Working Paper

Net Operating Loss Carryforwards and Corporate Tax Policy

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Abstract

This paper explores the role of net operating loss carryforwards (NOLCFs) in the decision-making and valuation of large firms. NOLCFs allow firms to carry losses or negative profits into the future and deduct them from taxable income in a future period. To understand how this tax deduction affects key variables, such as investment, equity distributions, and corporate income tax revenue, I estimate a dynamic firm investment model using simulated method of moments. After determining the deep parameters of the model, I vary policy parameters and evaluate the effects of policy changes on the key moments. For a firm with average assets, the results show that the average NOLCF stock before the 2017 U.S. federal tax reform improved corporate valuation by approximately 5-6%. Further, the 40% decline in the corporate tax rate in 2017 reduced the impact of NOLCFs on corporate valuation roughly proportionally.

Keywords: loss carryforwards; firm heterogeneity.

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1   Introduction

A feature of the U.S. federal tax code is the deductability of previous losses against current taxable income. Such losses carried are known as *net operating loss carryforwards* (NOLCFs), and the availability of these deductions influences how firms make key decisions. The availability of NOLCFs also influences how firms respond to changes in corporate tax structure, such as those implemented in the corporate tax reform of 2017. This paper studies the role of NOLCFs in the decision-making of firms and evaluates the effects of changes in the corporate tax code.

To understand why governments allow NOLCF deductions, consider an example of two firms. The first firm earns exactly zero profits every period, while the second firm's profits are randomly distributed with mean zero. Suppose the government only taxed positive profits without allowing any deductions. Then the first firm would never pay any taxes, while the second firm would pay taxes in periods of positive profits. In this case, the tax code would make the first firm more valuable than the second firm, even though both have the same expected profits. A naive solution to address this asymmetric tax treatment would be a linear tax on all profits - positive or negative, again with no deductions. In that case, since the second firm's profits are zero on average, its tax payments are zero on average, and its valuation is the same as the first firm. In the real world, this tax structure might encourage a firm to incur arbitrarily large losses and exit with a large government subsidy. In this sense, NOLCF deductions are a second-best solution to the problem of asymmetric corporate profit taxation.

The goal of this paper is to understand the role of the government's NOLCF policy in the decision-making and valuation of firms. To this end, I first consider a simple three-period dynamic firm optimization problem. This exercise provides insight into the effect of NOLCF deductibility and determines the general conditions under which the government may wish to allow some deductibility of NOLCFs. Next, I consider a full version of the model, where heterogeneous firms experience idiosyncratic productivity shocks and choose investment and NOLCFs. The government applies a proportional tax on positive profits and allows for the deduction of NOLCFs. To obtain parameter values, I estimate the model using simulated method of moments with data from the

WRDS COMPUSTAT data set.

To measure the effects of policy changes on key variables, I conduct three experiments. The first two experiments coincide with actual limitations of NOLCFs implemented by certain states and the federal government, while the third evaluates changes in the corporate tax rate. The results show no evidence of revenue declines resulting from raising the effective tax rate. The simulations show that limiting the NOLCFs, as in the 2017 tax reform has no long-term effect on either tax revenue or any other corporate variables.

Several papers have formalized the role of NOLCFs in the decision-making of firms. Auerbach and Poterba (1987) study the effect of loss deductions on a firm's effective tax rate and find that NOLCFs have a significant effect on a firms' investment incentive. This paper confirms that result and quantifies the magnitude of investment induced by NOLCFs. Edgerton (2010) proposes a firm model to measure the role of NOLCFs in the effectiveness of investment incentives. That paper finds that the concurrence of investment stimulus and NOLCF (and loss carryback) deductions during macroeconomic downturns reduces the effectiveness of investment incentives. While this paper focuses on steady-state analysis, the model shares a similar theoretical foundation, which would allow for simulation-based evaluations of cyclical investment incentives with the proper extensions of the model.

This paper appears to be the first to use structural estimation to derive the parameters of a standard corporate finance model with explicit NOLCF stocks. This approach follows several papers that have used structural estimation to obtain parameters of similar models. Cooper and Haltiwanger (2006) estimate a basic version of the model presented herein with alternative specifications of the capital adjustment cost function. This paper builds on the convex adjustment cost version of that model by adding corporate tax policy features relating to asymmetric taxation. Hennessy and Whited (2005) estimate a model with tax policy but focus on the role of debt deductibility. That paper uses a modified tax function to account for loss carryforwards in a tractable way. While this paper does not include debt, it explicitly accounts for NOLCFs by expanding the state space to allow for dynamic NOLCF accumulation and exhaustion.

NOLCFs may also play an important role in the capital structure and financial policy decisions

of firms. Graham (1996) finds evidence that firms with positive NOLCFs face significantly lower marginal tax rates, which impacts their financial decisions. Hennessy and Whited (2007) estimate a basic model with external financing constraints and find financing frictions play a significant role in firms' financial structures. Since NOLCFs can be used to shift tax liabilities over time, exhaustion of these tax loss assets may be influenced by financing constraints and choice of capital structure. Indeed, Heitzman and Lester (2018) find important interactions between a firm's financing decisions and NOLCFs. While it would be ideal to consider debt and external financing costs in the estimated model, such extensions to the model reduce its tractability and are left for future research.

The paper is organized as follows: Section 2 introduces a simple model and corresponding theoretical results, as well as the benchmark theoretical model. Section 3 discusses the data, and methodology and presents the estimation results. Section 4 shows the results of the counterfactual experiments, and Section 5 concludes.

2   Model

2.1   Simple Three-Period Model

This simple model highlights the role of NOLCFs in optimal investment decisions and determines the circumstances in which restricting its deductability reduces government revenue. The initial goal is to show that under reasonably general conditions, optimal investment is increasing in the availability of NOLCFs. Then, total revenue is characterized with respect to the NOLCF deduction.

The firm wishes to maximize its expected value, which is the sum of its expected income in each of the three periods. A permanent investment choice k is made in period one, and production occurs in periods two and three. For a given capital choice, the firm receives $R(k)$ in net revenue, which has properties for $k \in \mathbb{R}^+$: $R(k) \geq 0$, $R'(k) > 0$, $R''(k) < 0$, and $\lim_{k \to 0} R'(k) = \infty$. Period two production is risky; with probability p, the firm receives a shock $z < 0$, and net revenue (i.e., loss) is $zR(k)$. Positive net revenue is taxed at rate $\tau \geq 0$ and allows for the deduction of previous losses. For analytic purposes, suppose a fraction γ of losses can be deducted, which could only happen in period 3.

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The firm's expected profits $\Pi(k)$ over the three periods can be written as follows:

$$\Pi(k) = \underbrace{-k}_{\text{period 1}} + \underbrace{(1-p)(1-\tau)R(k) + pzR(k)}_{\text{period 2}} + \underbrace{R(k) - (1-p)\tau R(k) - p\tau(R(k) - \gamma|zR(k)|)}_{\text{period 3}}. \quad (1)$$

The term $|zR(k)|$ in the third period term is just the NOLCF, which reduces the expected tax bill in the third period [1]. Equation (1) can be rewritten as:

$$\Pi(k) = -k + R(k)\left[(1-p)2(1-\tau) + p(1+z-\tau+\gamma\tau|z|)\right] \quad (2)$$

Notice that the term in the brackets is a constant that is increasing in the term relating to the NOLCF: $\gamma\tau|z|$. Then, the first-order necessary (and sufficient) condition gives:

$$R'(k^*) = \left[(1-p)2(1-\tau) + p(1+z-\tau+\gamma\tau|z|)\right]^{-1}. \quad (3)$$

The right-hand-side of (3) is decreasing in γ, so by the concavity of R, k^* is increasing in γ.

Now consider the effect of limiting NOLCFs on total tax revenue. Total revenue as a function of optimal investment is:

$$TR(k^*) = \tau R(k^*)\left[(1-p)2 + p(1-\gamma|z|)\right] \quad (4)$$

Differentiating with respect to γ gives:

$$\frac{\partial TR(k^*)}{\partial\gamma} = \tau\frac{\partial R(k^*)}{\partial k^*}\frac{\partial k^*}{\partial\gamma}\left[(1-p)2 + p(1-\gamma|z|)\right] - \tau R(k^*)p|z| \quad (5)$$

The term $\frac{\partial R(k^*)}{\partial k^*}\frac{\partial k^*}{\partial\gamma} \equiv \mu$ is marginal firm revenue induced by increasing γ. Setting (5) to zero and solving for the government-revenue-maximizing NOLCF deductability γ^* gives:

$$\gamma^* = \frac{\mu(2-p) - p|z|R(k^*)}{\mu p|z|}. \quad (6)$$

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[1] This deduction is usually limited by the magnitude of positive revenues in the period, but this restriction is omitted from the simple model without loss of generality.

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First, notice that if the right-hand-side of (6) is greater than or equal to one, then the government and the firm are both worse off if the government limits the deductability of NOLCFs. Second, γ^* is unambiguously decreasing in the probability of losses, p, the magnitude of the adverse shock, $|z|$, and the magnitude of potential losses $|z|R(k^*)$. Finally, γ^* is increasing in marginal revenue induced by NOLCF deduction allowance as long as $\frac{(2-p)}{p|z|} > 1$, which relates expected gains to expected losses. Of course, if $\frac{(2-p)}{p|z|} < 1$, the firm's unconditional expected value is negative, and the firm should not produce.

2.2 Benchmark Model

Suppose now that firms choose over capital and loss carryforwards to maximize an infinite stream of equity payments discounted geometrically at rate $\frac{1}{1+r}$. Firms own capital k and experience productivity risk. In any period, the firm's total factor productivity is determined by a random shock that follows a first-order autoregressive process,

$$z' = \bar{\rho} + \rho z + \epsilon \tag{7}$$

$$\epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2). \tag{8}$$

The specification of productivity allows for negative income shocks, which play a critical role in understanding NOLCFs. Production experiences decreasing returns to scale, and the firm's income function can be written as zk^θ. Capital depreciates at rate δ, and investment is chosen the period before capital becomes productive: $k' - (1 - \delta)k$. If firms change their capital stocks, they incur quadratic adjustment costs: $\frac{\gamma}{2}(k' - (1 - \delta)k)^2$.

Firms pay proportional taxes τ on positive corporate income. If corporate income is negative, the firm incurs a loss of that magnitude and can carry the loss forward to deduct it from taxable income in a future period. In reality, before the 2017 tax reform, the U.S. corporate tax code allowed firms to carry losses forward for up to 18 years and back for 3 years, but the dimensionality required to account for this feature makes the model intractable. Instead, the model assumes only carryforwards and no such expiration for NOLCFs.

The Bellman equation describing firm optimization is:

$$V(k, c, z) = \max_{k', c'} \left\{ zk^\theta - \tau(y - (c - c')) - (k' - (1 - \delta)k) - \frac{\gamma}{2}(k' - (1 - \delta)k)^2 + \frac{1}{1 + r} E_{z'|z}\left[V(k', c', z')\right] \right\}$$

(9)

$$s.t. \quad \begin{cases} c - c' \in [0, \min\{zk^\theta, c\}], & if \quad zk^\theta \geq 0 \\ c' = c + \mid zk^\theta \mid, & if \quad zk^\theta < 0 \end{cases}$$

(10)

$$\text{where} \quad y = \max\{zk^\theta, 0\}.$$

(11)

The loss carryforward constraint (10) describes feasible NOLCF exhaustion in the case of positive income and NOLCF accumulation in the case of negative income. The first condition of (10) ensures that losses deducted $(c - c')$ from positive income do not exceed the lesser of current income and losses carried into the current period. The condition $c - c' \leq zk^\theta$ implies that the deduction is not refundable, while $c - c' \leq c$ is a non-negativity constraint on c', ensuring that firms can not use NOLCFs as a borrowing mechanism. Constraint (10) also implies $c \geq c'$ in profitable periods so that firms can not choose to pay taxes in excess of the tax bill and incur NOLCFs for use in a future period. Such a constraint, however, is an arbitrary feature of the tax system and open to further evaluation.[2] The taxable income equation (11) restricts taxation to positive income levels, giving rise to the study of asymmetric corporate taxation.

For a given set of parameters, moments of the model correspond to the steady-state distribution over the state space. Specifically, let $\Lambda_t(k, c, z)$ be any distribution over the state space at time t, and let $\Gamma(\cdot)$ be the transition function determined by the productivity shock's Markov process and optimal decision rule over the state space, such that:

$$\Lambda_{t+1}(k, c, z) = \Gamma(\Lambda_t(k, c, z)).$$

(12)

Then the steady-state distribution is represented by the fixed point of Γ:

$$\Lambda(k, c, z) = \Gamma(\Lambda(k, c, z)).$$

(13)

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[2]This would never be optimal with linear taxes, though it might be desirable under nonlinear taxation.

3 Estimation

3.1 Data and Methodology

Data moments are derived from the WRDS COMPUSTAT data set. The time period is 2000-2016. That time period includes roughly as many years before the start of the Great Recession as after. Inactive firms, firms with missing data, and firms with total assets below $10 million are excluded from the data set. Also, because of differing financial structures, regulated, financial, and quasi-private firms with SIC code between 4900-4999, 6000-6999, and greater than 9000 are removed from the data set. The remaining data provides 66,910 observations. The top and bottom 1% of estimated values are windsorized, and standard errors are determined using a boostrapping procedure.

The goal of the estimation procedure is to find the vector of structural parameters, $\beta = \left\{ \theta, \delta, \gamma, \tau, \bar{\rho}, \rho, \sigma_\epsilon^2 \right\}$ such that the model-generated moments closely match the corresponding data moments. With the exception of the corporate tax rate τ, estimating this set of parameters is standard in the structural corporate finance literature. Including the corporate tax rate as an estimated parameter ameliorates some of the discrepancies between various tax deductions and incentives in the real world and the deductions explicitly modeled. The only remaining parameter is the interest rate, which is set to $r = 0.04$.

Parameters of the structural model are estimated using simulated method of moments. Let $M(x)$ be a vector of moments of the data, x, and let $m(\beta)$ be the corresponding model moment vector as a function of the parameter set β. Finally, let W be a positive semi-definite matrix corresponding to the inverse of the covariance matrix of the moments. The estimated parameter vector, $\hat{\beta}$, is the solution to the optimization problem:

$$\hat{\beta} = \operatorname*{argmin}_{\beta}(m(\beta) - M(x))'W(m(\beta) - M(x)). \tag{14}$$

To increase the likelihood of finding a global optimum, simulated annealing is used to solve (14). Model variables and the data analogs are summarized in Table 1.

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Variable	Model Calculation	Compustat Name and Derivation
Capital	k	'Assets - Total'
Income	zk^θ	'Pretax Income'
Investment	$k' - (1-\delta)k$	'Capital Expend Property, Plant and Equipment Schd V'
Equity	$zk^\theta - \tau(y - (c - c')) - (k' - (1-\delta)k) - \frac{\gamma}{2}(k' - (1-\delta)k)^2$	'Sale of Common and Preferred Stock' minus 'Purchase of Common and Preferred Stock'
Tax	$\tau(y - (c - c'))$	'Income Taxes - Federal'
NOLCF	c	'Tax Loss Carry Forward'

Table 1: Model and Data Variables

The productivity shock process is discretized into 11 states using the method described in Adda and Cooper (2003). For a given set of parameters, the model moments are computed by solving the firm's problem, then applying the law of large numbers to approximate the invariant distribution corresponding to the state space. The resulting distribution differs from the common Monte Carlo approach to estimating model moments. Many applications of this process in the literature solve the agent optimization problem by discretizing the choice space. The decision rule corresponding to a discretized choice space gives exact grid points in the state space, reducing the computational cost of Monte Carlo simulation. However, because the model in this paper is solved by an optimization routine, which generally provides solutions between gridpoints, multi-dimensional interpolation would be required in every iteration of a Monte Carlo simulation. The computational requirement for this approach is prohibitive and likely reduces the precision of the model moments. Instead, the invariant distribution is approximated, and statistics dependent on the simulation sample size are replaced by the asymptotic equivalent.

3.2 Identification

Choice of moments to be matched reflects the ability of the moment to help estimate the parameters of the model. Accordingly, moments of income, investment, equity, and taxes are included. With the exception of correlations, all moments reflect the variable relative to the firm's capital stock. While it would be ideal to include NOLCFs as a targeted moment, that variable in

the COMPUSTAT data is known to suffer from significant measurement error.[3] Instead, values corresponding to NOLCFs are reported in the Appendix as untargeted moments.

The discrete distribution approach to measuring model moments complicates serial correlation calculation, which is sometimes used to capture the persistence of the shock process.[4] Instead, the frequencies of positive income and positive taxes are introduced to help infer the distributional properties of the shock process. In particular, the stochastic process characterizing the productivity shock determines the frequency of positive income, so including that moment helps determine the parameters of the AR1 process.

Mean income is another moment often included to capture features of the income process. While total income in the data is positive (i.e., the sum over all income data points), average income-to-asset ratio (i.e., *mean income* in the context of the moment names) is negative. Including this moment skews parameter values in the estimated model in a way that understates total income, so mean income is omitted as a targeted variable. Mean income and the variance of income are, however, reported as untargeted moments, and the variance of income in the model is a close match to the data.

3.3   Results

	Model Moment	Data Moment	S.E.
Mean Investment	0.0516	0.0580	0.0003
Mean Equity	0.0519	0.0488	0.0007
Mean Tax	0.0114	0.0099	0.0001
Variance of Investment	0.0051	0.0046	0.0001
Variance of Equity	0.0349	0.0267	0.0004
Variance of Taxes	0.0003	0.0003	0.0000
Positive Tax Share	0.4958	0.4975	0.0023
Positive Income Share	0.6364	0.6156	0.0019
Correlation of Taxes and Income	0.7624	0.5231	0.0212

Table 2: Targeted Model and Data Moments

Targeted model moments and corresponding data moments with standard errors are reported

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[3]See, for example, Heitzman and Lester (2018).

[4]Cooper and Haltiwanger (2006) and Hennessy and Whited (2005), for example.

in Table 2, and untargeted moments are reported in the Appendix. Parameter estimates and corresponding standard errors are reported in Table 3. With the exception of correlation of taxes and income, all model moments are close to the corresponding data moments. The U.S. corporate tax code allows for several types of deductions that are excluded from this model, including debt interest and taxes paid to lower levels of government. To that extent, model correlation of taxes and income should be greater than the real world value.

	Parameter Estimates	S.E
θ	0.7492	0.0091
δ	0.0350	0.0004
γ	0.4402	0.0095
τ	0.0998	0.0012
$\bar{\rho}$	0.1795	0.0129
ρ	0.2386	0.0171
σ_ϵ^2	0.2333	0.0245

Table 3: Parameter Estimates

Estimates of the model parameters are consistent with existing estimates in the literature. In a model that includes taxes, corporate debt, and external financing costs, DeAngelo, DeAngelo, and Whited (2011) estimate the curvature parameter to be $\theta = 0.7880$, which is close to the value estimated in this paper. Cooper and Haltiwanger (2006) estimate a similar dynamic firm model with alternative specifications of the capital adjustment cost function. In the version of the model that has convex adjustment costs, they find an adjustment cost parameter $\gamma = 0.455$, which is extremely close to the value in this model. Bazdresch, Kahn, and Whited (2017) estimate a standard dynamic corporate finance model and find a depreciation rate of $\delta = 0.0449$ using a moments-based estimator, which is close to the value estimated for this model. The specification of the profitability shock in their paper assumes log-normal distribution. Such a specification for this model yielded similar parameter values but a poorer fit to the data. By contrast, the profitability shock in this paper is normally distributed with a positive mean. Finally, the implied federal tax rate is roughly 10%, which is somewhat below the 14% effective tax rate on pretax income paid by firms between 2008 and 2012, according to a report by the General Accountability Office.[5] Again,

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[5]https://www.gao.gov/assets/680/675844.pdf

the inclusion of other deductions in the model would have provided a more realistic corporate tax rate, but the estimated value conforms to the particular features of this model.
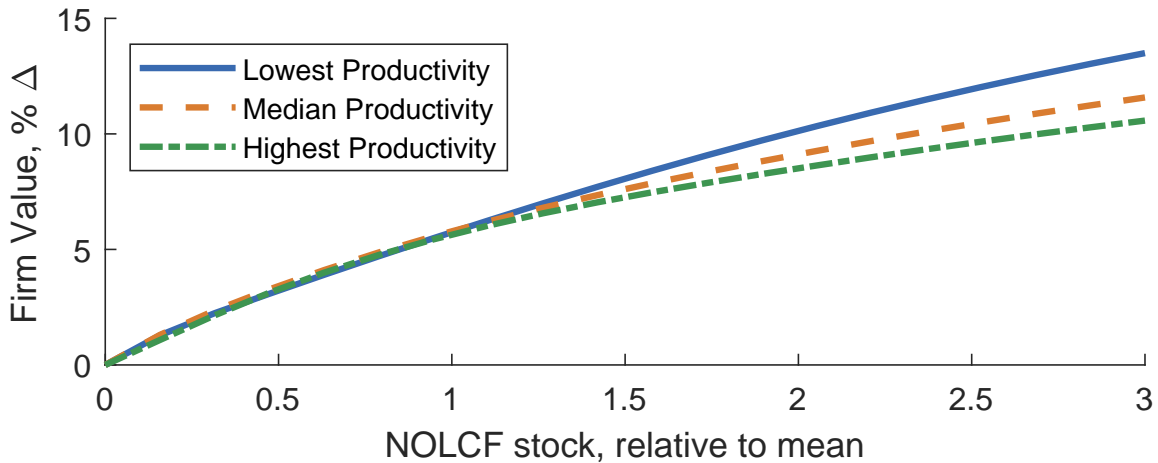

Figure 1: Contribution of NOLCF stock to firm valuation.

Current and future taxes are decreasing in a firm's NOLCF stock, implying that the value of a firm is increasing in the NOLCF stock. Figure 1 shows this contribution of NOLCF to the valuation of a firm with average assets. Specifically, the graph maps $100 \times \frac{V(\bar{k}, c, z_i)}{V(\bar{k}, 0, z_i)}$, where $\bar{k}$ is the mean capital stock, i corresponds to the productivity shock, and values of c are normalized by the mean. This graph suggests that an average NOLCF stock comprises 5-6% of the value of a firm with average assets.[6] Further, the contribution of NOLCFs to a firm's value is robust to variations in the productivity of the firm.

A higher NOLCF stock reduces a firm's near-term marginal tax rate, which raises the firm's expected return to capital. Accordingly, Figure 2 shows, for a firm with average capital stock, how much capital expansion is induced by a change in the firm's stock of NOLCFs. This graph can be compared to Figure 1, which is conceptually the same with the value function switched out for the capital policy function.

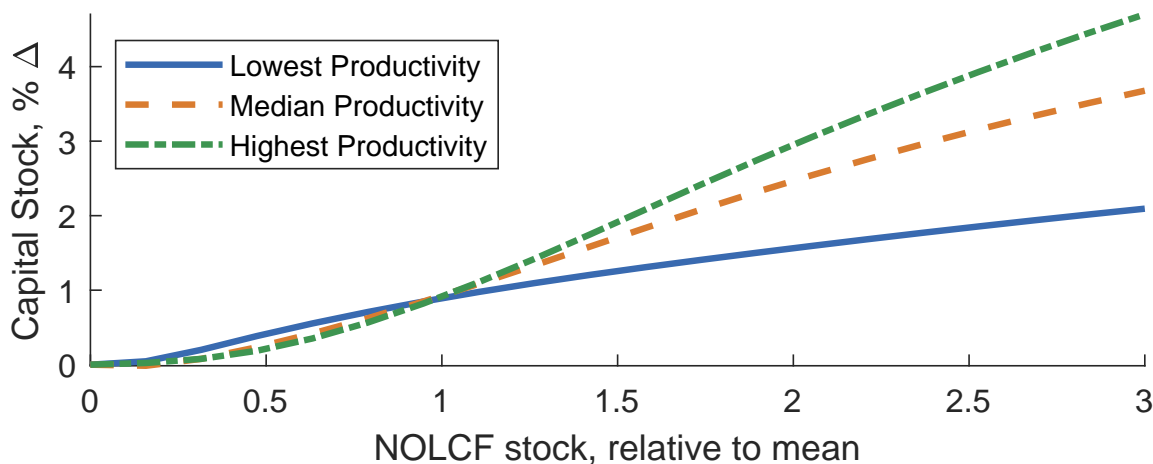[6]Note that the calculation of average NOLCF stock includes a large share of firms with zero NOLCFs.

Figure 2: Capital expansion induced by NOLCF stock.

4 Policy Evaluation

Given the estimated parameter values, the model provides a framework for counterfactual policy evaluation. The most common policy actions with regards to NOLCFs involve limiting their usage or moving the window of availability (i.e., allowing carrybacks or extending the expiration of carryforwards). Since changing the window of availability in the model involves a change to the dimensionality of the firm optimization problem, the focus of the first part of this section studies the consequences of limiting NOLCFs. The effectiveness of NOLCF policy corresponds to the magnitude of the corporate tax rate. To that extent, the second part of this section evaluates changes in the corporate tax rate with a particular focus on the 2017 corporate tax reform.

4.1 NOLCF Restrictions

The first policy evaluated involves a common proposal to limit NOLCFs. As of 2017, two states - New Hampshire and Pennsylvania cap NOLCF accumulations at $10 million and $5 million, respectively. [7] Additionally, in the tax reform of late 2017, the U.S. federal government limited the deduction of NOLCFs to be 80% of taxable income. To that extent, the second policy evaluated

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[7]https://taxfoundation.org/net-operating-loss-carryforward-carryback-2017/

involves limiting NOLCF deductions to a percentage of taxable income.

In the case where NOLCF has a cap of $\bar{c}$, the NOLCF constraint (10) becomes:

$$
\begin{cases}
c - c' \in [0, \min\left\{zk^\theta, c\right\}], & if & zk^\theta \geq 0 \\
c' = \min\left\{\bar{c}, c + \mid zk^\theta \mid\right\}, & if & zk^\theta < 0.
\end{cases}
\tag{15}
$$

In the case where NOLCF usage is restricted to a share (α) of taxable income, the constraint (10) becomes:

$$
\begin{cases}
c - c' \in [0, \min\left\{\alpha zk^\theta, c\right\}], & if & zk^\theta \geq 0 \\
c' = c + \mid zk^\theta \mid, & if & zk^\theta < 0.
\end{cases}
\tag{16}
$$

The results of the counterfactual policies that limit NOLCFs are summarized in Figure 3. For policies that cap NOLCFs, the x-axes correspond to model values of $\bar{c}$ in (15), and for policies that limit the permitted share of taxable income, the x-axes correspond to values of α in (16). Consider first the effect of each NOLCF-limiting policy on the accumulation of NOLCFs and share of firms with positive NOLCFs, as shown in Figure 3(a) and Figure 3(b). Since a cap reduces the maximum amount that any firm can sustain, the aggregate value tends to zero with the cap, as does the share of firms with any NOLCFs accumulated. Conversely, since the second policy limits the amount of NOLCFs exhausted in any period, aggregate NOLCFs become arbitrarily large and the share of firms with any NOLCFs accumulated rises to 100% as the taxable income share declines.[8] Both policies cause the share of firms with a positive tax bill to rise. The sharp rise in the case of the second policy results from the discrete nature of the productivity grid. In the absence of any deductions, tax bills are a fraction of positive incomes, and taxes are highly correlated with taxable income. NOLCFs allow firms to smooth tax bills over time, causing the correlation of taxes and income to decline, which is shown in Figure 3(d).

Figure 3(e) shows that limiting NOLCFs discourages capital accumulation, which drives several outcomes in the model. Fully eliminating NOLCFs causes total capital to fall nearly 20% and total income to fall by almost 15%, as shown in 3(f). NOLCF policy exists to help offset the

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[8]In this case, aggregate NOLCFs tend towards the highest grid point of the discretized state space.
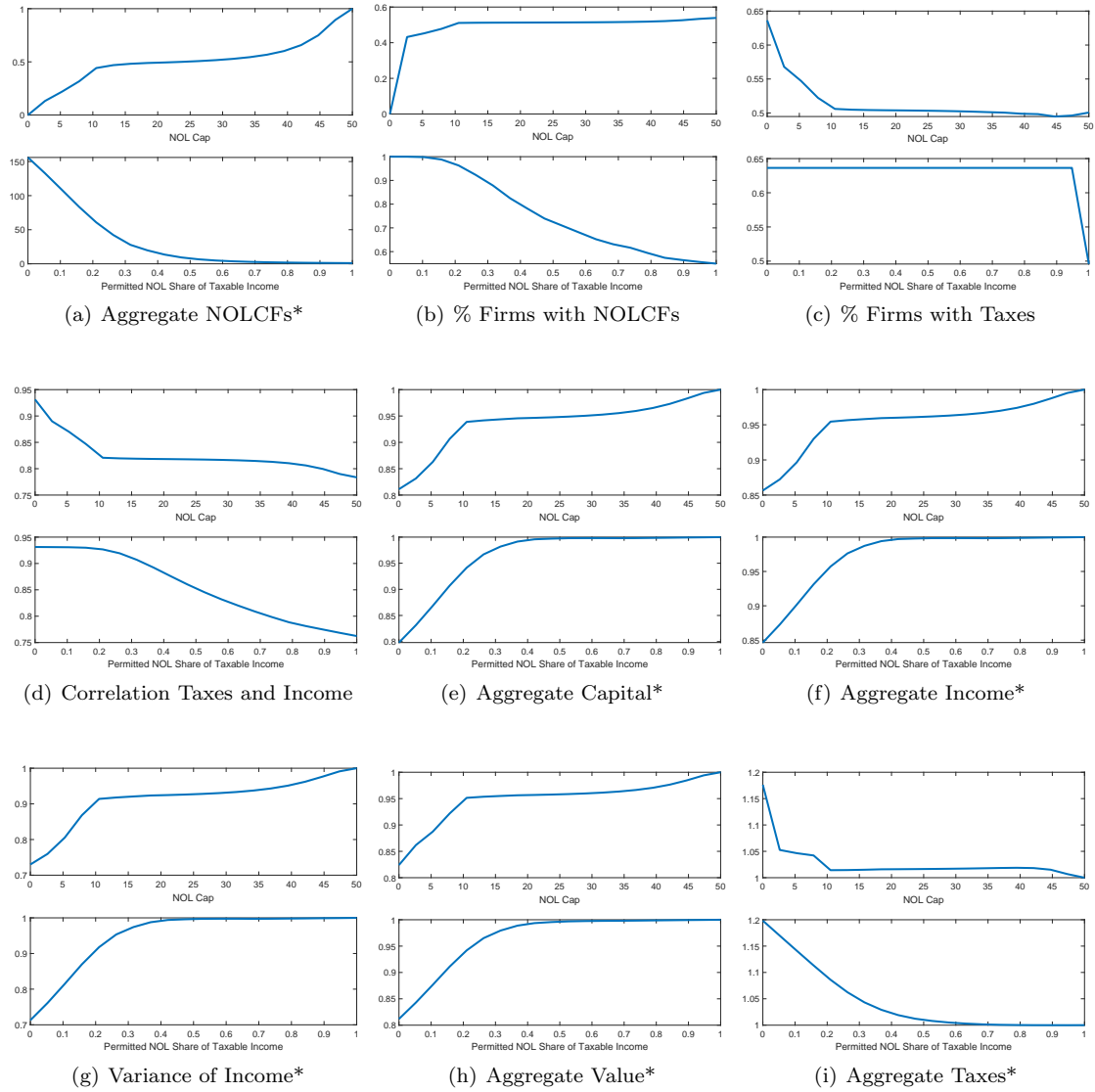
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Figure 3: Response of model moments to limiting NOLCFs. (*) denotes percentage of baseline.

asymmetry of positive income taxation that would otherwise disproportionately hurt firms with higher income volatility and discourage business risk-taking. This effect is apparent in Figure 3(g), as the variance of income falls by nearly 30% with the elimination of NOLCFs. Figure 3(h) suggests that unrestricted NOLCF availability accounts for roughly 18% of aggregate corporate valuation.

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Finally, Figure 3(i) shows that tax revenue would rise as a result of limiting NOLCFs, suggesting that capital incentives created by a NOLCF deduction, as studied in Section 2.1, are not enough to induce an increase in tax revenue. Perhaps, the more important result is that the permitted NOLCF share of taxable income must decline to less than 65% before the policy begins raising tax revenue. The Joint Committee on Taxation found that the 2017 restriction of NOLCFs to 80% of taxable income would generate $201 billion in additional corporate tax revenue from 2018 to 2027. While short-run revenue is likely to increase from this limitation, the results of this paper suggest that the policy simply shifts tax payments to the near-term, slowing the exhaustion of NOLCFs, and resulting in no additional long-run tax revenue or economic effects.
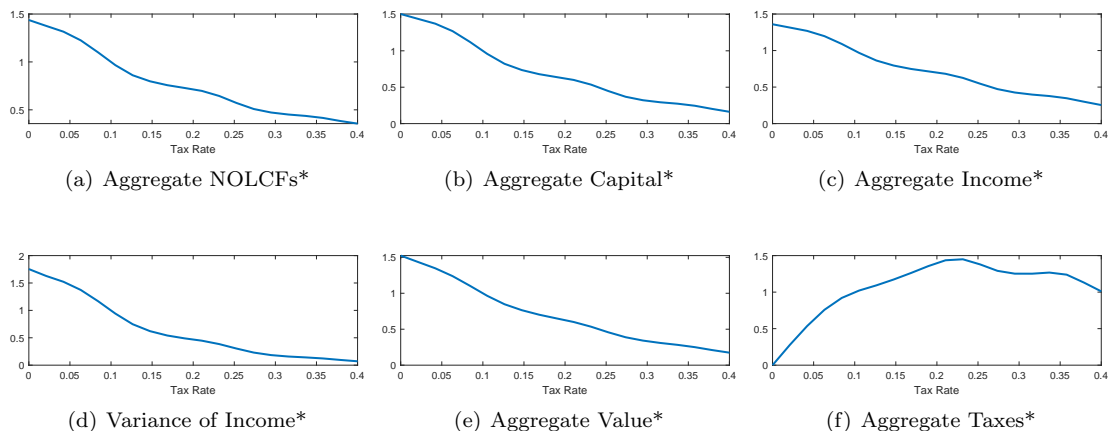

(a) Aggregate NOLCFs*   (b) Aggregate Capital*   (c) Aggregate Income*

(d) Variance of Income*   (e) Aggregate Value*   (f) Aggregate Taxes*

Figure 4: Response of model moments to changes in the corporate tax rate. (*) denotes percentage of baseline.

4.2   Alternative Tax Rates

Without corporate income taxation, NOLCF policy would be irrelevant. To that extent, this section studies the effects of alternative corporate tax rates on the model's key variables. As shown in Figure 4, the corporate tax rate has a highly distortionary effect on capital choice, which drives nearly every value in the model. Although the model does exhibit a Laffer Curve effect as shown in Figure 4(f), the corporate tax rate before the 2017 tax reform could more than double before

further tax increases cause revenue to decline.

The estimated value of the model's corporate tax rate is approximately 10%, which is close to effective tax rate estimates before the 2017 tax reform but well below the statutory tax rate of 35%. Mapping the 2017 corporate tax reduction from 35% to 21% suggests a 40% reduction in the model's corporate tax rate to approximately 6%. Such a corporate tax reduction results in a 27.2% reduction in corporate tax revenue and a 24.2% increase in total NOLCFs. The disproportionate decline in tax revenue results from a 28.9% increase in capital, which improves corporate income by 21.1%. The corporate tax reduction also increases corporate valuation by 25.7%.
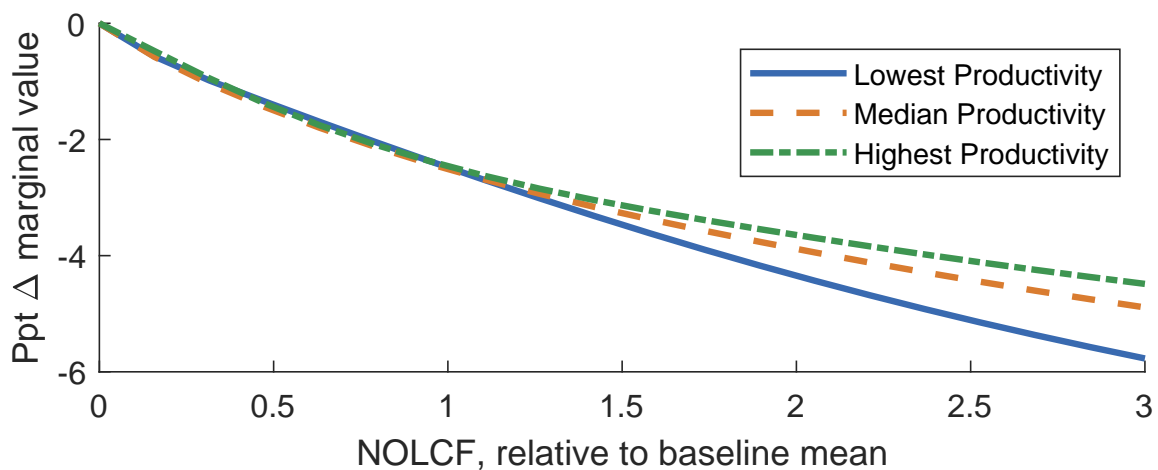

Figure 5: Effect of 40% tax reduction on marginal NOLCF valuation.

When the corporate tax rate declines, so does the value of NOLCFs to a firm. To measure this effect, Figure 5 shows the change in marginal valuation of NOLCF stocks after the 40% corporate tax rate reduction. Mathematically, this graph shows $100 \times \left(\frac{\tilde{V}(\bar{k},c,z_i)}{\tilde{V}(\bar{k},0,z_i)} - \frac{V(\bar{k},c,z_i)}{V(\bar{k},0,z_i)} \right)$, where $\tilde{V}$ is the value of the firm after the tax reduction, and $\bar{k}$ is the mean capital stock in the baseline. Again, the domain is normalized to units of the mean NOLCF stock in the baseline case. The results show that the decline in the contribution of NOLCFs to the valuation of the firm is roughly proportional to the decline in the corporate tax rate. This relationship is visualized more clearly in Figure 6. For a firm with mean assets, Figure 6 shows the marginal valuation of having the mean NOLCF

stock (relative to no NOLCFs) for a continuum of tax reductions. In relation to Figure 1, this figure maps values of the function at the mean NOLCF given reductions in the corporate tax rate.
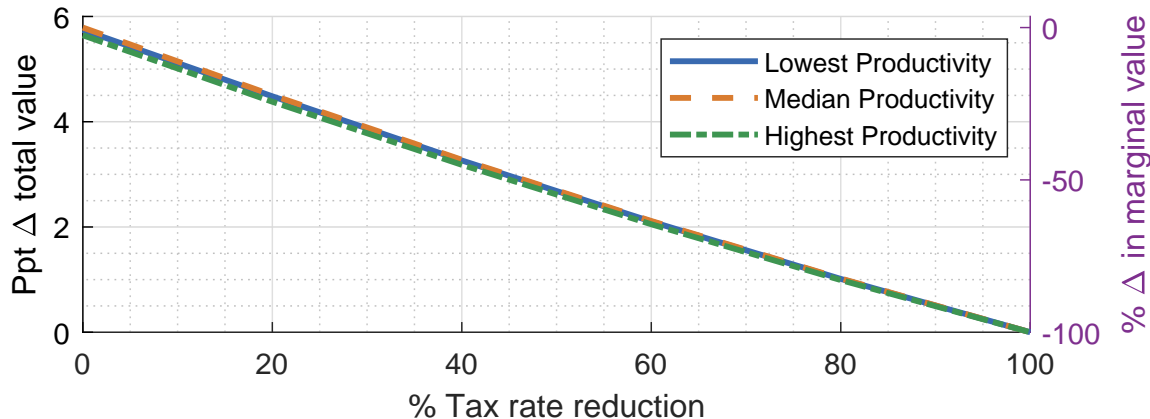

Figure 6: Effect of tax reductions on marginal NOLCF valuation.

5   Conclusion

NOLCFs allow firms to smooth tax payments over time, dampening a natural asymmetry of income tax implementation. Their availability is an important public financing instrument often found at the center of fiscal policy discourse. Understanding the role of NOLCFs within the firm helps guide fiscal policy implementation and valuation of these tax assets. This paper introduces NOLCFs to the state space of a standard corporate finance model to address these fiscal policy and corporate finance issues.

This paper presents a simple theoretical model to provide intuition regarding the fiscal policy effects of NOLCF deduction allowance. The paper then extends the simple model to include several of the salient features and dynamics of optimal firm decisions and NOLCF policy. Structural parameters of the extended model were estimated using simulated method of moments. This procedure produced baseline model moments that closely matched several of the moments chosen for estimation.

The baseline model provided an ideal framework for NOLCF policy evaluation. In particular,

policy evaluation included capping NOLCFs, which is policy in two U.S. states, and limiting annual NOLCF deductions to a share of taxable income, which is a policy the U.S. federal government introduced in the 2017 tax reform. The results showed that binding caps have real economic consequences and affects tax revenue. The same is true for sufficiently restrictive limits of annual NOLCF deductions as a share of taxable income, although the 80% limit introduced in the 2017 tax reform was shown to have no long-term effects and generate no additional long-term revenue. Changes to the tax rate were also evaluated and shown to have large effects on capital accumulation, which drives several variables in the model. While a tax reduction improves the total value of the firm, the marginal contribution of NOLCFs to the valuation of a firm was shown to change by approximately as much as the percentage change in the corporate tax rate.

This paper presents a framework for analyzing NOLCFs in a standard corporate finance model. The model could be modified or extended to evaluate several interesting questions. For example, NOLCF deductability is often credited for reducing the volatility of business cycles because of its role as an automatic stabilizer. This model provides an ideal framework for evaluating the stabilization properties of NOLCF policy. Another interesting application of this framework would involve evaluation of alternative tax functions. In particular, with progressive income taxation, a firm may not wish to exhaust NOLCFs immediately. In fact, a firm facing a convex tax function may actually want to prepay taxes to smooth payments over time, resulting in potentially interesting behavior.

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Appendix

Untargeted Moments

	Model Moment	Data Moment	S.E.
Mean Income	0.1166	-0.0260	0.0009
Mean NOLCF	1.2454	0.6589	0.0070
Variance of Income	0.0597	0.0522	0.0006
Positive NOLCF Share	0.5493	0.7428	0.0020

Table 4: Untargeted Model and Data Moments