively on Compustat

[1] Source: Office of Management and Budget, Historical Tables, Table 2.1

[2] Briefly, if a significant ownership change occurs at the firm--an event tied directly to transactions by 5% block holders over a three-year period--U.S. tax rules impose a statutory limitation on future utilization of NOL benefits. We discuss this limitation in additional detail in Section 2.

reporting to identify loss carryforwards (variable *tlcf*). We construct a new measure of expected NOL benefits based on identifying a firm's total worldwide tax losses from information disclosed in the notes to the financial statements. We validate that our measure of tax losses is superior to the summary measure provided in Compustat by quantifying the incorrect incidence of tax losses based on *tlcf* and by showing that our measure predicts future cash tax savings while the Compustat measure does not. We then use our more accurate proxy to empirically test the association between NOL benefits and firm financing and savings policies.

Under the tradeoff theory of capital structure, non-debt corporate tax shields—such as tax loss carryforwards—significantly reduce the marginal tax benefits of debt (DeAngelo and Masulis, 1980; Graham, 1996). While debt is a key source of external funding, NOL carryforwards increase the after-tax cost of debt financing by crowding out and thus reducing the present value of incremental interest deductions.[3] Thus, if firms require external financing and if managers respond to the relative after-tax costs of debt and equity in choosing the type of external financing, we predict that firms with greater NOL benefits should choose to issue less debt and/or more equity than firms with fewer (or no) NOL carryforwards.

A related decision is whether firms build liquidity reserves to finance future investment and operations in anticipation of high costs of external financing or high cash flow uncertainty. In addition to agency conflicts that reduce the value of these cash reserves to investors (Dittmar and Mahrt-Smith, 2007), taxes have also been recognized as a potential cost of holding excess cash (Riddick and Whited, 2009). All else equal, it is generally more tax-efficient for the firm to distribute excess cash to shareholders for investment than for the company to retain it and generate

[3] Specifically, firms that have existing tax losses may not be able to immediately deduct interest expense paid on borrowing; instead, the interest deductions will add to the existing tax loss and be carried forward. Thus, the interest deduction may not be used until a future period if/when the company reports taxable income.

passive investment income subject to double taxation. A firm with NOL carryforwards can directly lower the tax cost of corporate savings by shielding investment income from tax at the corporate level (without directly affecting the tax at the investor level). Thus, we expect a positive association between NOL benefits and cash holdings.[4]

To test our predictions, we first construct a comprehensive panel of NOL carryforward data for a large sample of U.S. firms from 2010 to 2015 using hand-collected information from firms' publicly-available financial statements. Compustat appears to understate the frequency of firms with NOL carryforwards: we identify 89 percent of the firms in our sample reporting an NOL carryforward, whereas Compustat reports just 67 percent for the same observations (variable *tlcf*). Compustat also understates the dollar amount of the NOL carryforward. When *tlcf* is missing, we estimate average NOL benefits of $213 million. When *tlcf* is reported, we estimate that the average NOL carryforwards are approximately 27.5 percent higher than that reported in Compustat ($838.0 million from our data as compared to $657.1 million from Compustat).

We then derive an estimate of the NOLs' undiscounted value that weights each dollar of the pre-tax NOL carryforward by an estimated statutory tax rate for the relevant jurisdiction in which the NOL was generated.[5] Compustat *tlcf* does not include details on the location of the NOL, which

[4] Although corporate taxes play a key conceptual role in many recent studies, the empirical evidence directly linking corporate taxes to cash holding decisions is limited, with the exception of the literature on repatriation taxes (e.g. Foley et al. 2007; Hanlon et al., 2015; Nessa, 2017; Harford et al., 2017; De Simone et al., 2017; De Simone and Lester, 2017). US firms that generate profits in low-tax foreign subsidiaries are taxed again when the earnings are repatriated to the US parent. This tax can be avoided by leaving the earnings in the foreign subsidiary, leading to a "trapped cash" problem. We acknowledge that these repatriation taxes are an important first order determinant of cash holdings and thus attempt to control for this factor in all of our tests of cash holdings by including the *REPAT* variable from these prior studies. Furthermore, we note that the firm's NOLs–specifically those generated in the US—can be used to offset this tax to the extent that firms choose to repatriate. To the extent NOLs relax this repatriation tax constraint, we expect that the impact of repatriation taxes on cash holdings should be mitigated when the firm has domestic NOLs. In additional analyses, we also test and find this expected result: U.S. MNCs' domestic NOLs appear to shield the foreign profits from incremental US tax.

[5] It assumes that the entire pool of NOLs is immediately available for use, and therefore our estimates of NOL benefits should be viewed as upper bounds on the potential value of the NOL asset. The value of any given dollar of tax losses depends on the potential tax savings it generates; a one-dollar carryforward at the Federal level generates several times the cash tax savings as the same carryforward will at the state level. Thus, it would not be appropriate to use an

is critical in calculating the expected value of tax losses to the firm. Using our hand-collected data, we find that, of the $838 million in average total loss carryforwards, 37.8% are attributable to state NOLs ($317 million) and 25.6% to foreign NOLs ($214.7 million).[6] Thus, our hand-collected NOL data not only allow us to more accurately identify which firms have NOL benefits, they permit us to more precisely measure the total dollar amount and worldwide distribution of these tax attributes. The primary measure used in the empirical tests is the potential net operating loss carryforward benefit (the "NOL benefit"), calculated as the maximum potential cash tax savings from the utilization of existing tax loss carryforwards, reflective of location-specific rates, and scaled by total assets.

A proper measure of NOL benefits should predict cash tax savings in future periods. Therefore, we validate our measure by comparing its ability to explain future cash tax savings to that of the commonly-used Compustat-based measure. Conditional on having positive pretax income in year $t + 1$ (i.e., more likely to generate cash tax savings from utilization of an NOL carryforward), we show that (as expected) the cash tax paid per dollar of pretax income in year *t+1* is negatively associated with the NOL tax benefit available at the beginning of year *t+1*. Moving from the bottom to the top quartile of NOL benefits is associated with approximately a ten percentage point decline in the average cash tax rate. We also show that our proxy for NOL benefits performs significantly better in explaining future cash tax savings relative to the

unweighted measure because that would treat each dollar of tax losses (despite jurisdictional and tax rate differences) as the same. The expected value of the firm's NOL carryforwards should depend on the expected cash flows from the tax shields, properly discounted.

[6] For the majority of firms that disclose detail on the location of NOLs, the average loss carryforward is similar at the Federal and State level on a pre-tax basis. Compustat-based measures appear to ignore this obvious distinction in potential cash value, blending jurisdiction-specific pre-tax amounts into a single reported tax loss carryforward (*tlcf*). Compustat treats a firm with one dollar of Federal NOLs and one dollar of state NOLs as having two dollars in total NOLs, even though firms do not generate their NOLs in the same proportions across geographical boundaries even though tax rates vary across major jurisdictions. This is one example of the type of measurement issue inherent in the Compustat data.

Compustat-based measure. The association between the Compustat-based *tlcf* measure and tax savings on future profits is effectively zero when both proxies are included in the model.

We next provide evidence on the factors correlated with NOL benefits to study the types of firms reporting losses and, more specifically, assess if NOL benefits are simply another signal of financial distress. As expected, prior cumulative pre-tax losses explain an important fraction of firms' NOL benefit. However, NOL benefits are also positively associated with market-to-book ratios, R&D expenditures, and foreign operations, indicative of firms with significant growth opportunities. To confirm the existence of growth opportunities among NOL firms (and hence the potential demand for external financing), we empirically test and find that NOL benefits predict future asset growth. Specifically, we show that the NOL benefit is positively and significantly associated with growth in total assets, capital expenditures, and R&D spending.

Having shown that our hand-collected NOL data perform better at predicting future tax shields, we then test our predictions on the association between NOL benefits and future external financing decisions. We find that external financing activity from all sources is positive associated with the NOL tax benefit, consistent with these firms seeking capital to fund firms' asset growth. We then show, consistent with our predictions, that NOL benefits have a differential relation with debt and equity issuances. Adjusting for the growth in cash, we find the expected negative association between NOL benefits and future net debt issuances (debt issued less debt repaid); a ten percentage point increase in NOL benefits is associated with a decrease in net debt issuances of 0.9%. We observe a significantly positive relation between NOL benefits and new equity financing, consistent with firms choosing to issue equity when borrowing is otherwise relatively costly in the presence of NOL carryforwards. Our estimates suggest that an increase in NOL benefits of ten percentage points is associated with additional net equity issuances (stock issued less stock

repurchased) of 1.2% of assets. These results are robust to alternative measures of equity financing and including only intentional financing decisions (above 2% of beginning assets), as well as discrete choice models of seasoned offerings and large financing issuances.

Prior literature suggests that NOL carryforwards lower the relative cost of equity financing by raising the after-tax cost of debt. However, NOL carryforwards can directly affect the cost of accessing external equity financing. Specifically, new equity issuances, changes in existing shareholders, and even some repurchases can lead to a significant change in equity ownership that could trigger a statutory limitation on the firm's ability to use its US NOL carryforwards in future periods.[7] Consequently, NOL carryforwards can also increase the cost of equity financing for some firms because of the increased probability of impairing a firm's expected NOL benefits. Thus, we expect that the positive relation between NOL benefits and equity issuances will be attenuated when an equity issuance increases the risk of triggering this U.S. limitation. Consistent with this prediction, we find that the positive relation between NOL benefits and equity issuances is driven by the 22% of sample firms that disclose a pre-existing limitation and thus are less exposed to the potential risk that a future equity issuance will impair their NOL benefits.

Turning to the liquidity decision, we find that corporate cash is positive associated with the firm's NOL benefits, consistent with NOLs shielding investment income from corporate taxation and reflecting a potential tax incentive to save excess cash in the corporation. These results are robust to controlling for other important tax-related determinants of cash holdings, such as

[7] In short, if ownership by 5 percent shareholders changes by more than 50 percent within a three-year period, the amount of tax losses that can be used in future years is subject to a statutory limitation under IRC Section 382. While this U.S. rule was implemented to discourage firms from acquiring tax loss firms only for the expected future tax benefits, this limitation can affect any firm that crosses the 50 percent ownership change threshold. That is, the limitation can be triggered even without an acquisition of controlling interest by any single party. In response to the threat of the potential limitation on NOLs, hundreds of firms have adopted "NOL Poison Pills", mechanisms that preclude 5% block acquisitions without board approval (Erickson and Heitzman, 2010; Sikes et al., 2014).

repatriation taxes (Foley et al., 2007) and reserves for uncertain tax positions (Hanlon, Maydew and Saavedra, 2017). In additional tests that consider the interactions between NOLs, repatriation taxes, and tax planning, we find that NOL benefits relax the trapped cash problem by shielding the firm from repatriation taxes and also reduce the need to reserve cash for future settlements with tax authorities.

We next test whether NOL-driven increases in cash holdings are value-increasing. If the larger cash balances held by NOL firms is driven by a corporate tax advantage to savings that increases after-tax returns to investors, investor valuation of corporate cash should also be increasing in NOL benefits. To test this, we follow Faulkender and Wang (2006) and examine the valuation of cash holdings by regressing annual excess stock returns on the annual change in cash. The results are consistent with our prediction that investors place a significantly higher value on corporate cash when NOL benefits shield investment returns from corporate taxation.

Finally, we conduct several additional robustness tests. First, we address concerns that the NOL benefit is simply a proxy for non-tax financial constraints. We control for traditional measures of financial constraints in our financing, cash holdings, and cash valuation regressions and find that our results continue to hold. Second, we also address whether a firm's simulated marginal tax rate should better capture the relevant information because it also incorporates forecasts of future pretax income. We find that an alternative measure of tax status based on simulated rates does not explain cash tax savings, financing, or cash holdings decisions.

Our study contributes to the literature several ways. First, we address the well-known criticisms of Compustat-based measures of net operating loss carryforwards (Mills, Newberry and Novack, 2003) by showing that a hand-collected measure that incorporates jurisdiction-specific information, as well as firm-specific details on statutory limitations, can explain tax shields in

future periods when other proxies cannot. The construction of the NOL tax benefit proxy provides a possible explanation for the inconsistent effects of NOLs in prior work, and suggests an avenue for future improvements in simulated tax rates following a recent literature that has suggested alternative methodologies for forecasting taxable income (Blouin, Core, and Guay, 2010) and incorporating multinational tax exposure (Faulkender and Smith, 2016).

Second, this paper adds to the corporate finance literature by studying how managers respond to a key tax shield, NOL carryforwards. We build on prior literature that focuses primarily on the effects of NOLs on investment and accounting choices (Maydew, 1997; Albring et al., 2011; Erickson et al., 2013) by showing that NOL carryforwards can have important consequences for a firm's financing and savings decisions. Moreover, we are (to our knowledge) the first paper to show that the threat of statutory limitations on NOL value in the US can mitigate the incentive to shift from debt to equity financing. Finally, our results appear consistent with the survey findings in Graham et al. (2017), who show that managers appear more likely to base their decisions on simple tax heuristics such as the statutory tax rate or the effective tax rate. If the size and location of available NOLs also represents a simple heuristic available to managers, then this offers one explanation for our findings that financial policies are correlated with the tax benefits from NOL carryforwards.

Third, we contribute to the literature studying loss firms generally (Denis and Mckeon, 2016) and tax loss firms in particular by providing analysis of the determinants of NOL carryforwards. Approximately 89 percent of the large publicly-traded firms in our sample report NOL carryforwards. While high NOL benefit firms have performed poorly in the past and appear financially constrained, our data show that the sample also includes high growth firms that generate substantial accounting losses in their early years as they create value and invest in risky projects

that are critical for economic growth. These firms persist in the sample despite, or possibly because of, the NOL benefits that generate cash tax savings in future periods.

Finally, this paper informs policy makers about the mechanisms by which tax losses can affect important firm decisions. In the past sixteen years, U.S. tax loss rules have changed three times to permit more generous tax loss offsets (Dobridge, 2016). These statutory extensions show that policy makers consider and alter these tax loss rules when attempting to achieve certain fiscal policy goals, such as providing fiscal stimulus. However, these policies likely have nuanced or indirect effects on investor welfare, and we show that NOL carryforwards appear to be important through their impact on financing and cash holdings. Tax rules that determine carrybacks and carryforwards vary widely across countries and states, are likely to shape how firms interact with their subsidiaries at home and abroad, and represent an important avenue for future research.

2. Sample and Descriptive Statistics

2.1 Sample

Because our data must be hand-collected from the financial statement footnotes, we focus our sample selection on large publicly-traded U.S.-headquartered firms. We first sort all listed firms that we observe in Compustat based on an annual composite ranking of assets, sales, and market value of equity. We identify the largest 1,500 firms based on this ranking in any year between 2010 and 2015 for a sample of 1,958 distinct firms. Using the tax footnote, we hand-collect data in every available year of our sample period, yielding an initial sample of 9,910 firm-years. We drop all regulated and financial firms (2,302 observations), as these firms are subject to different rules that may affect firm valuation and the calculation of taxable income, and we retain

observations with at least three years of accounting and market data. These steps result in a final sample of 6,884 firm-year observations.

Table 1 provides details on the data obtained from the tax footnotes. Panel A compares the frequency of tax loss carryforwards in the hand collected sample to Compustat data. We show that 6,120 firms, or 88.9 percent of the sample, report some amount of tax loss carryforward, either through disclosure of a gross tax loss carryforward (the full amount of the loss available to offset future income) or through a deferred tax asset (the tax-effected amount of the loss carryforward) in the firm's income tax footnote. This figure is significantly higher than the 67.4 percent carryforward rate if relying on Compustat.

Panel A also provides further details for the subsample of 6,120 firm-year observations that disclose a tax loss carryforward. We identify 66.6 percent (4,076 observations) that disclose the location of the NOL carryforwards. Approximately 22.3 percent of the tax loss sample disclose existing statutory limitations on future utilization of the tax loss under Section 382 of the US Internal Revenue Code, and approximately 62.7 percent of tax loss firms report a large accounting valuation allowance that reduces the gross amount of total deferred tax assets recorded on the firm's balance sheet.[8]

Panel B provides further descriptive details on the losses reported. We first present statistics for the 4,076 observations disclosing the total pre-tax NOL carryforward by location. The average (median) tax loss carryforward is $823.4 ($206.9) million, meaning that an average firm could offset nearly $1 billion of future taxable income with existing NOL carryforwards. To evaluate the

[8] Firms generally report the valuation allowance in total, as opposed to reporting the amount of the valuation allowance specific to each deferred tax asset (such as the deferred tax asset related to tax loss carryforwards). While these allowances are often related to tax net operating losses, they can apply to any deferred tax asset. Because the valuation allowance can relate to many items, we report both the proportion of firms that have any valuation allowance (89.6 percent), as well as the proportion of firms with a large valuation allowance equal to at least 50% of the estimated NOL tax benefit (62.7 percent) to attempt to identify whether the valuation allowance likely relates to the tax loss.

relative significance of this amount given that the loss may apply to many jurisdictions, we report the carryforward amounts by location when disclosed. Of the 4,076 disclosing NOL carryforward location, 2,647 (64.5%) disclose Federal NOLs averaging $473.8 million, 68.4% disclose a state NOL carryforward averaging $453.9 million, and 58.6% disclose foreign carryforwards averaging $353.6 million. By comparison, the average loss carryforward reported in Compustat (*tlcf*) is $631 million. However, because Compustat data represent the simple sum of pretax losses carried forward and do not include jurisdiction-specific details, we are precluded from identifying and comparing the source and relative value of the tax losses.

Nearly all firms in the sample disclose a deferred tax asset for NOLs (5,894 observations or 96.3% of positive NOL firms). A firm's deferred tax asset should equal the firm's gross tax loss carryforwards, multiplied by the applicable tax rate in the corresponding tax jurisdiction. The mean (median) gross deferred tax asset for tax loss carryforwards is $221.4 ($45.6) million. We note that firms either provide an "uncontaminated" amount by reporting the tax loss benefit amount on a distinct line in the deferred tax asset and liability section of the income tax footnote, or combine the tax loss asset with other tax attributes such as credit carryforwards. For the 4,272 firm-years that report the deferred tax asset for the tax loss carryforward separately, the mean (median) asset is $170.3 ($36.3); for the 1,622 that blend the reported NOL carryforward asset with other items, the mean (median) is higher at $356.0 ($70.0) million. Some firms also disclose the location of the deferred tax asset. For these firms, the average gross deferred tax asset is $165.6 million at the Federal level, $42.6 million at the state level, and $127.8 million across foreign jurisdictions. The distribution is skewed, with reported medians at $29.0, $12.3, and $21.0 million respectively.

Based on the sample of firms that disclose both the deferred tax asset and the total amount of loss carryforwards by jurisdiction, we estimate the applicable U.S. federal, state, and foreign rates at 35.0 percent, 4.9 percent, and 26.6 percent respectively (i.e., the median tax rates as shown in Table 1, Panel B). For firms that disclose only the total amount of both the deferred tax asset and tax loss carryforward, we estimate a blended median tax rate of 22.7 percent.

2.2. Construction of the NOL tax benefit measure

Our proxy for NOL tax benefit is a tax rate-weighted measure of tax loss carryforwards that reflects variation in the value of NOLs created in Federal, state and foreign jurisdictions.[9] We prioritize information about the gross (not tax-effected) tax loss carryforward in calculating this measure and present these amounts in Panel C. This NOL benefit measure is the one used in the remaining tables and in our empirical tests. To construct the measure, we first use tax loss carryforward data at the jurisdictional level, as disclosed by two-thirds of the sample (4,076 observations). We construct the NOL benefit amount as $\Sigma(NOL_{ij} \times \tau_j)$ where NOL_{ij} refers to the total reported losses carried forward for firm *i* in location *j* (Federal, state or foreign), and τ_j is the

[9] While this methodology represents an improvement in estimation of tax loss benefits, we acknowledge that this approach is still imperfect. The economic benefit from tax loss carryforwards is a function of expected future profits, the expected year of profitability, the expected future tax rate, and the firm's discount rate. Our methodology specifically addresses estimation of the expected future tax rate by measuring NOLs by jurisdiction and then applying the relevant estimated tax rate for that jurisdiction. We also capture data on valuation allowances and other statutory limitations that may otherwise limit future utilization. However, we note that shortcomings still exist, largely due to the lack of data availability to further refine our estimate. First, there are no data on how long it will take for the firm to use its NOLs; thus, our calculation of tax benefit assumes that all NOLs disclosed will be used. However, our amounts reflect managements' estimation of the likelihood of utilization because we collect and incorporate estimates of NOL-specific valuation allowances and statutory limitations. Second, there is no disclosure of specific state or country jurisdictions, such that our state and foreign tax rates are an approximation based on tax rates that we estimate from firms who provide jurisdiction-specific disclosures (discussed further below). Third, because we do not know the specific state or country jurisdictions, we are unable to factor in variation in carryforward limitations by location. To our knowledge, the only way to mitigate the second and third data issues would be to obtain tax return data for each jurisdiction in which a firm operates (federal, state, and foreign); however, we are unaware of any researcher who has obtained such data. In several tests, we perform analysis of domestic-only companies to address these concerns. While we still cannot perfectly observe the state jurisdictions in which these firms operate, these tests mitigate some of the issues outlined above by limiting the number of jurisdiction-specific rules to consider. We discuss these results in a later section.

applicable tax rate based on the median tax rates in Table 1, Panel B. If the firm does not provide jurisdictional data but does provide the total tax losses carried forward (NOL_i), we apply a blended rate of 22.7 percent (also the median tax rate from Table 1, Panel B). This latter methodology is used to estimate NOL benefits for approximately 8.9 percent of the sample (543 observations).

For the remaining 24.4 percent of the firms with NOLs, we use deferred tax asset disclosures to estimate the NOL benefit.[10] For firms that disclose the deferred tax asset amount, but not the carryforward amount, we estimate NOL benefits based first on jurisdiction specific disclosures (722 observations), then uncontaminated deferred tax assets (471 observations), and finally contaminated deferred tax assets (306 observations). Panel C of Table 2 provides the values for NOL benefits constructed using this methodology. The average (median) firm has NOL benefits of $178.4 ($40.0) million. Alternative methodologies used in calculating the benefit, namely those that prioritize the deferred tax asset amount rather than the gross tax loss carryforward amount in the estimation of tax loss benefits, yield similar results and are highly correlated ($\rho > 0.94$).

We then compare our amounts to those reported in Compustat. Of the 1,478 observations for which we identify an available NOL carryforward, but Compustat does not (*tlcf* is missing), carryforwards average $715.6 million, and the average estimated NOL tax benefit is $213.1 million. For 3,630 observations (59.3 percent) for which Compustat does report *tlcf*, the average

[10] While a firm's deferred tax asset for the loss carryforward should already reflect a rate-weighted methodology, there are several reasons why we do not rely primarily on deferred tax asset disclosures. First, a firm's deferred tax asset is shaped by accounting rules that could omit some tax loss carryforwards in determining the reported deferred tax asset. For example, the exercise of stock options generally creates a tax deduction. During most of our sample period, a portion of the stock option exercise deduction (the excess tax benefit) that increases tax loss carryforwards is reported "off book"; the correct and full amount of the tax loss carryforward is disclosed (including this stock option deduction), but the relevant deferred tax asset ignores it. Second, the deferred tax amount can include other tax attributes such as credit carryforwards that result in overestimation of the potential tax loss benefits. In our sample, approximately 27 percent of firms that disclose a deferred tax asset for tax loss carryforwards combine this amount with other deferred tax items. Third, the gross deferred tax asset usually does not include detail on the underlying jurisdiction. These deferred tax asset data permit measurement of tax losses that would otherwise be unavailable due to nondisclosure of total tax loss carryforward amounts.

NOL carryforwards are $657.1 million. For these same firms, our estimated average NOL carryforwards are $838 million, or a value that is 27.5 percent higher. Perhaps as important, we find that there is significant heterogeneity in the location, and hence after-tax value, of the NOL carryforwards. Within our sample, Federal NOLs average $306 million, while state and foreign losses average $317 million and $215 million, respectively.

Panel E present the trends in NOLs for a balanced panel of 770 firms with data in every year of the sample period. We find that the gross dollar value of the NOL benefit (i.e., unscaled) is increasing over time. However, the ratio of the NOL benefit to total assets is slightly declining over time, primarily due to the growth in total assets driving faster growth in the denominator.

Finally, Panel F presents the incidence and level of tax loss benefits by Fama and French 48 industry definitions. Tax losses are most prevalent in the Communications, Pharmaceutical, Automotive, Computers, and Electronic Equipment industries – all of which are R&D and investment-intensive. The tax losses for these industries average 5.0 to 6.7 percent of total assets. In contrast, firms reporting the lowest level of tax benefits are in Retail and Service industries. The relative under-reporting of NOLs within Compustat is observed across all of these industries, suggesting systematic misreporting as opposed to concentration within a limited set or type of firm.

2.3 Descriptive Statistics

Table 2 provides descriptive statistics for the variables used in validating the tax loss benefit measure and testing the determinants of tax losses (Tables 3 and 4). In Panel A, we present the average values for the full sample, followed by averages for each of five groups formed by sorting observations on the level of tax loss benefits as a percentage of total assets. The first group includes the 764 firm-years with no evidence NOL carryforwards. The remaining observations are sorted

into quartiles of NOL benefits. By construction, NOL benefits is increasing across the quartiles, from 0.2 percent of total assets in the bottom quartile to 10.4 percent of total assets in the top quartile. Among firms reporting tax losses, the percentage of firm-year observations subject to statutory U.S. IRC Section 382 limitations on these losses increases monotonically, from 14.6 percent of firms in the bottom quartile to 36.5 percent in the top quartile. Even among firms in the top quartile of tax loss assets, Compustat fails to identify nearly one in every five firms with NOL carryforwards. As expected, marginal tax rates, cash ETRs, and cash taxes paid all decline monotonically as NOL benefits increase. For example, the average cash taxes paid by firms with no NOL carryforwards is approximately 4.2 percent of total assets, whereas this amount falls to 0.7 percent of assets in the top quartile of tax loss benefits.

High tax loss firms report the lowest amount of pre-tax ROA (2.7 percent) and have the highest leverage ratios (32.9 percent). While firms with high tax loss carryforwards are unsurprisingly poor-performing by historical accounting metrics and by measures of financial constraints, the data reveal a more nuanced picture. These are the smallest firms in the sample by both book and market value, but they are still large by conventional measures (in part due to sample construction), averaging $5.1 billion in assets. Furthermore, high tax loss firms report the greatest levels of R&D expenditures (9.0 percent of sales) and capital investment (5.7 percent of assets), and they have higher market-to-book ratios than tax loss firms in the other quartiles. Approximately 77.3 percent of firms with high tax losses have some foreign presence, a proportion higher than the subsample of firms without tax losses and similar to the low-tax-loss quartile. In addition, high tax loss firms also report high sales growth during the year, averaging 16.2 percent. Because firms that report the largest tax loss carryforwards appear to have substantive growth opportunities and are

responsible for considerable investment activity, they should also be more sensitive to factors that affect their access to financing.[11]

Table 2, Panels B through D provide additional descriptive statistics on firm characteristics over time; in each panel, we partition the sample into five subgroups based on the ratio of NOL benefits to assets in 2010 and report the average NOL benefit over future periods. In Panel B, we study the persistence of tax losses and observe that, for all groups except the high-tax-loss firms, NOL benefits increases slightly over the sample period. For example, firms in the third quartile of tax loss firms report a small increase from 2.3 to 2.5 percent of total assets. By comparison, firms reporting the highest level of tax losses experience a decline over the sample period, from 11.9 percent of total assets in 2010 to 7.1 percent in 2015.

In Panel C, we examine the ratio of cash taxes paid to total assets. We find that cash taxes paid increase over time, and that this increase is most pronounced among the highest two quartiles of NOL benefits (increases of 4% and 5%, respectively). Panel D shows that the highest proportion of constrained firms are within the high-NOL-benefit quartile, but the proportion of constrained firms fluctuates within each group across the six year sample period.

2.4 Does our NOL tax benefit proxy better capture tax shields?

To validate our measure, we compare the relative power for the NOL benefit measure and the Compustat-based measure to explain future cash tax payments. An NOL measure should predict future tax savings if it correctly identifies firms' ability to shield future income from tax. To test

[11] The descriptive statistics on the other quartiles reveal that there is a non-monotonic relationship between the level of tax losses and several important firm characteristics. For example, the firms in the second quartile are the largest firms based on the book value of assets, and the second and third quartiles contain the highest proportion of firms with a foreign presence. In short, firms in the second and third quartiles of tax loss firms do not exhibit the common characteristics of poorly-performing, constrained firms and instead are large, profitable, multinational companies.

the performance of these two measures in capturing future tax savings, we estimate the following model:

$$Tax\ paid_{i,t+1} = \alpha_0 + \alpha_1 PTI_{i,t+1} + \alpha_2 NOL\ benefit_{i,t} + \alpha_3 PTI_{i,t+1} \times NOL\ benefit_{i,t} + e \quad (1)$$

where *Tax paid*$_{i,\ t+1}$ is the amount of cash taxes paid scaled by total assets by firm *i* in year *t+1*, *PTI*$_{i,\ t+1}$ is pre-tax income scaled by total assets of firm *i* in year *t+1*, and *NOL benefit*$_{i,t}$ is described earlier in Sections 2.1 through 2.3. We expect *PTI*$_{i,\ t+1}$ to be positively associated with *Tax paid*$_{i,\ t+1}$, and the coefficient α_3 reflects the average cash tax rate across all firms. We expect α_2 to be negatively associated with future cash tax payments to the extent book pretax income measures taxable income with error. For the coefficient of interest, α_3, we expect a negative coefficient, as it captures the extent to which the NOL benefit reduces the average cash tax rate on pretax earnings by shielding that future income from cash taxes due.

The results are presented in Table 3. In each column, we present results from three sets of regressions. First, we estimate Eq. (1) as outlined above. Second, below that, we re-estimate Eq. (1), replacing *NOL benefit*$_{i,t}$ using Compustat data (*Compustat NOL benefit*$_{i,t}$ Finally, in the third regression within each column, we include both measures to test their relative explanatory power.[12] In Column (1), we find a negative and significant coefficient on the interaction term. The coefficient estimate of -0.912 implies that approximately a 10% increase in the NOL benefit (moving from the lowest to the highest quintile), is associated with a 9.1% decrease in the average cash tax rate. While the estimate from the Compustat NOL benefit is significant in the second set of results presented in Column (1), the coefficient of -0.247 predicts a reduction just one-fourth as large as that estimated using *NOL benefit*$_{i,t}$. Interestingly, when we include both measures and

[12] The correlation between the two proxies is approximately 0.35.

their corresponding interaction terms in the model in the third set of results, we find that only the NOL benefit proxy (i.e., the proxy constructed from our hand-collected data) exhibits an economically and statistically significant reduction in future cash taxes.

Given the asymmetric payoff structure of NOL benefits and the fact that only firms with positive taxable income can use NOL carryforwards to reduce their tax payments, we partition the sample into firm-years with positive and negative pre-tax income (Columns (2) and (3), respectively). Consistent with expectations, we observe that the negative effect of the NOL benefit proxy on future cash tax payments is concentrated within firm-years with positive pre-tax income, similar to the results using Compustat data reported by Dyreng, Lewellen, and Lindsey (2017). The coefficient on $PTI_{i,\,t+1}$ is much smaller in tax loss years, reflecting that NOL benefits provide little value for a firm with current year losses. The explanatory power of the model is also substantially higher in profit years (67 percent R-squared in Column (2) as compared to 2 percent R-squared in Column (3)). In Columns (4) through (6), we re-estimate Eq. (1), measuring both *Tax_paid* and *PTI* over the following two years and find similar results. That is, NOL benefits predict future cash tax savings over both one and two year horizons.

In Panel B, we partition the sample based on whether the firm is multinational and whether the NOLs are subject to existing statutory limitations. We find that the coefficient on α_3 is similar for both domestic and multinational firms across all specifications. Furthermore, among domestic firms only, NOL benefits are able to explain future tax reductions independent of the variation in pretax income. The estimate of -0.078 suggests that, for each dollar of NOL tax benefit, the firm realized approximately $0.08 in tax savings the following year, in addition to the savings tied to variation in pretax profitability. We also find that statutory limitations on the utilization of existing NOLs appear to reduce their effectiveness as tax shields in Columns (3) and (4). The coefficient

on the interaction between pretax income and NOL benefits is -1.11 for firms without Sec. 382 limitations, and approximately half of that magnitude (coefficient = -0.597) for those facing Sec. 382 limitations.

2.5 What determines the NOL benefits?

We next provide evidence on the determinants of firms' balance of NOL benefits. Our purpose is threefold. First, we confirm the basic intuition that the primary driver of NOL benefits is prior economic losses, and that the relation between NOLs and profitability is strongest among firms with cumulative losses. That said, these losses do not completely explain the tax loss. Therefore, second, we include a variety of firm attributes that further explain the level of NOL benefits. Third, although we conclude that the NOL benefit measure is superior to that reported by Compustat, we realize that subsequent research is unlikely to replicate the effort to collect such data until technologies such as XBRL are able to consistently record these values. To that end, we estimate a model based on observable data whose parameter estimates can be used to refine the estimate of NOL benefits available in Compustat.

Table 4 provides an analysis of the determinants of the NOL benefit. Our analysis begins by regressing $NOL\ benefit_{i,t}$ on prior profitability, measured as pretax income accumulated over the five years preceding measurement of the NOL ($\Sigma PTI_{i,\ t-4\ t}$). The results in Column (1) confirm that prior book losses are the primary determinant of tax losses: the negative and significant coefficient on $\Sigma PTI_{i,\ t-4\ t}$ means that NOL benefits increases to the extent firms reporthigh cumulative losses over the period. The explanatory power of the model with no other controls or fixed effects is 22 percent. In Column (2), we split pre-tax income into two variables that separately capture cumulative profitability or losses. As expected, we find a larger coefficient for the association between prior tax losses and NOL benefits.

In Columns (3) and (4), we include additional control variables that may affect the level of a firm's tax loss carryforward. We show that foreign activity is positively associated with NOL benefits. Firms with more valuable growth opportunities, captured with the market-to-book ratio, and more investment in intangible assets, captured by R&D, also report higher NOL benefits. Asset tangibility, a proxy for depreciation deductions, is not associated with NOL benefits, while a balance in the goodwill account, as a proxy for historical acquisition activity, suggest that acquired NOLs are not likely to be a first-order driver of the NOL benefits we observe. Leverage is associated with higher NOL benefits, a result likely attributable to the endogeneity of tax status to leverage. Large firms have lower NOL benefits. We note that, while adding both additional variables in Column (3) and industry and fixed effects in Column (4), the R-squared climbs modestly to 32 percent and 37 percent, respectively. Thus, several fundamental factors are important in explaining NOL benefits, but pre-tax losses are still the primary input.

In Columns (5) and (6), we split the sample into domestic-only and multinational firms. We find a stark difference in the explanatory power of the model across these sub-samples: for domestic-only firms, the model can explain 59 percent of the level of tax benefit, whereas the R-squared in Column (6) is only 31 percent. This difference reinforces that a determinants model has the best overall ability to explain tax losses for firms that operate in fewer jurisdictions.

2.6 Are NOL firms growing?

Table 4 suggests that firms with high NOL benefits also have a high level of growth opportunities. In Table 5, we explicitly test the association between tax losses and future investment spending, given that growth opportunities should then predict external financing activity when investment cannot otherwise be funded by internal cash flows. Panel A provides

descriptive statistics on the variables used in these tests; the average firm in the sample spends 5.6 percent of total assets and 2.9 percent of total sales on capital expenditures and R&D, respectively.

In Panel B, we provide the results from regressing future investment spending on the NOL tax benefit and control variables that capture growth opportunities (market-to-book), potential internal financing sources (operating cash flows), and both leverage and size. The NOL benefit is positively and significantly associated with investment spending as measured by total asset growth, capital expenditures and R&D spending. The coefficient estimates from the first column of Panel B suggest that a 10% increase in the NOL benefits is associated with a 2.9% greater growth in total assets. To the extent NOL firms need external capital to fund this investment, we expect to observe stronger financing activity. In the next section, we empirically test this association by studying whether the NOL benefit affects a firm's preference for debt or equity financing.

3. Hypothesis Tests

3.1. NOL benefits and financing decisions

In this section, we test our predictions on the association between NOL benefits and financing decisions. If the NOL benefits increase the relative after-tax cost of debt by reducing the value of interest deductibility, then we expect a negative association with debt financing and a positive association with equity financing. To test these predictions, we follow Balakrishnan, Core and

Verdi (2014) and model the financing decision as a function of investment opportunities, cash flows, cash holdings, leverage, size and asset tangibility:

$$Ext\ Fin._{t+1} = a_0 + a_1 NOL\ Ben._t + a_2 Market\_to\_Book_t + a_3 CFO_t + a_4 Leverage_t + a_5 \ln(MVA_t) + a_6 Tangibility_t + e \quad (2)$$

where the dependent variable is a measure of external financing activity in year *t+1*, and the independent variables reflect firm attributes in year *t*. The variables are as defined previously, except that we now include $Tangibility_{i,t}$ to proxy for debt capacity that arises when assets have higher collateral value. We include industry and year fixed effects and calculate significance levels based on standard errors clustered by firm.

External financing is measured several ways. We first use net financing, defined as the sum of net equity and net debt financing based on cash paid and received from financing activities disclosed on the Statement of Cash Flows. Specifically, net equity financing is cash raised from equity sales (sstk) less cash paid to repurchase stock (prstkc). Net debt is cash from debt issued (dltis) less cash paid to retire debt (dltr). As an alternative measure of debt financing, we subtract the change in cash holdings (che) from net debt. Alternative measures of equity financing include two measures from Fama and French (2005) that capture growth in equity but do not strictly rely on cash flow data. The first measure, dSM, is calculated as the change in common shares outstanding, times the firm's average share price over the year; this amount is scaled by beginning total assets. The second measure, dSB, is calculated as the change in shareholders' equity (net of the change in retained earnings), scaled by beginning total assets. Additionally, we consider

whether the firm conducts a seasoned equity offering using data on equity issuances from the Securities Data Corporation (SDC).

Table 6, Panel A presents the distribution of the primary external financing measures. The average firm in our sample does access external financing, with net debt and equity issues totaling 1.7% of beginning assets. However, the average firm appears to have cash outflows from equity financing of 1.9% of assets and cash inflows from debt financing of 3.5% of assets. The dSM and dSB measures from Fama and French (2005), however, suggest that the average firm's shareholders' equity is increasing by 1.1% of total assets, primarily based on the growth in shares outstanding (dSM).

We present the main results from estimating Eq. (2) in Panel B. The evidence is consistent with NOLs playing a role in financing decisions. In Column (1), external financing activity is significantly higher when firms have greater available NOL benefits. We then partition the financing decision into equity (Columns (2) through (4)) and debt issuances (Columns (5) and (6)). As expected, we observe a positive and statistically significant relation between tax losses and equity issuances; this result holds across all three measures of external equity financing. In Column (2), the coefficient of 0.116 suggests that increasing the ratio of NOL benefits to assets by 0.1 is associated with larger equity issues equivalent to 1.2% of beginning assets.

In Columns (5) and (6), we focus on debt financing decisions. The results in Column (5) indicate no statistically significant relation; NOL benefits do not seem to be associated with future debt issuances. This is not inconsistent with the tax hypothesis, as growing NOL firms can de-lever through larger equity issuances. However, after controlling for the change in internal cash holdings, which arguably better approximates the economic notion of leverage, we do observe a negative and statistically significant coefficient, albeit at the 10% level. The coefficient of -0.092

on cash-adjusted net debt issues suggests that a ten percentage point increase in the ratio of NOL benefits to assets is associated with a reduction in the proceeds from debt issuances by approximately 0.9% of total assets. Collectively, our results are consistent with tax losses shifting firms to equity for their incremental financing decisions.

One potential concern is that small changes in equity and debt arise because of artifacts in the data unrelated to intentional capital structure decisions (Graham, 1996). To mitigate this concern, Panel C presents results that focus on intentional financing decisions defined as debt or equity issues that exceed 2% of the firm's beginning assets (in absolute value). After imposing this restriction, our results hold and suggest even larger magnitudes for equity issues. The impact of a 0.1 change in the ratio of NOL benefits to assets on future net equity issues rises from 1.2% of assets to 2.1%. The impact on debt financing appears qualitatively similar.

In Panel D, we use a discrete choice model to explain external financing. In this regression, we re-estimate (2) with a logistic model in which we replace the dependent variable with an indicator variable equal to one if the firm has large external financing activity, and zero otherwise. The dependent variables in Columns (1) through (4) are equal to one if the firm engaged in large equity change; if the firm had an announced equity offering based on data from SDC; if the firm had a large stock issue; and if the firm reported a large stock repurchase or zero otherwise. In Column (5), the dependent variable is equal to one if the firm had a large debt issue (net of the change in cash), or zero otherwise. For all variables except the SDC indicator for seasoned offerings, large issues are those that fall within the top 20% of the full Compustat sample. We continue to observe consistent results; the probability of a large equity change or large stock issue

is positively related with the tax loss benefit, whereas repurchases of shares and large (net) debt issues are negatively related.

Collectively, the results in these tables confirm our predictions: NOL benefits reduce the present value of interest deductions, thus discouraging firms from issuing debt and motivating them to issue equity.

3.2. Equity issuances and statutory limitations on NOL utilization

As discussed previously, some jurisdictions impose limitations on the use of future tax losses if the ownership of the tax loss firm has significantly changed. This law prohibits the "trafficking" in NOLs by discouraging firms from acquiring tax loss firms only for the expected future tax benefits. In the U.S., this rule is included in Section 382 of the Internal Revenue Code. In brief, this provision states that, if ownership by 5 percent shareholders changes by more than 50 percent within a three-year period, the amount of tax losses that can be used in future years is limited. Thus, we expect that the amount and likelihood of equity issuances among the sample of tax loss firms will vary based on whether these equity issuances are likely to trigger this limitation.In Table 7 we test this conjecture. Specifically, we estimate the coefficient on NOL benefits separately for firms that have and have not previously triggered and disclosed a Section 382 limitation. We find that the positive association between tax losses and equity issuances is concentrated within the firms that have a pre-existing statutory limitation; that is, these firms have already triggered the limitation and thus are not constrained from issuing equity by the threat of this rule. In contrast, for firms that have not already triggered Section 382, we observe little relation between tax loss benefits and external equity financing. That is, the threat of triggering a future limitation appears

sufficiently costly to discourage firms from issuing equity, while firms whose NOLs are already subject to a limitation face no new threat.

The economic threat of triggering 382 limitations in equity market transactions applies largely, if not exclusively, to domestic NOLs.[13] In Panel B, we further bifurcate the NOL benefit into a domestic component and a foreign component, and split the domestic component according to the existence of limitations. The regression is estimated using observations that disclose the location of the NOL or disclose no NOLs at all. We continue to observe that the equity result holds within the sample of firms that have previously triggered a Section 382 limitation. However, after removing foreign NOL benefits, we now also observe that firms not currently subject to Section 382, and thus facing higher costs of issuing equity in the future, appear to issue *more* debt as indicated in Column (5). Thus, the results suggest that, while NOL benefits can push firms away from issuing debt when interest deductibility has less value, it can push them back toward debt when an equity issue threatens to impair the value of the NOL benefits in the future.

3.3. Do NOL firms hold more cash?

Tables 6 and 7 suggest that NOL benefits affect the relative cost of debt and equity and, by extension, the manager's external financing decisions. If managers respond to taxes in deciding the firm's financing policies, it is natural to expect them to also consider taxes when determining the level of liquidity and savings. Firms may optimally retain more cash within the firm to provide an internal source of financing when external sources are costly or when future cash flows are uncertain (Opler et al., 1999; Denis and Sibilkov, 2009). The corporate taxation of income earned on cash and liquid securities is viewed as an important cost of retaining cash in the firm, but firms

[13] In this test, domestic includes both US Federal and state. Foreign countries also frequently have ownership-based limitations, but these would have a limited effect since our firms are headquartered and largely traded in the US.

with available NOL tax shields should incur less or even no tax, thereby lowering the cost of holding cash in the corporation and increasing observed cash levels.

We test this prediction and present results in Table 8. We regress the log of the ratio of total cash holdings to total assets on several variables prior research has shown to influence cash holdings. In column (1), consistent with prior research, we find that larger, dividend-paying firms with greater working capital, higher levels of capital expenditures and debt, and more acquisition spending hold less cash. Firms with more growth opportunities, greater R&D spending, higher ROA, and greater net debt issuances hold more cash. Firms with lower foreign taxes, as well as firms with more uncertain tax benefits from tax planning, also hold more cash.

In Column (2), we include the tax loss benefit, scaled by total assets. The tax loss asset has a positive and significant association with the firm's cash holdings; the coefficient of 0.10 implies that increasing the ratio of NOL benefits to assets by 0.1 is associated with a 1% increase in cash. This result is robust to controlling for other tax incentives to hold cash discussed in prior literature, including reserves for uncertain tax benefit settlements in future years (UTBs) and the repatriation tax cost due when foreign profits are repatriated to the US parent (Foley et al., 2007; Hanlon et al., 2015; Blouin et al., 2017; Hanlon et al., 2017).

In Panel B, we ask whether interactions between NOL benefits, repatriation tax costs, and uncertain tax benefits can further explain cash holdings. The motivation for these tests is to understand whether a firm's NOLs can mitigate frictions such as the repatriation tax. For example, to the extent the firm has domestic NOLs that can shelter dividends from foreign subsidiaries otherwise subject to the U.S. repatriation tax, we may observe an attenuated relation between repatriation taxes and cash holdings. We find results consistent with this in Column 2 of Panel B. Among the multinational firms in our sample, we observe a positive and statistically significant

coefficient on the main effect of NOL benefits and repatriation tax cost, but a negative and statistically significant coefficient on the interaction term, suggesting that NOLs allow firms to more freely repatriate foreign profits by shielding the tax due upon repatriation. Consistent with this interpretation, we find that the effect of NOL benefits on mitigating the relation between repatriation taxes and cash holdings is driven by the variation in Federal NOL benefits.

The results in this table also suggest that NOL benefits reduce the need to retain cash when the firm takes uncertain tax positions, a result that holds for both domestic and multinational firms. One explanation is that the tax planning that generates UTBs does not reduce current cash tax paid when firms are in NOL positions. While firms with NOLs may be less likely to have their positions challenged in an audit, even if the positions are challenged, the increase in tax liability can be offset by the NOL and require no cash outlay. As a result, firms with high NOL benefits are less likely to save cash in anticipation of a challenge of items for which they have reserved a liability. The results are consistent with this conjecture.

3.4. Are the additional cash holdings value-increasing?

If managers hold more cash in response to higher NOL benefits that shield income earned on corporate cash from taxation, then investors in NOL firms should place a higher value on cash holdings than investors in other firms. To test this assertion, we test the valuation of cash holdings within a firm following the methodology of Faulkender and Wang (2006), which has emerged as an intuitive approach to understanding the importance of capital market frictions and agency conflicts. Faulkender and Wang (2006) show that the value of an additional dollar of cash is greater when firms face financing constraints because internal funding allows managers to pursue positive net present value projects when external funding is costly. In contrast, the value of cash appears to fall when managers operate in weaker monitoring environments (Dittmar and Mahrt-

Smith, 2007), suggesting that an additional dollar of cash is more likely to be spent on projects providing private benefits to entrenched managers (Jensen, 1986; Harford, 1999). Thus, these cash valuation models provide a simple and intuitive empirical framework in which to investigate the economic consequences of a variety of firm attributes.

The firm generates returns on cash and securities (both of which are captured in the commonly used measure of *che*) that are subject to tax first at the corporate level, and then again at the individual level once distributed to shareholders. However, NOLs can absorb this tax cost such that investment income can escape tax at the corporate level and convert the return to tax-favored capital gains tax at the investor level. Holding investors' after-tax discount rate constant, the cash saved by high NOL benefit firms will generate more after-tax cash flows and should thus be valued more highly by investors.

We test the impact of NOL benefits on cash valuation using the regression specification from Faulkender and Wang (2006), adapted to include the components of net financing as proposed by Halford et al. (2016) and used by Harford, Wang and Zhang (2017). Specifically, we estimate the following:

$$\begin{aligned} r_{i,t} - R_{i,t}^{B} = {} & \gamma_0 + \gamma_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma_2 \frac{NOL\ Ben_{i,t-1}}{M_{i,t-1}} + \gamma_3 \frac{\Delta C_{i,t}}{M_{i,t-1}} \times \frac{NOL\ Ben_{i,t-1}}{M_{i,t-1}} + \gamma_4 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \gamma_5 \frac{\Delta NA_{i,t}}{M_{i,t-1}} \\ & + \gamma_6 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \gamma_7 \frac{\Delta I_{i,t}}{M_{i,t-1}} + \gamma_8 \frac{\Delta D_{i,t}}{M_{i,t-1}} + \gamma_9 \frac{C_{i,t-1}}{M_{i,t-1}} + \gamma_{10} L_{i,t} + \gamma_{11} \frac{STKIS_{i,t}}{M_{i,t-1}} \\ & + \gamma_{12} \frac{STKPR_{i,t}}{M_{i,t-1}} + \gamma_{13} \frac{NETDT_{i,t}}{M_{i,t-1}} + \gamma_{13} \frac{ACCUM_{i,t}}{M_{i,t-1}} + \gamma_{14} \frac{C_{i,t-1}}{M_{i,t-1}} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma_{15} L_{i,t} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} \\ & + \varepsilon_{i,} \end{aligned} \tag{3}$$

where Δ denotes the change in the variable over the year. The dependent variable is the firm's excess stock return, where $r_{i,t}$ is the total return for firm i in year t, and $R_{i,t}^{B}$ is firm i's benchmark

return in year *t*. The benchmark return is constructed as the value-weighted return on a size and book-to-market matched portfolio (Fama and French, 1993; Faulkender and Wang, 2006).

C is the firm *i*'s cash holdings and is defined as cash plus marketable securities. Both the change in cash holdings ($\Delta C_{i,t}$) and cash at the beginning of the year $C_{i,t-1}$ are included in Eq. (1). *NOL Ben.* is our proxy for tax loss benefits, taken at the beginning of the year to mitigate the information content of new tax loss carryforwards for current performance.[14]

The model also includes other firm-specific factors associated with stock returns: firm *i*'s earnings (*E*), calculated as earnings before extraordinary items; net assets (*NA*), equal to total assets less cash; R&D (*RD*) and interest (*I*) expenses; total dividends (*D*) paid to common shareholders; and market leverage (*L*), calculated as total long-term debt plus debt in current liabilities, divided by the market value of assets. Following Halford et al. (2016), we decompose net financing into stock issues (*STKIS*), stock repurchases (*STKPR*), net debt issues (*NETDT*), and an indicator equal to one if cash holdings increased during the year. R&D is set equal to zero if missing. All variables (other than market leverage *L*) are scaled by the firm's equity value (*MVE*) at the beginning of the fiscal year such that the coefficients can be interpreted as the dollar change in a firm's equity value associated with a one-dollar change in the corresponding independent variables.

The coefficient γ_1 estimates the marginal value of a dollar of cash and theoretically should be equal to \$1.00. To test the effect of the tax loss asset on the valuation of cash, we interact the change in cash with the measure of a firm's tax loss benefits (*NOL Benefit*). We present results in Table 9. Panel A provides descriptive statistics for the variables used in the test; Panel B present

[14] The ending tax loss carryforward is comprised of the beginning carryforward plus the change in carryforwards during the year. A primary source of changes in carryforwards is firm profits, which reduce the carryforward, or firm losses, which increase it. In unreported tests, we include the change in the tax loss carryforward in Eq. (1) and find that increases in carryforwards are associated with lower stock returns, consistent with the change in carryforward being driven by an underlying tax loss.

the regression results. We first replicate Faulkender and Wang (2006) in Equation 1. We then extend their approach by including a variable that captures the NOL Benefits and the interaction of the change in cash with NOL Benefits. We observe a positive and statistically significant coefficient, evidence that the cash holdings attributable to the NOL are viewed by investors as value-increasing.[15]

3.5. Additional analyses

In robustness tests, we explore whether the connection between NOL benefits, financing, and cash savings are driven by a financial constraints explanation; that is, whether the NOL benefits are simply a sort on constrained firms. We first examine univariate statistics based on several measures of financial constraints. NOL firms appear more constrained under common indexes like Kaplan and Zingales (1997) and Whited and Wu (2006) and more distressed using Altman's Z-score, in large part because of the construction of the measure is a function of penalty levied on poor profitability and the lack of dividend payments. We re-estimate the main specifications, including various proxies for financial constraints, including indices based on Kaplan and Zingales (1997), Whited and Wu (2006), vanBinsbergen, Graham and Yang (2010), and other variables correlated with constraints, such as those based on firm size, dividend policy, and debt ratings. Our results are robust to including various indicators for financial constraints in the regression.

[15] Some have argued that NOLs introduce agency problems, which would predict an opposite sign between NOLs and the value of cash. One specific channel through which tax loss benefits would be associated with weaker governance that may enable agency issues is through a shareholder rights plan ("poison pill") designed to prevent unfriendly takeovers by forcing dilution of the buyer's interest once their ownership stake comprises 15 or 20 percent (Ryngaert, 1988; Brickley et al., 1994; Comment and Schwert, 1995; Coates, 2000; Fich et al., 2016). Since 2005, dozens of firms have adopted poison pills that are triggered at a lower 5 percent ownership threshold (based on the statutory tax rules of Internal Revenue Code Section 382) to protect the firm's tax loss asset from inadvertent impairment. Erickson and Heitzman (2010) and Sikes et al. (2014) study these tax loss poison pills. While the Delaware Court ruled that the poison pill was an appropriate action to preserve the value of the tax loss asset, Sikes et al. (2014) find that the market reaction to announcements of these poison pills is negative, which suggests that investors view these plans as a mechanism to insulate management from the threat of takeover in the market for corporate control.

Another potential concern is that a firm's simulated marginal tax rate should better capture the information contained in both *tlcf* and our hand-collected measure by incorporating forecasts of future pretax income. For completeness, we re-estimate our validity tests as well as our marginal financing analyses, controlling for the firm's marginal tax rate when available. These marginal tax rate estimates do not explain short-run tax savings when NOL benefits are included, a result that is not surprising given the long-run forecasts of profitability that the MTR estimates are based on. Of course, this relative lack of explanatory power could arise because estimates of marginal tax rates use *tlcf* as the starting value for tax shields in the MTR simulation (Graham 1996; Blouin, Core and Guay 2010). In additional tests, we also find that the firm's MTR does not appear to explain external financing or cash holding decisions. Thus, the measure we construct predicts cash taxes due in the short run and exhibits important economic and statistically significant relations with key firm decisions.

4. Conclusion

Using detailed data on the amounts and attributes of tax losses as reported in firms' financial statements, the population of firms with tax loss carryforwards appears much greater than what has been suggested by prior work, encompassing nearly 90% of the firms in our sample. Tax policies that determine tax loss benefits vary over time and across countries, affecting the cost of debt and equity and corporate savings decisions.

We study if and to what extent these NOL carryforwards affect external financing decisions and internal liquidity. We find that the tax losses are negatively associated with debt issuances, but positively associated with equity issuances. However, the relative tax advantage of equity disappears when a firm risks impairing the NOL benefits by transacting in equity markets in ways

that could trigger statutory limitations under IRC 382. We then test and find that cash holdings are increasing in the tax loss benefit and that these additional cash holdings are viewed by investors as value increasing.

In addition to contributing knowledge about the population of tax loss firms and the amount of these important assets, we add to the literature demonstrating why taxes matter. Prior studies of tax loss firms focus primarily on documenting the amount of these losses and studying how the losses affect investment incentives. This study offers an important step in considering additional effects of these tax losses on other firm decisions.

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Appendix – Variable Definitions

Variable	Definition
NOL benefit	Tax-rate weighted NOL carryforwards divided by total assets
Federal NOL benefit	NOL benefit for carryforwards at the US Federal level (when available) divided by total assets
State NOL benefit	NOL benefit for carryforwards in US states (when available) divided by total assets
Foreign NOL benefit	NOL benefit for carryforwards in foreign jurisdictions (when available) divided by total assets
Limited by 382	Dummy variable if footnote discloses NOL carryforwards are limited by Section 382
Valuation allowance > 50%	Dummy variable if valuation allowance exceeds 50% of NOL benefit
NOL Poison pill (0,1)	Dummy variable for 382-based shareholder rights plan (source: SharkRepellent data from Factset)
Compustat NOL benefit > 0	Dummy variable if Compustat tax loss carryforwards (tlcf) is positive
Compustat NOL benefit	Compustat tax loss carryforwards (tlcf)*0.23 divided by total assets
$MTR_{\text{after-fin (before-fin)}}$	Simulated marginal tax rate after (before) financing costs available from John Graham's website
Cash ETR	Cash paid for taxes (txpd) divided by pretax income
Cash tax paid	Cash paid for taxes (txpd) divided by total assets
Repatriation tax cost	Foreign pretax income (pifo) * 35% - foreign taxes (txfo) divided by total assets. Set equal to zero if negative
Perm. reinvested earnings	Permanently reinvested earnings (pre) divided by total assets
Uncertain tax benefits	Reserve for uncertain tax benefits (txtubend) divided by total assets
PTI	Pretax income adjusted for special items (pi – spi) divided by total assets
PTI ($\Sigma_{t-5,t}$)	Five-year sum of PTI ending in year t, divided by total assets in year t
Foreign activity (0,1)	Dummy variable equal to one if firm discloses non-zero pretax foreign income (pifo) or foreign taxes (txdfo or txfo)
Net working capital / Assets	Nonc0ash current assets (ca - che) less current liabilities (cl)
Real book assets	Total assets (at) in 2010 dollars
Real market value of assets	Market value of assets (at - ceq + prcc_f*csho) in 2010 dollars
M/B Assets	Market value of assets divided by total assets
R&D	Research and development expense (xrd) divided by net sales (sale)
Tangibility	Property, plant and equipment, net (ppent) divided by total assets
Goodwill > 0	Dummy variable if firm reported positive goodwill (gdw)
Leverage	Total long-term debt (dltt + dlc) divided by total assets
Fin. constrained (WW)	Indicator variable if Whited-Wu index in top 40% of all firms
Fin. constrained (BGY)	Indicator variable if both low z-Score low external financing
Low external financing	Indicator variable if firm was not in top 40% on any single measure of external financing activity for the year (dltis/at, dltr/at, sstk/at, or prstk/at)
Low Z-score	Indicator variable if firm in bottom 40% of Altman's Z-score
ΔAssets	Change in total assets divided by beginning total assets
Capex	Capital expenditures (capx) divided by beginning total assets
Acquisitions	Sum of cash (cashacq) and stock acquisitions (acqcshi*(1/2)*(ending price + beginning price)/2)divided by beginning assets

Net financing	Net stock and debt issuances (sstk – prstkc + dltis – dltr) divided by beginning total assets
Net stock issued	Stock issued during the year (sstk) - stock repurchased during the year (prstkc) divided by beginning total assets
dSM	(ΔCommon shares outstanding (csho)*(End share price + Beg share price price)/2) divided by beginning total assets
dSB	(ΔShareholders equity (seq) – ΔRetained earnings (re)) / beginning total assets
Excess return	The annual return over the fiscal year divided by the return on a size and book-to-market matched portfolio
ΔCash / lag(MVE)	The change in cash and marketable securities from the prior year divided by beginning market value of equity
lag(TL benefits) / lag(MVE)	Potential taxes avoided due to tax loss carryforwards at the beginning of the year, divided by beginning market value
ΔEarn / lag(MVE)	Change in earnings before extraordinary items (ib) divided by beginning market value
ΔNet assets / lag(MVE)	Change in non-cash assets (at – che) divided by beginning market value
ΔPretax Inc. / lag(MVE)	Change in pretax income (pi) divided by beginning market value
ΔTax exp. / lag(MVE)	Change in total tax expense (txt) divided by beginning market value
ΔR&D / lag(MVE)	Change in R&D expense (xrd) divided by beginning market value
ΔInterest / lag(MVE)	Change in interest expense (xint) divided by beginning market value
ΔDividends / lag(MVE)	Change in dividends (dvc) divided by beginning market value
lag(Cash) / lag (MVE)	Cash and marketable securities (che) at the beginning of the year divided by beginning market value
Debt / MV Assets	Total debt (dltt + dltc) divided by the market value of assets at the end of the year
Net financing / lag(MVE)	Net stock and debt issuances (sstk – prstkc + dltis – dltr) divided by beginning market value
Stock issued / lag(MVE)	Stock issued during the year (sstk) divided by beginning market value
Stock repurchased / lag(MVE)	Stock repurchased during the year (prstkc) divided by beginning market value
Net debt issued / lag (MVE)	Debt issued less debt repaid during the year (dltis – dltr) divided by beginning market value
Cash accumulation (0,1)	Indicator variable equal to one if the change in cash and marketable securities (che) is positive

Table 1– Descriptive statistics on NOL carryforwards and construction of NOL benefits

This table reports summary statistics on net operating loss (NOL) carryforwards disclosed in firms' financial statements between 2010 and 2015. The sample includes firms that were in the top 1,500 publicly-traded firms by a combined ranking of book assets, market capitalization, and sales. If the firm is among the top 1,500 for any given year, we collect the tax loss data for all six years when available. We drop all firms in the financial and utilities industries and present statistics for the final sample of 6,884 firm-years used in the empirical tests. Panel A provides statistics on the percentage of firms reporting tax loss and other information. Panel B provides descriptive statistics on the amount of net operating losses and deferred tax assets disclosed. Panel C derives the Tax Loss Benefit amount used as the primary measure in the empirical tests. Panel D compares dollar values for tax losses between the hand-collected and Compustat data. Panel E provides trends in the average reported tax losses over time, and Panel F presents industry statistics on high and low tax loss firms.

Panel A: Number of firms disclosing NOL carryforwards

	2010 - 2015 (N = 6,884)	
	N	% sample
% firm-years disclosing NOL carryforwards > 0		
Per hand-collection	6,120	88.9%
Per Compustat (tlcf > 0)	4,642	67.4%
Of firm-years with hand-collected NOL carryforwards > 0 , % disclosing		
Location and amount of NOL carryforward	4,076	66.6%
Location and amount of deferred tax asset for NOL carryforward	1,625	26.6%
Gross NOL carryforward	3,869	56.2%
Gross deferred tax asset for NOL carryforward	5,894	96.3%
Gross deferred tax asset amount includes other tax assets	1,643	26.8%
Disclosing existence of Sec. 382 limitation	1,366	22.3%
Positive valuation allowance for deferred tax asset	5,481	89.6%
Valuation allowance equal to at least 50% of estimated NOL tax benefit	3,838	62.7%

Table 1 (cont'd) - Descriptive statistics on NOLs

Panel B: NOL carryforward and NOL Tax Benefit amounts (in $millions) disclosed

	2010 - 2015 (N = 6,120)		
	N > 0	Mean	Median
Of firms disclosing NOL carryforward location:			
Σ(Federal, State, Foreign)	4,076	$823.4	$206.9
Federal NOL carryforward	2,627	473.8	98.9
State NOL carryforward	2,790	453.9	114.8
Foreign NOL carryforward	2,390	353.6	68.6
Of firms disclosing deferred tax assets for NOL carryforwards, amounts for:			
Total DTA (all)	5,894	221.4	45.6
Total DTA (uncontaminated)	4,272	170.3	36.3
Total DTA (mixed with other tax items)	1,622	356.0	70.0
Federal DTA	759	165.6	29.0
State DTA	1,040	42.6	12.3
Foreign DTA	912	127.8	21.0
Of firms disclosing both, the ratio of DTA / NOL carryforward			
Total (when disclosed)	4,423	24.6%	22.7%
Federal	386	34.1%	35.0%
State	379	9.9%	4.9%
Foreign	389	27.6%	26.6%

Panel C: Total inferred tax loss benefit (NOL benefit)

	N > 0	Mean	Median
NOL benefit (total)	6,120	$190.6	$39.4
Comprised of amounts calculated as follows:			
$\Sigma(NOL_j \times \tau_j)$	4,076	178.4	40.0
$NOL_j \times \tau_j$	543	223.5	64.2
ΣDTA_j	722	195.3	40.9
Total DTA (uncontaminated)	471	186.5	20.1
Total DTA (contaminated)	306	289.2	33.7
When jurisdiction information available:			
Total NOL Benefit	4,840	179.8	39.5
Domestic (Federal + State) NOL Benefit	4,840	117.0	15.4
Federal NOL benefit	4,840	99.0	4.9
State NOL benefit	4,840	18.0	2.0
Foreign NOL benefit	4,840	62.9	2.8

Table 1 (cont'd) - Descriptive statistics on NOLs

Panel D: NOL carryforwards, Hand-collected vs Compustat ($mm)

	N > 0	Mean	Median
Compustat NOL (tlcf) is missing:			
NOL Benefit	1,478	$213.1	$29.0
Total NOL DTA	1,434	266.2	33.4
Total NOL carryforward (ΣNOL_j, if location not reported then gross NOL)	484	715.6	214.6
Compustat NOL (tlcf) is available & NOL location unavailable:			
Compustat NOL (tlcf)	1,012	541.8	99.4
Total NOL	1,012	491.8	0.3
Compustat NOL (tlcf) is available & NOL location available:			
Compustat NOL (tlcf)	3,630	657.1	202.0
Total NOL [Σ(Federal, State, Foreign)]	3,630	838.0	207.0
Federal NOL	3,630	306.2	21.5
State NOL	3,630	317.1	38.1
Foreign NOL	3,630	214.7	11.8

Panel E: Trends over time for a balanced panel of 770 firms

	2010	2011	2012	2013	2014	2015
NOL Benefit (Total $mm)	159.7	171.8	183.8	194.6	194.1	200.6
When jurisdiction disclosed:						
Federal NOL benefit	75.0	80.4	87.5	87.3	87.2	84.0
State NOL benefit	13.7	14.2	17.3	18.6	18.2	19.8
Foreign NOL benefit	49.6	55.3	59.9	72.9	71.5	77.8
NOL Benefit / Assets	0.025	0.024	0.024	0.026	0.021	0.022
When jurisdiction disclosed:						
Federal NOL benefit / Assets	0.016	0.015	0.015	0.017	0.012	0.012
State NOL benefit / Assets	0.003	0.003	0.003	0.003	0.002	0.002
Foreign NOL benefit / Assets	0.005	0.005	0.006	0.008	0.006	0.007

Panel F: Highest and NOL benefits by industry

	Average NOL Benefit / Assets (%)	% NOL Benefits > 0	% Compustat NOL > 0
Highest NOL Benefit			
Communication	6.7%	99.2%	73.6%
Pharmaceutical	6.4%	92.6%	66.8%
Automobiles and Trucks	5.2%	87.5%	55.4%
Computers	5.1%	91.8%	78.7%
Electronic Equipment	5.0%	93.8%	73.0%
Lowest NOL Benefit			
Food	0.8%	79.1%	61.0%
Wholesale	0.9%	82.9%	62.6%
Restaurants, Hotels, Motels	0.9%	64.4%	37.0%
Retail	1.1%	77.5%	52.4%
Personal Services	1.2%	83.1%	56.8%

Table 2 – Descriptive statistics

This table reports the average values of key variables for 6,884 firm-year observations of non-financial, non-regulated firms between 2010 and 2015. Among firms reporting NOL carryforwards, firms are ranked into quartiles each year by the ratio estimated tax loss benefits to total assets. Variable definitions are described in the Appendix. The symbols * indicate amounts estimated based on 4,840 observations with jurisdiction data; ** indicate $MTR_{after\text{-}fin}$ ($MTR_{before\text{-}fin}$) amounts estimated on 3,739 (3,283) observations; and *** indicates amount estimated with 5,431 observations.

Panel A: Descriptive statistics

		By size of NOL Benefit / Assets				
	All	None	1 - Low	2	3	4 - High
N =	6,884	764	1,529	1,529	1,533	1,529
NOL Benefit	0.029	0.000	0.002	0.007	0.020	0.104
Federal NOL Benefit*	0.023	0.000	0.001	0.002	0.009	0.074
State NOL Benefit*	0.004	0.000	0.001	0.002	0.003	0.009
Foreign NOL Benefit*	0.007	0.000	0.001	0.003	0.008	0.015
Detail on jurisdiction (0,1)	0.791	0.000	0.740	0.758	0.807	0.858
Limited by 382 (0,1)	0.198	0.000	0.146	0.148	0.234	0.365
Valuation allowance > 50% (0,1)	0.557	0.000	0.627	0.672	0.596	0.614
NOL poison pill (0,1)	0.010	0.000	0.002	0.005	0.001	0.037
Compustat NOL Benefit > 0 (0,1)	0.674	0.007	0.673	0.733	0.800	0.824
Compustat NOL Benefit	0.030	0.000	0.006	0.015	0.020	0.096
$MTR_{after\text{-}fin}$**	0.149	0.336	0.157	0.132	0.108	0.092
$MTR_{before\text{-}fin}$**	0.322	0.342	0.337	0.335	0.319	0.267
Cash ETR***	0.232	0.285	0.254	0.247	0.213	0.165
Cash tax paid (t + 1)	0.023	0.042	0.030	0.025	0.018	0.007
Repatriation tax	0.004	0.002	0.004	0.004	0.004	0.003
Permanently reinvested earnings	0.096	0.040	0.090	0.118	0.117	0.086
Uncertain tax benefits	0.010	0.006	0.007	0.010	0.013	0.010
PTI (t+1)	0.091	0.159	0.118	0.106	0.082	0.027
PTI ($\Sigma_{t\text{-}5,t}$)	0.374	0.612	0.476	0.452	0.368	0.071
Foreign activity (0,1)	0.788	0.543	0.787	0.860	0.854	0.773
Market-to-book	1.989	2.346	1.983	1.962	1.813	2.020
R&D	0.042	0.015	0.027	0.035	0.033	0.090
Tangibility	0.265	0.334	0.237	0.238	0.268	0.284
Goodwill > 0 (0,1)	0.858	0.751	0.910	0.931	0.879	0.759
Leverage	0.260	0.182	0.235	0.249	0.265	0.329
Book value of assets ($bn)	8.309	6.923	9.293	12.121	7.406	5.111
Market value of assets ($bn)	10.838	12.913	12.634	16.715	8.619	4.352
No dividend	0.447	0.336	0.423	0.360	0.413	0.649
Financially Constrained (WW) (0,1)	0.108	0.115	0.080	0.058	0.091	0.202
Financially Constrained (BGY) (0,1)	0.064	0.010	0.024	0.034	0.063	0.160
Low external financing activity (0,1)	0.353	0.373	0.323	0.339	0.347	0.394
High Z-score (0,1)	0.154	0.031	0.052	0.072	0.142	0.409

Table 2 (cont'd) – Descriptive statistics

Panel B: Average future NOL Benefits of firms sorted by NOL Benefit in 2010

	NOL Benefit / Assets					
	2010	2011	2012	2013	2014	2015
0 - No NOL Benefit in 2010	0.000	0.001	0.001	0.003	0.006	0.006
1 - Low NOL Benefit in 2010	0.002	0.004	0.005	0.006	0.007	0.007
2	0.007	0.009	0.012	0.011	0.012	0.012
3	0.021	0.023	0.025	0.025	0.025	0.025
4 - High NOL Benefit in 2010	0.119	0.112	0.105	0.097	0.086	0.071

Panel C: NOLs and future tax status

Average future Cash tax paid / Assets for portfolios sorted on NOL Benefit / Assets in 2010

	Cash tax paid / Assets					
	2010	2011	2012	2013	2014	2015
0 - No NOL Benefit in 2010	0.040	0.038	0.040	0.039	0.041	0.041
1 - Low NOL Benefit in 2010	0.028	0.028	0.027	0.028	0.029	0.027
2	0.024	0.023	0.025	0.024	0.025	0.025
3	0.016	0.018	0.020	0.020	0.022	0.022
4 - High NOL Benefit in 2010	0.004	0.008	0.009	0.010	0.010	0.013

% firms with tax paid < 0.5% of assets

	Cash tax paid / Assets < 0.5%					
	2010	2011	2012	2013	2014	2015
0 - No NOL Benefit in 2010	0.094	0.110	0.103	0.118	0.067	0.106
1 - Low NOL Benefit in 2010	0.159	0.195	0.165	0.149	0.131	0.130
2	0.205	0.192	0.159	0.153	0.171	0.113
3	0.383	0.313	0.287	0.288	0.253	0.218
4 - High NOL Benefit in 2010	0.633	0.582	0.557	0.547	0.505	0.442

Panel D: NOL benefits and financial constraints

Average fraction of firms considered constrained in the future (Whited and Wu)

	Financially constrained (WW)					
By NOL Benefit in 2010	2010	2011	2012	2013	2014	2015
0 - No NOL Benefit in 2010	0.118	0.116	0.103	0.145	0.121	0.089
1 - Low NOL Benefit in 2010	0.072	0.073	0.068	0.066	0.059	0.054
2	0.061	0.059	0.055	0.057	0.060	0.040
3	0.091	0.082	0.089	0.089	0.105	0.112
4 - High NOL Benefit in 2010	0.186	0.180	0.235	0.252	0.216	0.174

Average fraction of firms considered constrained in the future (Z-score & van Binsbergen, Graham and Yang)

	Financially constrained (Z × BGY)					
By NOL Benefit in 2010	2010	2011	2012	2013	2014	2015
0 - No NOL Benefit in 2010	0.012	0.018	0.006	0.020	0.007	0.035
1 - Low NOL Benefit in 2010	0.042	0.042	0.028	0.037	0.034	0.027
2	0.053	0.047	0.042	0.070	0.069	0.062
3	0.061	0.035	0.069	0.059	0.081	0.029
4 - High NOL Benefit in 2010	0.136	0.160	0.135	0.122	0.122	0.100

Table 3 – Relative performance of NOL benefit proxies

This table reports the results from tests comparing the relative power of NOL benefit proxies in explaining future tax payments. Panel A reports results using cash taxes paid in one future year, as well as the sum of taxes due over the following two years. Columns (1) and (4) reflect results for the full sample. Due to the asymmetric nature of NOL benefits on tax savings, the coefficients are estimated separately for profit and loss years; Columns (2) and (5) present results for firms with positive pre-tax income; and Columns (3) and (6) present results for firms with negative pre-tax income. Panel B presents results for different sub-samples of firms based on geographic footprint and statutory limitations imposed on the future utilization of the tax loss benefit. Regressions include year and industry fixed effects. *p*-values are based on standard errors clustered at the firm level.

Panel A: Explaining future cash tax payments

		Dependent variable = Cash tax paid$_{t+k}$					
		One year ahead (t + 1)			Two years ahead [Σ(t+1,t+2)]		
		All	PTI > 0	PTI ≤ 0	All	PTI > 0	PTI ≤ 0
	N=	6,884	6,108	776	6,452	5,847	605
		(1)	(2)	(3)	(4)	(5)	(6)
PTI_{t+k}		0.211***	0.273***	0.009***	0.196***	0.213***	0.044***
PTI_{t+k} × NOL Ben.$_t$	+	-0.912***	-1.038***	-0.002	-0.821***	-0.786***	-0.105
NOL Ben.$_t$	+	-0.022**	0.009	0.004	-0.039***	-0.041*	-0.009
R-squared		0.60	0.67	0.02	0.59	0.60	0.14
PTI_{t+k}		0.193***	0.257***	0.009***	0.177***	0.204***	0.032***
PTI_{t+k} × Comp. NOL Ben.$_t$		-0.247***	-0.489***	0.001	-0.212***	-0.155	-0.001
Comp. NOL Ben.$_t$		0.009	0.038**	0.000	0.019	0.011	-0.004
R-squared		0.55	0.64	0.02	0.54	0.57	0.13
PTI_{t+k}		0.211***	0.273***	0.001***	0.196***	0.214***	0.043***
PTI_{t+k} × NOL Ben.$_t$		-0.905***	-0.949***	0.006	-0.869***	-0.824***	-0.093
PTI_{t+k} × Comp. NOL Ben.$_t$		-0.010	-0.110	0.004	0.042	0.139	-0.032
NOL Ben.$_t$		-0.020*	0.002	-0.005	-0.026**	-0.028	-0.013
Comp. NOL Ben.$_t$		-0.003	0.008	0.004	-0.012	-0.021	0.002
R-squared		0.60	0.67	0.02	0.59	0.60	0.14

Table 3 (cont'd) – Relative performance of NOL benefit proxies

Panel B: Comparing NOL proxies, multinational vs domestic and existing 382 limitation

	Dependent variable = Cash tax paid$_{t+1}$			
	Domestic only	Multi-national	Existing 382 limit	No 382 limit
N=	1,460	5,426	1,366	5,520
	(1)	(2)	(3)	(4)
PTI_{t+1}	0.197***	0.219***	0.173***	0.219***
$PTI_{t+1} \times$ NOL Ben.$_t$	-0.974***	-0.924***	-0.597***	-1.111***
NOL Ben.$_t$	-0.078***	0.000	-0.015	-0.020**
R-squared	0.62	0.61	0.55	0.61
PTI_{t+1}	0.177***	0.218***	0.153***	0.204***
$PTI_{t+1} \times$ Comp. NOL Ben.$_t$	-0.378***	-0.261***	-0.215***	-0.399***
Comp. NOL Ben.$_t$	-0.056***	0.015**	-0.013*	0.029***
R-squared	0.54	0.57	0.51	0.56
PTI_{t+k}	0.197***	0.219***	0.174***	0.219***
$PTI_{t+k} \times$ NOL Ben.$_t$	-1.036***	-0.894***	-0.510***	-1.095***
$PTI_{t+k} \times$ Comp. NOL Ben.$_t$	0.056	-0.026	-0.059*	-0.019
NOL Ben.$_t$	-0.084***	0.001	-0.014	-0.018*
Comp. NOL Ben.$_t$	0.008	-0.002	-0.003	-0.002
R-squared	0.62	0.61	0.56	0.61

Table 4 – The determinants of tax loss carryforward benefits

This table reports the results from regressing the NOL Benefit on pre-tax income and other variables that may contribute to the tax loss. The regressions are estimated on the 6,406 observations with pretax income available five years. All variables are defined in Appendix A. ***, **, and * indicate significance at the 0.01, 0.05 and 0.10 levels and reflect standard errors clustered at the firm level.

	Dependent var. = NOL Benefit$_t$					
	All Firms (1)	All Firms (2)	All Firms (3)	All Firms (4)	Domestic-only (5)	Multi-Nationals (6)
Intercept	0.060***	0.044***	0.064**	0.041**	0.039**	0.058***
$\sum PTI_{t-4,\,t}$	-0.072***					
$PTI_{t-4,\,t}$ (≤ 0)		-0.143***	-0.107***	-0.110***	-0.086***	-0.097***
$PTI_{t-4,\,t}$ (> 0)		-0.048***	-0.061***	-0.057***	-0.047***	-0.055***
Foreign activity			0.009***	0.008***		
R&D			0.023**	0.013**	0.001	0.019***
Market-to-book			0.008**	0.007***	0.008***	0.006***
Tangibility			-0.006	0.007	-0.024**	0.022**
Goodwill > 0			-0.009**	-0.010***	-0.009**	-0.012**
Leverage			0.029***	0.026***	0.054***	0.020**
ln(Real book assets)			-0.004***	-0.004***	-0.003*	-0.005***
Industry & Year FE	No	No	No	Yes	Yes	Yes
N	6,406	6,406	6,406	6,406	1,337	5,069
R-squared	0.22	0.27	0.32	0.37	0.59	0.31

Table 5 – NOL benefits and asset growth

This table presents the results from estimating the relation between investment spending and tax loss benefits. Panel A includes descriptive statistics; Panel B includes the regression results. Investment spending is measured with the change in total assets (Column (1)), capital expenditures (Column (2)), research and development (Column (3)), and acquisition spending (Column (4)). All variables are defined in the Appendix. ***, **, and * indicate significance at the 0.01, 0.05 and 0.10 levels and reflect standard errors clustered at the firm level. Industry and year fixed effects are included.

Panel A: Distribution of investment growth year *t* + 1

	Mean	Std. Dev	25th	50th	75th
$\Delta Assets_{t,t+1}$	0.100	0.284	-0.019	0.048	0.134
$Capex_{t+1}$	0.056	0.064	0.020	0.036	0.065
$R\&D_{\backslash t+1}$	0.029	0.061	0.000	0.000	0.029
$Acquisitions_{t+1}$	0.049	0.126	0.000	0.001	0.032

Panel B: NOL benefits and future asset growth

	Dependent variable = $Investment_{t+1}$			
	$\Delta Assets_{t,t+1}$	$Capex_{t+1}$	$R\&D_{t+1}$	$Acquisitions_{t+1}$
	(1)	(2)	(3)	(4)
$NOL\ Benefit_t$	0.289^{***}	0.036^{**}	0.213^{***}	-0.030
$Market\text{-}to\text{-}Book_t$	0.044^{***}	0.004^{***}	0.017^{***}	0.004^{**}
CFO_t	0.334^{***}	0.168^{***}	-0.101^{***}	0.024
$Leverage_t$	-0.097^{***}	0.011	-0.042^{***}	-0.028^{**}
$ln(MVA_t)$	-0.024^{***}	-0.005^{***}	-0.002^{**}	-0.011^{***}
N	6,884	6,884	6,884	6,884
R-squared	0.11	0.42	0.54	0.04

Table 6 – NOL benefits and financing

This table presents the results from testing the relation between NOL benefits and external financing. Panel A includes descriptive statistics, and Panel B presents results from estimating Eq. (1). Panel C includes results including only large, intentional external financing (issuances of greater than 2% of beginning assets), and Panel D includes a discrete choice model The dependent variables represent financing activity in year *t+1*;net financing is the sum of net equity and net debt. Net equity issued is cash raised from equity sales, less cash paid to repurchase stock. Net debt is cash from debt issued less cash paid to retire debt . Net debt adjusted for cash subtracts the change in cash holdings from net debt. dSM and dSB measure the growth in equity following Fama and French (2005). All financing variables are scaled by total assets at the beginning of the period. The explanatory variables include the NOL benefit scaled by assets, market-to-book, operating cash flows scaled by assets, book leverage, the market value of the firm's assets, and asset tangibility. All variables are defined in the Appendix. ***, **, and * indicate significance at the 0.01, 0.05 and 0.10 levels and reflect standard errors clustered at the firm level. Industry and year fixed effects are included.

Panel A: Distribution of financing activity in year t + 1

	Mean	Std. Dev	25th	50th	75th
Net external financing	0.017	0.171	-0.048	-0.010	0.027
Net equity financing	-0.019	0.093	-0.041	0.005	0.001
dSM	0.011	0.163	-0.028	0.001	0.012
dSB	0.015	0.150	-0.018	0.003	0.014
Net debt financing	0.035	0.117	-0.011	0.000	0.045
Net debt - ΔCash	0.023	0.138	-0.037	0.004	0.059

Panel B: NOL benefits and external financing decisions

	Dependent variable = External financing$_{t+1}$					
	Total	Equity Issuances			Debt Issuances	
	Net external financing (1)	Net equity issued (2)	dSM (3)	dSB (4)	Net debt issued (5)	Net debt - ΔCash (6)
NOL Benefit$_t$	0.174***	0.116***	0.369***	0.249***	0.027	-0.092*
Market-to-Book$_t$	0.020***	0.010***	0.040***	0.030***	0.010***	-0.007**
CFO$_t$	-0.419***	-0.395***	-0.548***	-0.351**	0.009	0.067
Leverage$_t$	-0.012	0.002	0.001	-0.012	-0.002	0.018**
ln(MVA$_t$)	-0.017***	-0.011***	-0.015***	-0.014***	-0.005***	-0.002
Tangibility$_t$	0.031	0.027*	0.025	0.008	0.003	-0.008
N	6,884	6,884	6,884	6,884	6,884	6,884
R-squared	0.10	0.19	0.19	0.12	0.03	0.02

Table 6 (cont'd) – NOL benefits and financing

Panel C: NOL benefits and external financing decisions, large changes only (> 2% of beginning assets)

	Dependent variable = External financing $_{t+1}$					
	Total	Equity Issuances			Debt Issuances	
	Net external financing (1)	Net equity issued (2)	dSM (3)	dSB (4)	Net debt issued (5)	Net debt - ΔCash (6)
NOL Benefit$_t$	0.225**	0.209**	0.530***	0.302***	0.084	-0.114*
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	4,797	3,087	3,371	3,041	3,560	5,179
R-squared	0.13	0.28	0.25	0.18	0.11	0.03

Panel D: NOL benefits and external financing decisions, discrete choice models

	Dependent variable = pr(External financing$_{t+1}$ = 1)				
	Large equity change (dSM) (1)	Equity offering (SDC) (2)	Large stock issue (sstk) (3)	Large stock repurchase (prstk) (4)	Large net debt issue (5)
NOL Benefit$_t$	2.515***	0.161	1.505*	-4.045**	-6.17***
Controls	Yes	Yes	Yes	Yes	Yes
Pr(financing = 1)	12.7%	8.1%	6.5%	6.4%	22.6%
N	6,884	6,884	6,884	6,884	6,884
Pseudo R-squared	0.20	0.11	0.17	0.41	0.10

Table 7 – NOL benefits and financing: Exposure to statutory limitations

This table presents the results from testing how the relation between NOL benefits and external financing varies based on statutory limitations on future NOL utilization. Panel A presents results from estimating Eq. (1), including separate indicator variables of interest for whether the firm has an existing limitation under Section 382 of the U.S. Internal Revenue Code. All variables are defined in the Appendix. ***, **, and * indicate significance at the 0.01, 0.05 and 0.10 levels and reflect standard errors clustered at the firm level. Industry and year fixed effects are included.

Panel A: Existing 382-based NOL limitations and financing decisions

	Dependent variable = External financing$_{t+1}$					
	Total	Equity Issuances			Debt Issuances	
	Net external financing (1)	Net equity issued (2)	dSM (3)	dSB (4)	Net debt issued (5)	Net debt - ΔCash (6)
NOL Benefit$_t$						
Existing 382 limit = 0	0.080	0.054	0.155**	0.060	0.026	-0.030
Existing 382 limit = 1	0.201**	0.147**	0.476***	0.341***	0.007	-0.146*
Difference	0.122	0.093	0.321	0.281**	-0.019	0.116
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	6,884	6,884	6,884	6,884	6,884	6,884
R-squared	0.10	0.19	0.19	0.13	0.03	0.02

Panel B: NOL location, 382-based limitations, and financing decisions

	Dependent variable = External financing$_{t+1}$					
	Total	Equity Issuances			Debt Issuances	
	Net external financing (1)	Net equity issued (2)	dSM (3)	dSB (4)	Net debt issued (5)	Net debt - ΔCash (6)
NOL Benefit$_t$						
Domestic NOL Ben.						
Existing 382 limit = 0	0.173*	0.051	0.122	0.050	0.101*	0.021
Existing 382 limit = 1	0.373***	0.229**	0.661***	0.474***	0.071	-0.122
Limit – No Limit	0.200	0.178	0.539**	0.424***	-0.039	-0.143
Foreign NOL Ben.	-0.754***	-0.170	-0.547***	-0.322***	-0.431***	-0.391***
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	5,604	5,604	5,604	5,604	5,604	5,604
R-squared	0.11	0.19	0.20	0.14	0.04	0.03

Table 8 – NOL benefits and cash holdings

This table presents the results from regressions of cash holdings on tax loss benefits for a sample of non-financial and non-regulated firms between 2010 and 2015. The dependent variable is the natural log of the ratio of cash and short-term investments to total assets. In Panel A, we estimate the regression on the full sample with the total NOL benefit included. In Panel B, we interact NOL benefit with the repatriation tax cost and uncertain tax benefits. The regressions are estimated for multinational firms only (col. 2), domestic firms only (col. 3), and by defining the NOL benefit as either the Federal (col. 4), state (col. 5), or foreign (col. 6) benefit among firms that disclose location information. Standard errors clustered at the firm level. Industry and year fixed effects are included. Other variables are defined in the Appendix.

Panel A: Cash holdings and NOL benefits

	Dependent variable = $\ln(Cash_t/Assets_t)$		
	(1)	(2)	(3)
$NOL\ Benefit_{tt}$		0.10^{**}	0.10^{**}
$Repatriation\ tax\ cost_t$	2.56^{***}	2.59^{***}	
$Permanently\ reinvested\ earnings_t$			0.11^{***}
$Uncertain\ tax\ benefits_t\ (UTB)$	0.38^{***}	0.32^{*}	0.38^{**}
$\ln(real\ book\ assets_t)$	-0.02^{***}	-0.02^{***}	-0.02^{***}
$Net\ working\ capital_t$	-0.25^{***}	-0.25^{***}	-0.25^{***}
$Market\text{-}to\text{-}book_t$	0.02^{***}	0.02^{***}	0.02^{***}
CFO_t	0.09^{**}	0.11^{**}	0.14^{***}
$R\&D_t$	0.09^{**}	0.09^{**}	0.09^{**}
$Capex_t$	-0.28^{***}	-0.29^{***}	-0.30^{***}
$Cash\ acquisitions_t$	-0.26^{***}	-0.26^{***}	-0.26^{***}
$Dividend\ dummy_t$	-0.02^{***}	-0.02^{***}	-0.02^{***}
$Leverage_{t-1}$	-0.14^{***}	-0.14^{***}	-0.14^{***}
$Net\ debt\ issue_{t-1}$	0.16^{***}	0.16^{***}	0.16^{***}
$Industry\ cash\ flow\ risk_t$	0.48^{***}	0.47^{***}	0.48^{***}
N	6,884	6,884	6,884
R-squared	0.56	0.57	0.56

Panel B: Impact of NOL benefits on trapped cash and cash held to satisfy tax challenges

				NOL Benefit =		
	All	MNC	Domestic	Federal	State	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
$NOL\ Benefit_t$	0.25^{***}	0.20^{***}	0.26^{***}	0.29^{***}	1.04^{**}	0.10
$Repatriation\ tax\ cost_t$	3.09^{***}	3.01^{***}		2.73^{***}	2.65^{***}	2.58^{***}
UTB_t	0.55^{***}	0.52^{**}	1.03^{**}	0.66^{***}	0.57^{***}	0.76^{***}
NOL Ben. x Repat. tax cost	-20.46^{***}	-17.85^{***}		-19.09^{**}	-85.55	-23.78
NOL Ben. x UTB	-4.70^{***}	-4.14^{**}	-7.72^{**}	-4.81^{**}	-7.41	-18.57^{*}
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	6,884	5,423	1,461	5,604	5,604	5,604
R-Squared	0.57	0.56	0.58	0.57	0.57	0.57

Table 9 - NOL benefits and the valuation of cash

This table reports the regressions of excess stock returns between 2011 and 2016 on the change in cash, beginning NOL benefits, and the interaction between the two, including control variables for 6,884 firm-year observations. Panel A reports descriptive statistics for the model variables results for all firms. Panel B reports the results from regressions of excess stock returns on explanatory variables. The baseline regression is in column (1). In column (2), the valuation of cash is conditioned on the ratio of NOL benefits to beginning market value of equity. All variables except leverage, are scaled by beginning market value of equity. Standard errors clustered at the firm level. Industry and year fixed effects are included.

Panel A: Descriptive statistics for cash valuation model

	Mean	Std. Dev	Q1	Median	Q3
NOL Benefits$_t$	0.050	0.120	0.001	0.008	0.035
Excess Return$_{t+1}$	0.014	0.347	-0.190	-0.009	0.175
ΔCash$_{t,t+1}$	0.005	0.103	-0.020	0.002	0.026
ΔEarn$_{t,t+1}$	0.003	0.178	-0.013	0.004	0.018
ΔNet assets$_{t,t+1}$	0.056	0.415	-0.017	0.026	0.097
ΔR&D$_{t,t+1}$	0.001	0.008	0.000	0.000	0.001
ΔInterest$_{t,t+1}$	0.001	0.013	-0.001	0.000	0.002
ΔDividends$_{t,t+1}$	0.001	0.018	0.000	0.000	0.002
Cash$_t$	0.152	0.231	0.041	0.095	0.185
Market leverage$_t$	0.186	0.162	0.063	0.149	0.267
Stock issued$_t$	0.015	0.064	0.000	0.003	0.008
Stock repurchased$_t$	0.026	0.037	0.000	0.010	0.038
Net debt issued$_t$	0.027	0.153	-0.011	0.000	0.041
Cash accumulation$_t$ (0,1)	0.538	0.499	0.000	1.000	1.000

Panel B: The relation between tax loss benefits and the valuation of the marginal dollar of cash

	Dependent Variable: Excess Returns$_{t+1}$	
	(1)	(2)
ΔCash$_{t,t+1}$	0.65***	0.56***
NOL Benefits$_t$		0.33***
ΔCash$_{t,t+1}$ × NOL Benefits$_t$		1.02***
ΔEarn$_{t,t+1}$	0.31***	0.29***
ΔNet assets$_{t,t+1}$	0.11***	0.11***
ΔR&D$_{t,t+1}$	1.72***	1.68**
ΔInterest$_{t,t+1}$	-1.56***	-1.58**
ΔDividends$_{t,t+1}$	0.34	0.40
Cash$_t$,	0.13***	0.07*
Market leverage$_t$	-0.37***	-0.45***
Stock issued$_t$	0.22*	0.48***
Stock repurchased$_t$	0.33***	0.33***
Net debt issued$_t$	-0.07***	-0.07
Cash accumulation$_t$ (0,1)	0.03***	0.03***
ΔCash $_{t,t+1}$ × Cash$_t$	-0.10	-0.18**
[ΔCash/lag(MVE)] x [Debt/MV Assets]	-0.58	-0.78**
R-squared	0.15	0.17