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# 10 Tax-Loss Carryforwards and Corporate Tax Incentives

Alan J. Auerbach and James M. Poterba

The corporate income tax in the United States provides only limited tax relief to firms that report tax losses. Firms that have paid positive taxes during the three years prior to the loss year may "carry back" their losses and receive a tax refund, provided it does not exceed their total taxes in those three years. For some firms, however, current losses exceed potential carrybacks. This may happen when a firm experiences losses in several consecutive years, or when it incurs an especially large loss in a single year. Firms that exhaust their potential carrybacks must carry losses forward, using them to offset future taxable earnings. For these firms, the marginal tax rate on current earnings, as well as the value of tax deductions, depends critically upon when, and if, they regain their taxable status. Firms that anticipate persistent loss carryforwards will in effect face very low marginal tax rates.

Imperfect loss-offset provisions may substantially alter the incentive effects of the corporate income tax. Two features of the tax, the incentive to undertake new investment and the incentive to use debt as opposed to equity finance, are particularly sensitive because loss-carryforward firms may be unable to claim the benefits of depreciation or of interest tax shields.

Alan J. Auerbach is professor of economics at the University of Pennsylvania and a research associate at the National Bureau of Economic Research. James M. Poterba is associate professor of economics at the Massachusetts Institute of Technology and a research associate at the National Bureau of Economic Research.

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Standard analyses of corporate investment incentives assume that firms claim depreciation allowances and investment tax credits as they accrue. For firms with loss carryforwards, however, accrual and realization occur at different dates. This timing difference can change both the relative tax incentives for investments in plant and equipment, and the overall investment incentive facing the firm. For assets with high tax burdens, typically those with long depreciation lives, such as structures, a loss-carryforward firm may have a greater incentive to invest than a currently taxable firm. This occurs because the gain from postponing the tax payments on the asset's earnings exceeds the loss from postponing its tax depreciation benefits. The opposite result may obtain for assets with highly accelerated depreciation allowances, such as equipment. For these assets, the cost of delayed realization of the depreciation benefits may exceed the gain from deferring taxes on the project's profits, and loss-carryforward firms may therefore face smaller investment incentives than taxable firms.

Loss-offset provisions may also exert an important influence on corporate financing choices. Interest deductions are worth less to a loss-carryforward firm than to a currently taxable firm, so a firm with a tax-loss carryforward has less incentive to use debt finance than does a currently taxable firm. In addition, a firm's probability of experiencing future loss carryforwards may depend upon its financial policy, since higher interest deductions lower taxable profits and raise the chance of realizing losses. This has led some to propose a theory of corporate capital structure based on the proposition that firms borrow until the expected marginal cost of additional debt due to the increased probability of becoming nontaxable and losing preexisting tax shields equals the expected marginal benefit of additional deductions when taxable. This theory implies that tax systems with more generous loss-offset provisions provide a greater incentive for corporate borrowing.

Several recent studies have suggested that the loss-carryforward provisions of corporate tax codes are of more than academic interest. Cordes and Sheffrin (1983) analyzed the distribution of corporate marginal tax rates on additional interest deductions, and estimated that only 56% of corporate receipts accrued to firms that paid the maximum statutory corporate tax rate on marginal earnings. This is due to the combined effect of tax-loss carryforwards and binding income-linked constraints on the use of investment and foreign tax credits.[1] In Canada, Mintz (1985) reports that only half of the investment in manufacturing is undertaken by currently taxable firms, and the incidence of loss-carryforward firms is much higher in some other sectors, such as mining. For Great Britain, Mayer (1986) cites evidence that, during the early 1980s, only 40% of British companies were paying corporation tax on marginal profits. The stock of tax-loss carryforwards in the United Kingdom was nearly three times as large as the annual revenue yield of the corporation tax.

This paper presents new evidence on the importance of tax-loss carryforwards in the United States. It uses a new data set gathered from corporate annual reports and 10-K forms to investigate the incidence of loss carryforwards, and then examines how effective tax rates on different assets are affected by loss-offset constraints. The most important finding is that tax-loss carryforwards are highly persistent and significantly affect investment incentives for some firms. Nearly 15% of the firms in our sample had tax-loss carryforwards in 1984, and the fraction is much higher in some industries. Analyzing the effect of the corporate income tax on tax-loss firms is therefore essential to understanding investment and financing incentives in these industries. We estimate the persistence of loss carryforwards and use the results to calculate effective tax rates on new investments in structures and industrial equipment for both currently taxable and loss-carryforward firms. We find that the presence of a tax-loss carryforward has a dramatic effect on a firm's incentive to invest in equipment but relatively little impact on the incentive to invest in structures.

The paper is divided into five sections. The first outlines the tax rules governing loss carryforwards and carrybacks. It also explains the difficulties that arise in using standard data sources to measure tax-loss carryforwards, and describes our new data set. The second section presents our basic findings on the importance of firms with tax-loss carryforwards and examines the persistence of loss carryforwards for the firms that experience them. The third section outlines how loss-offset constraints alter the effective tax rates on various assets and describes our numerical procedures. The fourth section presents our calculations of the effective tax rates on plant and equipment investment for both currently taxable and loss-carryforward firms. A concluding section discusses the implications of our results for understanding the allocative effects of the corporate income tax and suggests a number of directions for future work.

## 10.1 The Definition and Measurement of Tax-Loss Carryforwards

Loss-offset constraints restrict a firm's ability to obtain tax refunds when it generates negative taxable profits. A firm that realizes a tax loss may carry the loss back against tax payments in the previous three years, provided it does not claim current refunds in excess of total tax payments in those years. Firms that have exhausted their carrybacks may carry unused losses forward for a maximum of fifteen years, after which the losses expire and can no longer be used to reduce tax liability. Prior to 1981, loss carryforwards expired in five years. For firms with loss carryforwards, an additional dollar of taxable income has no effect on current tax liability. The marginal tax burden on an additional dollar of taxable earnings depends upon when the firm becomes taxable again in the future.

It is important to distinguish between firms with loss carryforwards and "firms that pay no taxes."[2] A firm with a tax-loss carryforward in a given year pays no tax, but it may receive a refund if it can carry part of the loss back against previous tax payments. A marginal change in the firm's taxable earnings, however, will have no effect on its current tax liability. Its current marginal tax rate is zero, although if it expects to exhaust its loss carryforwards in the near future it will face an effective marginal tax rate that differs from the statutory tax rate only by the price of an interest-free loan for the duration of its remaining tax-loss period.

Not all firms with negative current tax payments have loss carryforwards, however. Some firms that are carrying back current losses may not have exhausted their carryback potential. For these firms, the marginal tax rate on additional income is the statutory tax rate, because an additional dollar of earned income will reduce the amount of their carryback. These firms face the statutory marginal rate even though their current tax payments are negative.

Loss carryforwards are not the only factor that may cause a firm's marginal tax rate to differ from the statutory rate. Cordes and Sheffrin (1983) explain how constraints on the use of tax credits and the corporate minimum tax also affect the distribution of marginal corporate tax rates.[3] Unfortunately, publicly available information is not detailed enough to enable us to measure the marginal tax rates facing individual corporations. To calculate a firm's carryback potential, we would need information on its current tax credits, its credit and loss carryforwards, and even its previous tax payments. These data can only be obtained from a firm's past and present tax returns, which are confidential.[4] One type of tax data which can be gathered from published sources is the identity of firms with tax-loss carryforwards. Corporate annual reports and 10-K filings typically contain some information on carryforwards, so we focus on this source of variation in marginal corporate tax rates.

Data limitations prevent us from assessing the significance of firms with tax-credit carryforwards. Most of the firms that we identified as having tax-loss carryforwards also reported credit carryforwards. There may be other firms, however, with credit carryforwards but no loss carryforwards; Cordes and Sheffrin (1983) suggest that these credit-carryforward firms account for a substantial fraction of the firms facing marginal corporate tax rates below the statutory levels. We implicitly assume that firms either encounter loss and credit carryforwards simultaneously or that they encounter neither. Preliminary results, based on IRS data and incorporating both loss and credit carryforwards, are reported in Altshuler and Auerbach (1987).

The standard source of machine-readable information on corporate accounts is the COMPUSTAT data base compiled by Standard and Poor. Although the data set contains a company's tax-loss carryforward if the annual report includes one, there are several serious problems with these data. First, there are two distinct ways of calculating a firm's tax-loss carryforward. One is for *tax* purposes, the other is for *financial reporting* purposes. In computing financial-reporting loss carryforwards, firms exclude depreciation allowances in excess of straight-line depreciation. Financial-loss carryforwards may therefore be smaller than tax-loss carryforwards, because accounting profits are larger than taxable profits. The two measures also differ in the treatment of discontinued operations, write-offs, and many other activities. A firm that decides to write down its investment in an unprofitable subsidiary may book a substantial loss but receive no tax benefits for the transaction, thereby leading financial-reporting losses to exceed tax-purpose losses. The relevant measure for analyzing corporate incentives is the tax-purpose loss; unfortunately, if a firm reports both tax and financial-loss carryforwards, COMPUSTAT records the financial-purpose carryforward. This may lead to spurious classification of firms. Second, COMPUSTAT aggregates foreign tax-loss carryforwards along with U.S. carryforwards. For multinational firms, the data may therefore provide an unreliable description of current tax status.

Firms with loss carryforwards typically report both financial and tax-purpose data in their annual reports or 10-K statements. These published data, although not available in machine-readable form, provide the basis for our study. We began with the list of COMPUSTAT firms reporting loss carryforwards for any of the fiscal years from 1981 to 1984. We then consulted the annual reports for each of these firms; when it was available, we recorded the tax-purpose carryforward. We also investigated all of the firms on COMPUSTAT with either negative federal tax payments or zero investment tax credits. In some cases, we found that firms with COMPUSTAT carryforwards did not have U.S. tax-basis carryforwards; these were reclassified as loss-free firms. In other cases, the firms reported only one measure of their loss carryforward and did not indicate whether it was a tax or financial number. These firms (of which there were very few) were deleted from our sample. We also deleted all foreign-based firms before investigating the pattern of loss carryforwards.[5] Our data set includes 1,425 firms, 228 of which experienced tax-loss carryforwards at some point between

1981 and 1984. The total market value of the firms in our sample is roughly three-quarters of the total market value of the nonfinancial corporate sector.

There are several potential biases in our data sample that should be recognized at the outset. First, COMPUSTAT does not include all of the corporations which file tax returns; there were over three million such firms in 1982! The firms on COMPUSTAT are large, publicly traded firms. If losses tend to be more prevalent among smaller or start-up firms, then we may understate the number of firms with tax-loss carryforwards. Second, the data set follows COMPUSTAT in including only firms that were active in 1984. Some corporations that encountered tax-loss carryforwards in earlier years may either have been taken over or gone bankrupt, and the end-of-sample sampling rule imparts a clear selection bias. This may cause us to understate the number of loss-carryforward firms in 1981 through 1983, although the bias is likely to be small given the relatively low rate of both bankruptcy and takeover for firms on the COMPUSTAT tape. A third source of bias arises because not all firms with losses may report them. Firms are required to report loss carryforwards only if they are "material"; since some firms with small carryforwards may not appear as carryforward firms on COMPUSTAT, we may understate their importance.

A final problem with loss-carryforward data gathered from annual reports and 10-K filings is the divergence between the divisions of the firm included on its consolidated tax return and those included on the financial statements. For example, as Dworin (1985) explains, some firms do not include their finance subsidiaries in their financial statements although for tax purposes these subsidiaries are consolidated with the parent corporation.[6] We may therefore classify a parent firm as having a tax-loss carryforward even though the total taxpaying entity has no carryforward. This problem is impossible to overcome when using data published in annual reports.[7]

It is difficult to evaluate the impact of these biases. One simple check involves comparison of our aggregate estimate of loss carryforwards with aggregate IRS data. A lower bound for loss carryforwards by nonfinancial corporations can be calculated as the current deficit reported by firms with current losses, less total losses carried back. This lower bound was $57.1 billion in 1981 and $75.2 billion in 1982, roughly five times as large as our aggregate estimates. While the source of this discrepancy is unclear, we believe it is due primarily to small firms not included in our data and some large firms which do not report loss carryforwards on their accounting statements. This is likely to contaminate our estimates of the incidence of tax losses much more than our estimates of transition probabilities and effective tax rates.

## 10.2 The Importance and Persistence of Loss Carryforwards

This section uses our annual-report data set for the post-1981 period, as well as accounting-purpose loss-carryforward data available on COMPUSTAT for a longer sample period, to explore the economic significance of tax-loss carryforwards. We ask how many firms have carryforwards, and then examine the persistence of these losses.

### 10.2.1 The Importance of Loss-Carryforward Firms

Table 10.1 presents summary evidence on the importance of firms with tax-loss carryforwards in the years since 1981. It considers the total population of nonfinancial firms, as well as some particular industries. The table shows that about 15% of all firms are in the loss-carryforward regime. We also weighted firms by their 1984 net book assets, and found that 5.9% of all assets were held by loss-carryforward firms.

Table 10.1 also shows that there is substantial concentration of carryforward firms in some industries. In the oil industry (SIC codes 1311 and 2911), for example, nearly a quarter of the firms (accounting for 2% of the common stock) had loss carryforwards in 1984. In 1982 and 1983, 40% of the firms (accounting for about 10% of the value of outstanding common stock) in motor vehicles and car bodies reported tax loss carryforwards. In the steel industry, the findings suggest a third of the firms have losses, and, they account for half of the industry's outstanding equity value. Finally, for airlines we also find a high in-

**Table 10.1** **Tax-Loss Carryforward Firms, 1981–1984**

| Industry | Sample Firms (N) | % of Firms with Loss Carryforwards | | | |
|---|---|---|---|---|---|
| | | 1981 | 1982 | 1983 | 1984 |
| All Nonfinancial corporations | 1,425 | 7.58 | 12.00 | 13.96 | 14.67 |
| Oil (SIC 1311 & 2911) | 69 | 13.04 | 23.19 | 24.64 | 24.64 |
| Autos (SIC 3711) | 7 | 42.86 | 42.86 | 42.86 | 28.57 |
| Steel (SIC 3310) | 25 | 12.00 | 32.00 | 32.00 | 36.00 |
| Airlines (SIC 4511) | 20 | 30.00 | 35.00 | 35.00 | 40.00 |

*Note:* All calculations are based on the authors' data set, which is described in the text.

cidence of loss carryforwards: forty percent of the firms (accounting for roughly one-tenth of the industry's equity value).

Table 10.2 shows the total value of the loss carryforwards for the firms in our sample. These carryforwards aggregated to 5.1 billion dollars in 1981, 10.0 billion in 1982, 15.1 billion in 1983, and 12.8 billion in 1984. As noted above, the aggregate number for the nonfinancial corporate sector is probably substantially larger. The center panel in table 10.2 relates the value of the tax-loss carryforwards to the market value of the affected firms. In 1984, the nominal value of the carryforwards equalled 48% of the equity of the firms with these carryforwards. In some industries, notably steel, autos, and airlines, tax-loss carryforwards actually exceed the equity value of the loss-carryforward firms.

To provide additional perspective on the problem of loss-carryforward firms, table 10.3 displays the twenty largest loss-carryforward firms in our sample, measured by equity value, with their tax-loss carryforwards for 1983. The table depicts the same industry concentrations described above: the twenty firms include three railroads, four auto or heavy machinery manufacturers, four steel companies, and two copper companies. Although most firms on the list experienced tax losses because of poor profit performance, some firms (Storer Communica-

**Table 10.2 Estimates of Tax-Loss Carryforwards, 1981–1984**

| Tax-Loss Carryforwards, Millions of Current Dollars | | | | |
|---|---|---|---|---|
| Industry | 1981 | 1982 | 1983 | 1984 |
| All nonfinancial corporations | 5,070.1 | 10,000.8 | 15,083.6 | 12,841.7* |
| Oil | 45.7 | 129.4 | 1,353.3 | 1,291.3 |
| Autos | 2,278.7 | 2,407.0 | 2,853.0 | 1,262.0 |
| Steel | 96.8 | 1,274.0 | 2,389.1 | 3,808.3 |
| Airlines | 568.5 | 1,054.1 | 2,197.8 | 2,171.5 |
| **Tax-Loss Carryforwards as % of Affected Firms' Equity Value** | | | | |
| Industry | 1981 | 1982 | 1983 | 1984 |
| All nonfinancial corporations | 38.5 | 44.3 | 37.2 | 47.6* |
| Oil | 2.0 | 9.5 | 29.2 | 36.3 |
| Autos | 371.9 | 125.0 | 65.6 | 147.4 |
| Steel | 10.1 | 51.7 | 64.4 | 148.8 |
| Airlines | 127.8 | 141.1 | 279.8 | 204.6 |

*Note:* Calculations are based on the authors' data set consisting of 1,425 firms.

*Tabulations for 1984 exclude the Penn Central Company, for which no data were available. See text for further details.

**Table 10.3 The Tax-Loss Carryforward Top Twenty, 1983**

| Firm | Equity Value ($ million) | Tax-Loss Carryforward |
|---|---|---|
| 1. Burlington Northern | 3,677.8 | 405.1 |
| 2. Chrysler Corporation | 3,365.0 | 1,600.0 |
| 3. U.S. Steel | 3,178.4 | 1,200.0 |
| 4. General Dynamics | 3,064.4 | 137.3 |
| 5. Syntex Corporation | 1,799.7 | 110.0 |
| 6. Bethlehem Steel | 1,318.1 | 682.3 |
| 7. Penn Central | 1,164.0 | 2,097.4 |
| 8. LTV Corporation | 1,017.6 | 630.0 |
| 9. IC Industries | 799.1 | 126.3 |
| 10. Asarco Inc. | 775.6 | 12.4 |
| 11. Inland Steel | 771.8 | 466.1 |
| 12. Phelps Dodge Corp. | 622.2 | 380.0 |
| 13. Storer Communication | 612.7 | 39.8 |
| 14. Clark Equipment | 560,2 | 44.0 |
| 15. Datapoint Corporation | 552.8 | 4.2 |
| 16. Alleghany Corporation | 524.9 | unknown |
| 17. American Motors | 514.0 | 257.0 |
| 18. Turner Broadcasting | 484.2 | 17.3 |
| 19. Best Products | 478.1 | 1.0 |
| 20. International Harvester | 466.7 | 996.0 |

*Note:* Firms are ranked by outstanding equity value at the end of 1983. The Alleghany Corporation reported the presence of tax-purpose loss carryforwards, but it did not report their amount.

tions and Turner Broadcasting, for example) appear because substantial investment programs generated depreciation allowances significantly greater than taxable earnings from current operations.

### 10.2.2 The Persistence of Tax-Loss Carryforwards

The extent to which the restricted loss-offset provisions in the corporation tax affect investment and financing incentives depends upon the duration of nontaxable spells. If firms with loss carryforwards can expect to recover their taxable status within a year or two, then the absence of loss-offset provisions will have relatively little effect on incentives. If firms with carryforwards tend to be constrained for many years, however, then they may face incentive effects which are substantially different from those of taxable firms.

We adopt two different approaches to analyzing the persistence of tax-loss carryforwards. First, we use our data for the last four years to fit simple Markov models for transitions into and out of the loss-carryforward state. This provides the basis for our analysis of effective tax rates in later sections, but it is limited by the fact that our data span a period of only four years. Moreover, since these years include a very deep recession, transition probabilities from the recent period may be unrepresentative of those confronting firms over a longer horizon. To obtain information on long-term persistence of loss carryforwards, we therefore perform the same calculations using a second data source, the partially contaminated accounting loss-carryforward data from COMPUSTAT, for the period 1968–84. These data are also used to construct empirical distributions of the number of firms with losses that persisted for one year, two years, three years, etc. Although the differences between tax and book loss-carryforwards make these tabulations an imperfect source of information on persistence, they do permit us to compare the recent experience with that in prior years.

Table 10.4 reports summary statistics, based on our post-1981 data sample, for transitions into and out of loss-carryforward status. The top panel shows probabilities based on the first-order Markov assumption, i.e., treating a firm's current status as containing all relevant information about its transition prospects. These estimates show that for the 1983–84 period, the probability of a firm without a loss carryforward in period $t$ experiencing one in period $t + 1$ is .026. For a

**Table 10.4 Tax-Status Transition Probabilities**

| First-Order Markov Model | | |
|---|---|---|
| | Probability of Moving to State of | |
| Previous State | No Loss Carryforward | Loss Carryforward |
| No loss carryforward | .974 | .026 |
| Loss carryforward | .087 | .913 |
| **Second-Order Markov Model** | | |
| | State in Period $t + 1$: | |
| Previous State | No Loss Carryforward | Loss Carryforward |
| No loss carryforward ($t - 1$)<br>No loss carryforward ($t$) | .977 | .023 |
| No loss carryforward ($t - 1$)<br>Loss carryforward ($t$) | .099 | .901 |
| Loss carryforward ($t - 1$)<br>No loss carryforward ($t$) | .680 | .320 |
| Loss carryforward ($t - 1$)<br>Loss carryforward ($t$) | .083 | .917 |

*Note:* All calculations are based on the authors' data set, described in the text, which yields 2,849 firm years of data. The estimates are for transitions observed in 1983 and 1984.

firm with a loss carryforward in period $t$, the probability of remaining in the loss-carryforward state at $t + 1$ is .913.

In calculating simple Markov probabilities, we are implicitly assuming that all firms have identical transition probabilities and that these probabilities did not vary between 1983 and 1984. Neither assumption is realistic, and these results should therefore be regarded as a simple way of summarizing the data rather than as parameters of a structural model of transition behavior.

There are two significant reasons why the transition probabilities are likely to vary across firms: different firms have loss carryforwards of different sizes, and there are probably differences in the stochastic processes driving their taxable income streams. Auerbach (1983) estimates a model for tax status in which the firm's tax-loss carryforward was modeled as a continuous variable. This requires imputing potential carrybacks to firms with no loss carryforwards, and it also necessitates complicated numerical integration in evaluating effective tax rates. The Markov model used here yields great simplification in computing tax incentives. Both procedures may be sensitive to missing information about the vintages of carryforwards, since two firms with loss carryforwards of identical size, one with losses generated fifteen years ago and the other with losses generated last year, have radically different probabilities of escaping from the loss-carryforward state.

The second source of heterogeneity, potential differences in profit processes, is more difficult to treat because it invalidates our assumption of a simple Markov process. A firm's characteristics, including lagged values of its loss-carryforward status, may affect its transition probability.[8] We introduce some additional flexibility in our transition matrix by estimating a second-order Markov process.

The results of estimating the second-order process are shown in the second panel of table 10.4. We tested the assumption of a first-order Markov process against the alternative of a second-order process (see Anderson and Goodman [1957]) and rejected the first-order assumption at the .10 level but not the .05 level. The $\chi^2(2)$ statistic was 5.02, with a .05 critical value of 5.99. We use the second-order process in later sections to calculate effective tax rates.

Two important conclusions emerge from table 10.4. First, it is very unlikely for a firm without a tax-loss carryforward to incur one. Second, it is also unlikely for a firm with a tax-loss carryforward to "escape" and become taxable again. These findings are important, because they suggest that the burden of the tax code's asymmetry is not borne uniformly, but rather falls heavily on the relatively few firms with tax-loss carryforwards. This also implies that standard calculations of effective tax rates which neglect the role of loss carryforwards may conceal important interfirm variations in tax incentives.

The most significant drawback of our post-1981 data is that we cannot examine the long-term persistence of tax-loss carryforwards. We can address this issue using the data on accounting tax-loss carryforwards drawn from the COMPUSTAT tape, however. To evaluate the potential biases associated with these data, we compared their second-order Markov transition probabilities for the 1983–84 period with those obtained from our annual reports data. The probability that a firm with two previous years of loss carryforward would remain in the loss-carryforward state was .928 in the COMPUSTAT data, compared with .917 in the annual reports data. The probability of remaining carryforward-free after two years of being currently taxable was .966 rather than .977. The COMPUSTAT data therefore probably overstate the persistence of tax losses because the chances of experiencing a tax loss in a given year, for firms that have as well as those that have not experienced them in the past, are higher in these data. This is consistent with our finding that financial-purpose loss carryforwards, because they include asset write-offs and other losses, may appear more significant than the comparable tax-purpose losses. Nonetheless, the close agreement between the COMPUSTAT and annual report-based data suggest that valuable information can be obtained by studying COMPUSTAT transition probabilities over time.

Table 10.5 presents the pattern of transition probabilities from the COMPUSTAT sample. It reports our estimates of the four basic transition rates for each year between 1968 and 1984, as well as the probabilities for the full sample period and two subsamples. Two conclusions emerge. First, the probability that a firm with loss carryforwards in the two previous years will experience another year of tax loss increased substantially in 1981. We denote this probability as $p_{LLL}$, where the subscripts refer to the tax status in periods $t-2$, $t-1$, and $t$, respectively. The subscript takes the value $L$ for loss carryforward, and $T$ for currently taxable. The probability $p_{LLL}$, which never exceeded .90 in the years prior to 1980 and which was frequently below .80, averages .928 since 1981. The probability of remaining in the loss position rises between 1981 and 1983, then declines in 1984, reflecting in part changing business-cycle conditions. There is also a discontinuity in 1981 in the probability that a firm which has experienced a taxable year followed by a loss year will remain in the loss state, $p_{TLL}$ in our notation. From a pre-1981 average of .787, $p_{TLL}$ changes to a post-1981 value of .909.

The table also shows a substantial post-1981 increase in the probability that a taxable firm will experience a loss carryforward. From .024 before 1981, $p_{TLL}$ increased by nearly 40% to .034. There is a smaller increase in the chance that a firm which has experienced a loss-carryforward year followed by a taxable year will reenter loss status.

**Table 10.5 Tax-Status Transition Probabilities Estimated from Compustat Sample**

| Year | $p_{TTL}$ | $p_{TLL}$ | $p_{LTL}$ | $p_{LLL}$ |
|---|---|---|---|---|
| 1968 | .034 | .533 | .000 | .758 |
| 1969 | .024 | .840 | .067 | .800 |
| 1970 | .030 | .700 | .267 | .702 |
| 1971 | .045 | .889 | .129 | .895 |
| 1972 | .021 | .800 | .000 | .822 |
| 1973 | .022 | .773 | .133 | .778 |
| 1974 | .035 | .760 | .108 | .802 |
| 1975 | .020 | .900 | .069 | .798 |
| 1976 | .018 | .696 | .033 | .734 |
| 1977 | .026 | .850 | .087 | .786 |
| 1978 | .015 | .849 | .036 | .793 |
| 1979 | .016 | .647 | .167 | .709 |
| 1980 | .015 | .696 | .119 | .894 |
| 1981 | .020 | .727 | .050 | .921 |
| 1982 | .047 | .963 | .167 | .920 |
| 1983 | .034 | .923 | .000 | .941 |
| 1984 | .036 | .950 | .231 | .926 |
| Means | | | | |
| 1968–84 | .027 | .825 | .103 | .830 |
| 1968–80 | .024 | .787 | .102 | .789 |
| 1981–84 | .034 | .909 | .113 | .928 |

*Note:* Each column reports the transition probabilities calculated from the COMPUSTAT data set of financial purpose tax-loss carryforwards.

These movements in the Markov transition probabilities correspond to changes in the steady-state distribution of firms with respect to tax status. The pre-1981 probabilities imply that in the steady state 10.9% of all firms have tax-loss carryforwards. The comparable steady-state value for the post-1981 probabilities is 33.5%, a striking increase.[9] This undoubtedly overstates the long-run effect of the 1981 tax reform, since it is difficult to disentangle the effects of the 1981 tax reform from the post-1981 recession.

Our estimates of second-order Markov transition rates are incomplete because they shed no light on the behavior of firms that have experienced losses for many periods. One way to study this long-term persistence is by calculating the probability that a firm with a loss in a particular year will experience losses for one more year, two more years, etc. Table 10.6 presents calculations of these long-term transition rates from the COMPUSTAT data sample for the period 1974–83.[10] The table shows that a significant fraction of firms that experience tax losses in a given year will continue to have such losses for at least four more years. The probability of this much persistence has also risen

**Table 10.6 Persistence of Tax-Loss Carryforwards, 1974–1983**

| Year of Initial Loss | Fraction of Firms with Loss Carryforwards for: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 Year | 2 Years | 3 Years | 4 Years | 5 Years | 6 Years | 7 Years | 8 Years | 9 Years | 10 Years |
| 1974 | .801 | .588 | .432 | .319 | .226 | .179 | .152 | .125 | .117 | .105 |
| 1975 | .734 | .548 | .411 | .302 | .246 | .210 | .181 | .153 | .133 | |
| 1976 | .760 | .591 | .436 | .364 | .316 | .267 | .231 | .187 | | |
| 1977 | .782 | .559 | .472 | .418 | .355 | .314 | .259 | | | |
| 1978 | .705 | .589 | .521 | .430 | .377 | .309 | | | | |
| 1979 | .784 | .668 | .558 | .484 | .394 | | | | | |
| 1980 | .813 | .696 | .601 | .500 | | | | | | |
| 1981 | .836 | .717 | .594 | | | | | | | |
| 1982 | .849 | .709 | | | | | | | | |
| 1983 | .818 | | | | | | | | | |

*Note:* Tabulations are based on the financial-purpose loss carryforwards reported by firms on the 1984 COMPUSTAT industrial data file. See text for further details.

over time, from .32 in 1974 to .50 in 1980, the last year for which it is possible to calculate the four-year-later transition rate.

The estimates presented in this section are at best a rough characterization of the transition probabilities confronting firms. In the next two sections, we calculate effective tax rates for hypothetical firms whose movements into and out of the tax-loss state are given by our estimates. This analysis, which is primarily illustrative, demonstrates the potentially important effect of loss-offset provisions on effective tax rates.

## 10.3 The Incentive to Invest in the Presence of Tax Losses

Unlike more direct forms of investment subsidy, tax-loss carryforwards are not likely to have uniform effects on different firms and asset types. A firm with substantial unused tax benefits may appropriately view itself as temporarily "tax exempt," while a firm with a small carryforward which it expects to utilize during the next year regardless of its current decisions should take no account of it in making investment decisions. The differences across asset types stem from differences in the timing of taxable income. Many assets, such as equipment under current law, may be expected to generate negative taxable income in their initial years. If a firm has unused tax benefits when the project begins, this will *decrease* the asset's after-tax income. Since the accruing losses must be carried forward until the firm achieves a positive tax liability, some investments may actually be discouraged by the presence of unused tax benefits.[11] This section describes our methodology for quantifying these incentive effects.

There are a number of approaches to measuring the impact of tax-law asymmetries on investment incentives. Ideally, one would specify a dynamic model of firm value maximization in which risky investment would be affected by, and in turn would affect, the magnitude of unused tax benefits present at different dates in different states of nature. This problem is complicated by the joint endogeneity of investment and the firm's tax status.[12] To make the problem more tractable, if less general, one may restrict the endogeneity of either the firm's investment behavior or its tax status. The former approach is taken by Majd and Myers (1985, 1986). They value the tax payments associated with risky projects, taking account of the project's impact on the firm's future tax status. Their approach highlights the interaction between the project's risk and the risk of other random changes in the firm's tax status, but it ignores potential changes in corporate behavior which may result from variation in tax status.

An alternative approach, the one taken here, assumes that the probability distribution of future tax status is determined by the firm's history alone. This can be interpreted as treating the marginal investment project as small relative to the rest of the firm, so that the firm's tax status is determined by the stochastic returns on its prior investments. The assumption that the probability distribution of tax status is invariant with respect to marginal decisions is justified if this distribution is the direct result of firm optimization decisions. This interpretation highlights a shortcoming of this approach, however, in that it is necessarily restricted to partial equilibrium analysis of changes in tax rules or other components of the economic environment. We cannot predict how a change in tax regime would affect the incentive to invest, since it could both change the firm's statutory tax benefits holding its investment decisions fixed and alter the probability distribution of its future tax status.

### 10.3.1 Effective Tax Rates with Loss-Offset Limits

The summary statistic used throughout our analysis is the effective tax rate on a marginal investment project, calculated as the percentage difference between the internal rates of return on expected cash flows before and after tax. We assume that these marginal investments are inherently risk-free, and that the only source of uncertainty is the time profile of future tax payments. We designate the project's before-tax rate of return as $\rho$, which is set equal to .06 in all calculations. The asset depreciates at a constant rate, $\delta$, so an investment made at the beginning of period $O$ yields a gross return in period $t$ of $(\rho + \delta)(1 - \delta)^{t-1}$ per dollar of initial investment.

We assume that the investment tax credit and the first half-year depreciation allowance accrue at date $O$. Thus, the firm's project-specific accrued tax liability ($B_t$) at date $t$ is:

$$(1) \qquad B_t = \begin{cases} \tau[(\rho + \delta)(1 - \delta)^{t-1} - D_t(1 - i)^t] & t > 0 \\ - k - \tau D_0 & t = 0 \end{cases}$$

where $\tau$ is the corporate tax rate, $k$ the investment tax credit, $D_t$ is the nominal date $t$ depreciation allowance, and $i$ is the inflation rate. These expressions describe an equity-financed project; with debt finance, interest deductions would also enter the formula for $B_t$.

Under a symmetric tax system with full loss offset, equation (1) would describe actual tax payments. The project's after-tax internal rate of return, $r$, would be defined implicitly by the expression:

$$(2) \qquad -B_0 + \sum_{t=1}^{\infty} (1 + r)^{-t}[(\rho + \delta)(1 - \delta)^{t-1} - B_t]$$

$$= \sum_{t=1}^{\infty} (1 + r)^{-t}[(\rho + \delta)(1 - \delta)^{t-1}] - T(r) = 1$$

where $T(r)$ denotes the present value of tax payments computed using discount rate $r$. After simplification, equation (2) yields the more familiar user cost of capital expression:

$$\rho + \delta = (r + \delta)(1 - k - \tau z)/(1 - \tau). \tag{3}$$

We use $z$ to denote the present value of depreciation allowances discounted at $r$. The value of $r$ which solves (2) is used to define the effective tax rate:

$$ETR = (\rho - r)/\rho \tag{4}$$

which is just the difference between the pretax and posttax rate of return, measured as a fraction of the pretax return.

When the tax system imposes limitations on the deduction of losses, actual tax payments may differ from $B_t$. This requires us to amend equation (2) before $r$ and the effective tax rate can be calculated. Each accrued tax liability gives rise to a *distribution* of expected tax payments, since the firm may not be taxable when the tax liability or benefit accrues. In some states of nature, the firm will be taxable in period $t$ and the accruing tax, $B_t$, can then be realized immediately. If the firm has a tax-loss carryforward and $B_t$ is positive, its loss carryforward will be reduced and the firm will experience an increase in its tax payments in the year when it exhausts its carryforward and becomes taxable. If $B_t$ is negative, loss carryforwards will increase and there will be a reduction in the firm's tax payments in the (future) year when the firm begins paying taxes again.

To describe the distribution of tax payments corresponding to a tax accrual in period $t$, we need some notation. We define $\pi^t_{L^sT}$ to be the probability that a firm with a loss carryforward in year $t$ returns to being taxable in year $t + s$. The subscripts denote the firm's tax status in the years beginning in year $t$, and a $T$ subscript indicates a taxable year while an $L$ indicates a year with a loss carryforward.[13] Thus, $\pi^t_{LT}$ is the probability that a firm with a loss carryforward in year $t$ will become taxable in the next year. Both $\pi^t_{LLT}$ and $\pi^t_{L^2T}$ represent the probability that a firm with a loss carryforward in period $t$ will remain nontaxable for one more period, and then return to current taxable status two periods in the future. These probabilities, which we will ultimately derive from our Markov transition parameters, enable us to compute the expected tax payments corresponding to a tax accrual in period $t$.

Our analysis so far has omitted two important features of the tax system. First, since there are limits on the number of years ($N$) an accrued tax payment can be carried forward, the distribution of tax payments from an accrual at $t$ will be truncated after $t + N$. Second, we have ignored the role of loss carrybacks. Once carrybacks are permitted, each expected tax payment increases the firm's potential ability to subsequently carry back future tax losses. We will use $v_{ts}$ to denote the shadow value of additional tax payments in year $t + s$, viewed from the perspective of year $t$. With these complications, the present expected value of tax payments, $T$, becomes

$$(5) \qquad T(r) = \sum_{t=0}^{\infty} B_t \left(\frac{1 - i}{1 + r}\right)^t [\sum_{s=0}^{\infty} \left(\frac{1 - i}{1 + r}\right)^s \pi_{L^sT}^t(1 - v_{ts})].$$

The term in brackets is the expected present value of a one-dollar tax accrual in period $t$. Equation (5) defines $T(r)$, which can in turn be substituted into (2) to compute effective tax rates based on expected tax payments.[14]

### 10.3.2 Computing the Time Distribution of Tax Payments

To implement these effective tax-rate calculations, we need the probability distribution of tax payment dates for each accrued tax liability. We compute these distributions from the second-order transition probabilities in tables 10.5 and 10.6. These calculations are facilitated if we introduce new variables corresponding to the probability that a firm is in each of the four possible states, $TT$, $TL$, $LT$, and $LL$, in a given period. We use $q_{ij}^t$ to represent these probabilities. For a firm which is known to have a tax loss in the period before, and period of, a new investment, $q_{LL}^0 = 1$ and $q_{LT}^0 = q_{TL}^0 = q_{TT}^0 = 0$. In general, the probability that a firm will be taxable in period one is

$$(6) \qquad \pi_T^1 = q_{LT}^1 + q_{TT}^1 = (q_{LL}^0 p_{LLT} + q_{TL}^0 p_{TLT}) + (q_{TT}^0 p_{TTT} + q_{LT}^0 p_{LTT}).$$

The second part of the equation shows how the year-one probabilities can be built up recursively from the starting conditions, the $q_{ij}^0$, and the transition probabilities that were discussed in the last section. Similar calculations permit us to derive the probabilities of finding the firm in other tax states in period one.

The probability that the firm will carry its taxes from the investment year forward exactly one period is $\pi_{LT}^0 = q_{TL}^0 p_{TLT} + q_{LL}^0 p_{LLT}$. Parallel calculations show that the unconditional probability of carrying taxes forward for two years or more is $\pi_{LL}^0 = q_{TL}^0 p_{TLL} + q_{LL}^0 p_{LLL}$, and the probability of carrying a loss forward for exactly two years is $\pi_{LLT}^0 = p_{LLT}\pi_{LL}^0$. Probabilities corresponding to longer carryforwards can also be calculated recursively.

While these calculations have considered the distribution of tax accruals from period zero, it is straightforward to apply this approach to compute the distribution of tax payments corresponding to accruals later in the project's life. The initial conditions are just the $\{q_{ij}^t\}$ corresponding to the firm's probabilities of being in each tax state at the beginning of period $t$. These can be calculated recursively from the

$\{q_{ij}^0\}$ and the transition probabilities as in equation (6). As we iterate forward, however, the firm's tax status in year zero becomes less important as a predictor of its period $t$ status, and the $\pi$ vector converges to a steady-state value. In practice, we truncate our calculated $\pi$ vector after twenty elements and let the twenty-first element capture all of the remaining probability.[15]

We incorporate loss carryforwards by assuming that all deferred tax payments may be carried forward $N$ years, where $N$ is the statutory maximum for carrying losses forward.[16] Incorporating carrybacks is more complicated, since the opportunity to carry losses back has the effect of making every tax payment potentially valuable in facilitating the accelerated deduction of future tax losses. This imparts a shadow value to tax payments; we calculate this shadow value in two stages. First, we compute a distribution of expected tax payments under the assumption that there are no carrybacks. Then, we account for carrybacks by reducing each dollar of estimated tax payments by a shadow value which depends upon the firm's current tax status and the estimated transition probabilities. The calculation of the carryback shadow value is described in greater detail in the Appendix.

### 10.3.3 Qualifications

All of the analysis in this section presumes that the effective tax rates which apply to a firm's investment choices are a function of its own tax status. This need not be the case. Leasing arrangements are one example of a channel through which the effective tax rates of the firms using and owning an asset can be separated. These institutions have been particularly popular in some of the industries with a significant incidence of tax losses, such as airlines. It is important to realize, however, that although leasing can reduce the present value of tax payments for a constrained firm, its impact on the firm's incentive to invest in new capital is less clear. A firm that has a loss carryforward would be better off if it could utilize this tax benefit right away, since the tax benefit loses value over time and may expire. Given that the firm cannot use this tax benefit, however, it may be encouraged to invest more, since additional taxable income generated by new investment will enable it to offset part of the loss carryforward.

A second limitation inherent to our analysis is its exclusive focus on tax policies. For some of the large firms that have tax-loss carryforwards, taxation is just one of the many ways in which the government and the firm interact. Examples of other policies that clearly affect the performance of the firms and the welfare of their shareholders include direct loan guarantees, regulation (especially for airlines and railroads), tariff policy, and in some cases government purchasing policy. Analyzing changes in tax rules without considering the offsetting changes which might occur in the other policy instruments is necessarily incomplete.

## 10.4 Empirical Results

This section presents numerical calculations illustrating how tax losses affect investment incentives. We consider general industrial equipment and industrial buildings, and estimate the effective tax rates associated with each under the tax regimes of 1965, 1975, and 1985. We then explore the sensitivity of these tax rates under current law to changes in both the tax code and the economic environment.

### 10.4.1 Changes in Effective Tax Rates over Time

In 1965, the corporate tax rate was .48 and the investment tax credit, which was available only on equipment, was 0.07 with no basis adjustment. The equipment class could be written off over twelve years using the double-declining balance method with an optimal switch to straight-line, while structures received the same treatment over twenty-nine years. Tax losses could be carried forward for five years and back for three.

By 1975, the ITC on equipment had been raised to 0.10 and, due to the introduction of the Asset Depreciation Range System, equipment could be written off in ten years. In addition, structures had been restricted to using the 150% declining-balance method. The corporate tax rate was still .48, and the carryforward and carryback provisions were the same as those in 1965.

Through tax changes in 1978, 1981, 1982, 1984, and 1985, equipment in 1985 received a 10% ITC with 50% basis adjustment and depreciation over five years following the pattern established by the Accelerated Cost Recovery System (ACRS). Structures could be written off over nineteen years through the use of the 175% declining-balance method with switchover to straight-line. In 1981, the carryforward period for losses was increased to fifteen years. The statutory corporate tax rate in 1985 was .46.[17]

We estimate the pattern of before-tax cash flows for each asset, assuming that the before-tax rate of return, net of depreciation, is 6% and that the asset depreciates at the rate estimated by Hulten and Wykoff (1981): 3.61% per year for buildings, 12.25% per year for equipment. We set the inflation rate at 4% throughout our calculations, and use a real discount rate of .03 to compute the shadow values of potential carrybacks.[18]

A firm's tax burden is critically dependent on the vector of probabilities describing the number of years that will elapse before its first passage into currently taxable status. Using the transition probabilities estimated for the COMPUSTAT sample in the 1968–84 period, we calculate this vector for two hypothetical firms. The first has just experienced its second consecutive year of tax losses ($q_{LL}$ = 1), while the second is "the representative firm" in the sense that it has probabilities of being in states *LL*, *LT*, *TL*, and *TT* corresponding to the steady state of the Markov process.

Table 10.7 shows the $\pi$ vectors for each of these firms. The $\pi$ vector reports the probability that each firm will experience tax-loss spells of different lengths. The low probability of switching states leads very little of the representative firm's weight to be in states *TL* or *LT*. In the steady state, 83.2% of firms are taxable in both the current and the previous year, while 12.1% of firms have had tax-loss carryforwards in both years. Alternatively, roughly 85% of all accrued tax payments

**Table 10.7 Distributions of Years until First Passage into Taxable Status**

| Number of Years Until Taxable | Firm with Loss Carryforward in Periods $t$ and $t-1$ | Representative Firm |
|---|---|---|
| Currently Taxable | 0.000 | 0.854 |
| 1 | 0.170 | 0.025 |
| 2 | 0.141 | 0.021 |
| 3 | 0.117 | 0.017 |
| 4 | 0.097 | 0.014 |
| 5 | 0.081 | 0.012 |
| 6 | 0.067 | 0.010 |
| 7 | 0.056 | 0.008 |
| 8 | 0.046 | 0.007 |
| 9 | 0.038 | 0.006 |
| 10 | 0.032 | 0.005 |
| 11 | 0.026 | 0.004 |
| 12 | 0.022 | 0.003 |
| 13 | 0.018 | 0.003 |
| 14 | 0.015 | 0.002 |
| 15 | 0.013 | 0.002 |
| 16 | 0.010 | 0.002 |
| 17 | 0.009 | 0.001 |
| 18 | 0.007 | 0.001 |
| 19 | 0.006 | 0.001 |
| 20+ | 0.029 | 0.005 |

*Note:* All calculations are based on average transition probabilities from the full-sample 1968–84 COMPUSTAT data file. The first column reports the $\pi^t$ vector for a firm that reports a tax-loss carryforward in periods $t$ and $t-1$. The second column shows the analogous $\pi^t$ vector for a firm which has the steady-state probabilities of being in each state: *TT* with 82.9% probability, *TL* and *LT* each with 2.5% probability, and *LL* with 12.1% probability. See text for further details.

will accrue to firms that can deduct them immediately.[19] Firms that are nontaxable remain nontaxable for long periods, however. A firm with tax losses in the previous two years is more likely than not to wait at least four years until paying a currently accruing tax liability.

Table 10.8 presents our effective tax-rate calculations for the years 1965, 1975, and 1985 based on the assumption that each asset is entirely equity-financed. The table shows the general trend toward reduced effective tax rates on equipment over this time period, with the ETR for a taxable firm falling from 27.5% in 1965 to −5.0% in 1985. The dramatic reductions in the ETRs for taxable firms are, however, not reflected in the ETRs for tax-loss carryforward firms, where the reduction is from 30.8% in 1965 to 15.0% in 1985. For structures, the differences between taxable firms and loss-carryforward firms are much smaller. This is of course due to the much longer lifetime of these assets, and the consequent tendency for initial differences in tax status to be damped out over the project horizon.[20]

The effect of asymmetric treatment of gains and losses on effective tax rates is ambiguous, as noted in Auerbach (1983). Having a loss

**Table 10.8 Investment Incentives Measured by Effective Tax Rates**

| | General Industrial Equipment | | |
|---|---|---|---|
| Firm Type | 1965 Law | 1975 Law | 1985 Law |
| Loss carry-forwards at $t$ and $t-1$ | 30.8 | 24.2 | 15.0 |
| Taxable at $t$ and $t-1$ | 27.5 | 9.2 | −5.0 |
| Firm facing perfect loss-offset code | 34.2 | 15.8 | 0.8 |
| | **Industrial Buildings** | | |
| Firm Type | 1965 Law | 1975 Law | 1985 Law |
| Loss carry-forwards at $t$ and $t-1$ | 42.5 | 45.0 | 39.2 |
| Taxable at $t$ and $t-1$ | 49.2 | 53.3 | 42.5 |
| Firm facing perfect loss-offset code | 56.7 | 60.8 | 48.8 |

*Note:* All calculations assume an inflation rate of .04 and a pretax return to capital of .06. For equipment, $\delta = .1225$ and for structures, $\delta = .0361$. We employ the 1968–84 transition probabilities from table 10.5.

postpones all tax liabilities, but especially the earliest ones, which may be negative. The latter effect is most important for equipment, where the currently taxable firm faces a much lower effective tax rate than the loss-carryforward firm. The impact on structures, for which immediate tax benefits are smaller, is in the opposite direction.

The results also confirm the common view that tax losses prevent firms from receiving the full incentive to invest intended by increases in accelerated depreciation and the investment tax credit over recent years. While holding inflation at 4%, the hypothetical firm under symmetric taxation had its effective tax rate on equipment reduced by 33.4 percentage points in the last two decades. The taxable firm enjoyed a similar decline of 32.5 percentage points, but the reduction was just 15.8 percentage points for the nontaxable firm. It therefore received less than half of the full statutory benefit.

Our earlier results suggesting the high concentration of tax-loss firms in a few industries also indicate that previous estimates of effective tax rates by industry may be misleading.[21] For steel, airlines, and automobiles, for example, it is essential to recognize that a substantial fraction of firms have tax-loss carryforwards and therefore face effective tax rates different from those facing taxable firms. In these industries, there are also likely to be important interfirm differences in effective tax rates due to variation in corporate histories and tax status.

Our algorithm also computes the shadow value of carrybacks and the value of a dollar of accruing tax losses for a firm that has just entered the untaxed state. For 1965 and 1975, when the carryforward period was five years, the shadow value of a carryback to a firm that had been taxable for two years was .040; for a firm that had been nontaxable in the previous year and was taxable in the current year, this value was .072. The expected present value of a dollar of currently accruing losses to a firm that had just incurred a tax-loss carryforward for the first time was .479 dollars. In 1985, with the longer period for carrying losses forward, these three parameters were respectively .026, .044, and .661.

The magnitude of the carryback shadow values suggest the limited usefulness of current carryback provisions. This is because most losses accrue to firms that experience several years of losses, and because most future losses will be recovered through the carryforward provision. Allowing firms the option of carrying losses back typically accelerates the recognition of tax benefits but does not enable the firm to claim tax benefits that would otherwise have expired unused. By contrast, the length of carryforward provision does appear to have a substantial effect on the expected value of a dollar of accruing tax losses. The longer carryforward period in 1985 both raises the value of a marginal dollar of carryforwards and lowers the value of the carrybacks, since accelerating the recovery of a tax loss is less critical with the expiration constraint relaxed.

### 10.4.2 Sensitivity of Effective Tax Rates

Our results in table 10.8 may actually underestimate the dispersion of effective tax rates facing corporations. Table 10.9 presents calculations for a number of alternative assumptions about economic conditions, corporate behavior, and tax policy. The second row of each panel shows the effect of an inflation shock that raises the inflation rate from .04 to .10. This causes a large jump in all of the calculated effective tax rates, the largest for taxable firms investing in equipment. The effective tax rate rises by more in each case for currently taxable than for nontaxable firms. This is because loss-carryforward firms are

**Table 10.9 Sensitivity of Effective Tax Rates to Alternative Assumptions** (Estimates Using Transition Probabilities from COMPUSTAT Data Sample)

| Assumption | Firm with Loss Carryforward in Periods $t$ & $t-1$ | Firm Taxable in Periods $t$ & $t-1$ | Hypothetical Firm Facing Perfect Loss-Offset |
|---|---|---|---|
| General Industrial Equipment | | | |
| Base case | 15.0 | −5.0 | 0.8 |
| Inflation = .10 | 26.7 | 9.2 | 19.2 |
| Real interest payments = .10 (pretax returns) | 5.0 | −20.0 | −15.8 |
| Unlimited carryforwards | 14.2 | −5.0 | 0.8 |
| Elimination of carrybacks | 15.8 | −5.8 | 0.8 |
| Industrial Buildings | | | |
| Base case | 39.2 | 42.5 | 48.3 |
| Inflation = .10 | 44.2 | 51.7 | 60.8 |
| Real interest payments = .10 (pretax returns) | 28.3 | 30.0 | 34.2 |
| Unlimited carryforwards | 39.2 | 42.5 | 48.3 |
| Elimination of carrybacks | 40.8 | 43.3 | 48.3 |

*Note:* The baseline case corresponds to the 1985 law in table 10.8. Maintained assumptions are the same as those in table 10.8.

already receiving their depreciation allowances at later dates than currently taxable firms. This reduces the contribution of the depreciation allowances to the project's present value, and hence lowers the sensitivity of the effective tax rate to inflation shocks, which further erode the value of these allowances.

The third row of each panel shows the effective corporate tax rate, net of interest deductions, when investments support real interest payments equal to a historically typical 10% of before-tax investment returns. With the addition of interest deductions, the value of being taxable increases, particularly as inflation rises. The use of partial debt-finance lowers the expected corporate tax bill, although its effect on total corporate and individual tax payments is probably smaller given the individual tax advantage to holding equity. It is of greatest benefit for taxable firms. The effective tax rate reductions for equipment and structures are 15.0 and 12.5 percentage points for the firm with no losses in the last two years, compared to 10.0 and 10.9 points for the firm with two consecutive loss years and 16.6 and 14.1 points for the firm facing perfect loss-offsets. Overall, the addition of this moderate level of interest expense amplifies the advantage of being taxable. The effective tax rates on structures are very close, while taxable firms enjoy a substantial advantage in equipment. If interest deductions are taken into account, being nontaxable probably discourages marginal investment and induces a shift away from equipment investment.

The last two sets of calculations in table 10.9 consider the impact of altering the tax provisions regarding the loss carryforwards themselves. The first set estimates the effect of permitting unlimited carryforwards, while the second examines the impact of eliminating the ability to carry losses back. Our earlier calculations suggested that increasing the time limit on the use of tax losses from five to fifteen years in 1981 substantially increased the expected present value of a dollar of loss carryforwards. Extending the limit beyond fifteen years appears to be less important. For taxable firms, the effective tax rates on both equipment and structures are only changed in the second decimal place, and for equipment there is a small (0.8 percentage point) change in the effective tax rate for nontaxable firms as a result of allowing unlimited carryforwards. Similarly, disallowing carrybacks has a relatively small impact. The largest change in an effective tax rate is for structures, where the ETR on a nontaxable firm rises 1.6 percentage points and that for a taxable firm increases 1.2 points. Both types of firms experience smaller effects on the effective tax rate for equipment. Structures are more affected because the chance of a firm having an opportunity to use a loss-carryback provision is substantially greater due to the asset's longer life.

The pattern of ETR changes associated with carryback and carryforward reforms underscores the interaction between these provisions. Eliminating carrybacks raises the effective tax rate on all assets except equipment investment by taxable firms, where the ETR declines. Equipment investments initially had a negative effective tax rate, and the ETR becomes more negative. All of the other asset/firm status combinations had positive ETRs, and they become more positive. This is because eliminating carrybacks raises the shadow cost of tax payments and lowers the shadow value of tax benefits. When carrybacks are permitted, the firm's shadow cost of a tax payment is less than the actual payment because it may be used to carry back future losses. Eliminating carrybacks removes this option, and thereby raises the present value of the tax payments for all assets with initial positive tax rates. Since tax payments are now more costly, those assets with mostly positive tax payments are reduced in value. By comparison, the value of those assets with net tax benefits (i.e., equipment purchased by a currently taxable firm) increases, because the shadow value of receiving a tax deduction has also increased. This reduces still further the negative effective tax rates.

Allowing for unlimited carryforwards has no noticeable effect on any effective tax rate except that for nontaxable firms investing in equipment, where the effective tax rate rises. This occurs even though the firm carrying losses forward will be better off with an extension of the time limit, because positive marginal tax payments that otherwise might have been entirely avoided may now have to be made.

The results in this section have all been derived using the average transition probabilities estimated over the 1968–84 period. These suffer from several drawbacks, as suggested in the second section. Table 10.10 reports the baseline current-law effective tax rate and sensitivity calculations using the second-order transition probabilities estimated for the 1981–84 period. The results are strikingly similar to those in table 10.9, with the one significant exception being the effective tax rate on structures for firms with tax-loss carryforwards. Using the full-sample probabilities, this effective tax rate was 39.2%. In table 10.10, it is only 24.2%. The difference arises because, using the post-1981 transition probabilities, a firm with two years of loss carryforwards has a greater chance (.913) of remaining in the untaxed state than under the full-sample probabilities (.830). This increases the persistence of tax-loss carryforwards and raises the probability that a loss firm will defer the tax payments on the structure's earnings, as well as the (less important) depreciation allowances. This deferral reduces the effective tax rate.

There are other minor differences between the results in tables 10.9 and 10.10. When the post-1981 probabilities are used, the equipment

**Table 10.10** **Sensitivity of Effective Tax Rates to Alternative Assumptions** (Estimates Using Transition Probabilities from 1981–1984 Annual Report Data)

| Assumption | Firm with Loss Carryforward in Periods $t$ & $t-1$ | Firm Taxable in Periods $t$ & $t-1$ | Hypothetical Firm Facing Perfect Loss Offset |
|---|---|---|---|
| | General Industrial Equipment | | |
| Base case | 8.3 | −6.7 | 0.8 |
| Inflation = .10 | 12.5 | 8.3 | 19.2 |
| Real-interest payments = .10 (pretax returns) | 3.3 | −20.8 | −15.8 |
| Unlimited carryforwards | 7.5 | −6.7 | 0.8 |
| Elimination of carrybacks | 10.8 | −8.3 | 0.8 |
| | Industrial Buildings | | |
| Base case | 24.2 | 40.0 | 48.3 |
| Inflation = .10 | 25.0 | 50.0 | 60.8 |
| Real-interest payments = .10 (pretax returns) | 18.3 | 28.3 | 34.2 |
| Unlimited carryforwards | 25.0 | 40.0 | 48.3 |
| Elimination of carrybacks | 30.0 | 40.0 | 48.3 |

*Note:* Maintained assumptions are the same as those in table 10.9 except that we use the transition probabilities from table 10.4 rather than those from table 10.5.

ETR for a firm with tax-loss carryforwards is 8.3%, compared with 15.0% if the full-sample probabilities describe the transition matrix. The loss-carryforward firms are also much less sensitive to the inflation rate under the post-1981 probabilities, primarily because the chance that these firms will ever return to taxable status is lower, and so the present value of the tax allowances, the part of the calculation which is sensitive to the inflation rate, is much reduced.

## 10.5 Conclusions

This paper has explored the recent incidence of tax-loss carryforwards amongst nonfinancial corporations. Fifteen percent of all firms report loss carryforwards. There are, however, some industries in which losses are being carried forward by a significant fraction of firms, and where current loss-offset restrictions significantly affect corporate tax incentives.

A firm's tax status is a key determinant of its investment incentives. For firms with tax-loss carryforwards, effective tax rates on plant and equipment may be significantly different from those for taxable firms that are able to utilize tax deductions as they accrue. For equipment investments under 1985 law, taxable firms face lower effective tax rates than do firms with loss carryforwards. The opposite is true for structures. These findings, coupled with the concentration of losses in some industries, suggest that previous attempts to estimate interindustry differences in effective tax rates neglect an important source of tax-rate variation. The differences between firms in the same industry, depending on their current tax status, may be even more substantial.

Our calculations may understate the economic importance of tax-loss carryforwards for several reasons. First, as we emphasize in the text, aggregate evidence suggests that tax losses are substantially more prevalent than our estimates imply. Second, we have modeled the incentive effects assuming that all firms face the economy-wide probabilities of transiting between taxable and nontaxable states. If some firms have precise knowledge about the pattern of tax liabilities they are likely to face, this may induce much larger swings in their investment and financial behavior as they take advantage of intertemporal changes in marginal tax rates. Third, our calculations of the incidence of loss carryforwards may not reflect the steady state to which the economy will move if the post-1981 depreciation schedule had remained in effect. Since the presence of highly accelerated depreciation allowances increases the chance that firms will generate tax losses, there could have been long-term shifts in the fractions of taxable and nontaxable firms.

Data limitations preclude us from considering firms with tax-credit carryforwards. Although many of the loss-carryforward firms in our sample also report either investment or foreign tax-credit carryforwards, there may also be substantial numbers of firms with credit carryforwards but no loss carryforwards. For these firms, the marginal tax rate on additional income may be substantially different from the statutory marginal tax rate. By omitting them, we understate the importance of firms whose marginal tax rates deviate from statutory values. Altshuler and Auerbach (1987) present a more complex model which addresses this issue.

Our effective tax rate calculations embody a number of strong assumptions about the stochastic process determining the tax status of firms. In particular, we maintain the fiction that firms face identical, time-invariant, exogenous probabilities of moving into and out of periods during which tax losses are carried forward. Each of these assumptions is unrealistic and could usefully be relaxed in future work. Perhaps the most intriguing direction for future work concerns the endogeneity of a firm's tax status. There are a wide range of corporate actions that affect marginal tax rates, ranging from the traditional investment and financing choices (see Cooper and Franks [1983] and Auerbach [1986]) to less frequently analyzed accounting choices (see Watts and Zimmerman [1986]). We know relatively little about what firms do in both the real and the financial domains in order to alter their tax status. The potential response of these corporate decisions are fundamental for analyzing the incentive effects of the corporate tax.

The substantial differences across firms in expected future tax-status may provide a useful source of variation that can be used to study how taxes affect financing and investment decisions. If the magnitude of debt tax shields are an important influence on the capital structure of firms, as in DeAngelo and Masulis (1980), then we should observe different borrowing policies from firms with substantial tax-loss carryforwards and those that have large accumulated potential carrybacks and are currently taxable. Firms of the latter kind have a larger tax incentive for borrowing than do those of the former, and this may yield testable predictions of how taxes affect financing choices.

Finally, we can speculate about how the Tax Reform Act of 1986 (passed after the first version of this paper was completed) will affect the incidence and impact of tax losses. The new law changes several provisions affecting firms with tax losses. First, it scales back investment incentives and thereby lowers the chance that high-growth firms undertaking substantial investment programs will experience tax losses. At the same time, firms with tax loss carryforwards will face smaller disincentives to invest in machinery and equipment (relative to structures) because equipment investments will no longer yield substantial amounts of negative taxable income in their early years. These effects imply that inter-firm differentials in investment incentives, as well as inter-asset differentials for firms with losses, are reduced by the new law. These contributions to "levelling the playing field" were not usually recognized in discussions of the new bill.

A final provision in the new law affects the extent to which firms can utilize tax loss carryforwards through merger. Prior to the 1986 Act, tax loss carryforwards from a target firm could, provided certain conditions were met, be utilized immediately. The new law reduces the rate at which the stock of loss carryforwards from the target can be applied to reduce the tax liability of the acquirer: no more than 7% of the transferred stock of losses can be utilized in any year. There are also new restrictions on the preservation of NOL carryforwards when a company is reorganized in a bankruptcy. Although our analysis has not discussed any of these provisions in detail, they all have a common effect in making tax losses less valuable for firms that have them. The new legislation restricts the alternatives available for a firm trying to utilize a stock of losses. It will increase the incentives to undertake investments that will yield taxable cash flows.

# Appendix

## *Computing the Shadow Value of Tax Payments with Carrybacks*

This appendix describes our procedure for calculating the shadow value of tax payments, a value that arises from their possible future use in permitting loss carrybacks. A dollar of tax payments is valuable because, according to current law, it may be used to offset a tax loss occurring in the following three years. However, its value is less than the present value of such deductions because there is some probability that the loss that is made deductible in the next three years would have been offset through carryforwards at some future date. Tax losses forgone in future periods also have a shadow value because the associated increase in taxable income will in turn lead to the possibility of eventual carryback.

To compute the value of the carryback option, consider a taxable firm and define $v_{TT}$ as the expected carryback value of a one-dollar tax payment made in the second of a pair of adjacent taxable years. Define $v_{LT}$ in parallel fashion. Let $\omega_{TL}$ denote the present value of the future deductions forgone when a loss is realized; it is also the present value of the tax payments which result from a one-dollar increase in taxable income for a firm that was taxable in the previous year but is currently not taxable. This follows from the fact that a carryback is used as soon as possible, which means the first year in which there is insufficient taxable income. The value of $v_{TT}$ is given by:

$$\text{(A.1)} \quad \begin{aligned} v_{TT} &= [\beta p_{TTL} + \beta^2 p_{TTT} p_{TTL} + \beta^3 p^2{}_{TTT} p_{TTL}](1 - \omega_{TL}) \\ &= \beta p_{TTL}[1 + \beta p_{TTT} + \beta^2 p^2{}_{TTT}](1 - \omega_{TL}) \end{aligned}$$

where $\beta = (1 - i)/(1 + r)$ denotes the discount factor applied when shifting a tax payment one year into the future. Equation (A.1) denotes the expected present value of the carrybacks associated with a one-dollar tax payment. By the same logic, we can define

$$\text{(A.2)} \quad \nu_{LT} = [\beta p_{LTL} + \beta^2 p_{LTT} p_{TTL} + \beta^3 p_{LTT} p_{TTT} p_{TTL}]\,(1 - \omega_{TL})$$

for currently taxable firms that were not taxable last year. Each of these expressions depends upon $\omega_{TL}$, which is in turn given by

$$\text{(A.3)} \quad \omega_{TL} = p_{TLT}\beta(1 - \nu_{LT}) + p_{TLL}p_{LLT}\beta^2(1 - \nu_{LT}) + \ldots + p_{TLL}p_{LLL}^{N-2}p_{LLT}\beta^N\,(1 - \nu_{LT})$$

where $N$ is the maximum number of periods for which a loss may be carried forward. Solving these three equations for $\nu_{TT}$, $\nu_{LT}$, and $\omega_{TL}$ yields:

$$\text{(A.4)} \quad \nu_{TT} = [\alpha_{TT}(1 - \alpha_{TL})]/(1 - \alpha_{LT}\alpha_{TL})$$

$$\text{(A.5)} \quad \nu_{LT} = [\alpha_{LT}(1 - \alpha_{TL})]/(1 - \alpha_{LT}\alpha_{TL})$$

$$\text{(A.6)} \quad \omega_{TL} = [\alpha_{TL}(1 - \alpha_{LT})]/(1 - \alpha_{LT}\alpha_{TL}).$$

2

where $\alpha_{TT} = \beta p_{TTL}[1 + \beta p_{TTT} + \beta p_{TTT}]$, $\alpha_{LT} = \beta p_{LTL} + \beta^2 p_{LTT} p_{TTL} + \beta^3 p_{LTT} p_{TTT} p_{TTL}$, and $\alpha_{TL} = (1 - \nu_{LT})[\beta p_{TLT} + \beta^2 p_{TLL} p_{LLT} + \ldots + \beta^N p_{TLL} p_{LLT} p_{LLL}^{N-2}]$.

These shadow values are used in calculating the expected present value of tax liabilities. To account for firms' ability to carry losses back, we multiply each of the expected tax payments generated by the no-carryback analysis by either $(1 - \nu_{TT})$ or $(1 - \nu_{LT})$, depending on the firm's tax status. When a firm accrues a tax liability with a distribution of expected payments across many periods, the concurrent value of $q_{TT}$ determines the fraction of the expected tax payment that will be paid immediately in a state following a taxable year. This amount is multiplied by $(1 - \nu_{TT})$. All of the remaining components associated with this accrued liability are multiplied by $(1 - \nu_{LT})$, since they occur in states where the firm will have just reentered taxable status. In the notation of section 10.3 this implies

$$\text{(A.7)} \quad \nu_{ts} = \begin{cases} \nu_{LT} & s > t \\ (q^t_{TT}\nu_{TT} + q^t_{LT}\nu_{LT})/(q^t_{TT} + q^t_{LT}) & s = t. \end{cases}$$

This can be substituted into equation (5) to evaluate the internal rate of return, $r$, and then the effective tax rate.

# Notes

1. Cordes and Sheffrin (1983) calculate marginal tax rates using corporate tax-return data but they assume that firms cannot carry back either losses or

credits. This biases their findings toward the result that many firms face tax rates below the statutory maximum.

2. For an excellent summary of the recent debate surrounding average tax rates on large corporations, see the series of essays in *Tax Notes* 9 December 1985. The claim that sizable numbers of large corporations pay no tax is from McIntyre and Folen (1984) and McIntyre and Wilhelm (1986). Their calculations are based on the ratio of current tax payments to earnings, which bears little necessary relation to the firm's marginal tax status.

3. The extent to which firms can claim investment tax credits, foreign tax credits, R and D credits, and a number of other credits depends upon their taxable income. The ITC, for example, is limited to \$25,000 + .90*max [0,Tax − 25,000]. Additional taxable earnings for a firm bound by this constraint would raise tax liability by only $.10^{*}\tau$, where $\tau$ is the statutory tax rate.

4. Cordes and Sheffrin (1983) were affiliated with the Office of Tax Analysis when they used the Treasury Corporate Tax Model to calculate the distribution of corporate marginal tax rates.

5. We also tried to find examples of loss-carryforward firms that did not appear in the COMPUSTAT sample. For example, we examined the 50 firms with the smallest current tax payments in McIntyre and Folen (1984) and found no cases of firms with loss carryforwards that were not in our sample.

6. Stickney, Weil, and Wolfson (1983) provide a detailed analysis of the accounting by one firm, General Electric, for its financial subsidiary.

7. It is difficult to gauge the importance of omitting the financial subsidiaries of some firms. We studied the published financial statements of several large financial subsidiaries, those of General Motors, Chrysler, General Electric, Ford, and Westinghouse, and in no case did we find evidence of tax-loss carryforwards in the subsidiary; this suggests that the biases from annual reports which exclude these subsidiaries may not be too severe.

8. Although in principle we could model firm heterogeneity and estimate separate transition probabilities for firms with similar characteristics, the sparseness of some off-diagonal cells in our transition matrices suggests that it would be difficult to obtain precise estimates. For example, there are only 14 firms which make the taxable-loss carryforward-taxable transition in 1983–84, and only 20 firms in the loss carryforward-taxable-taxable cell. Another possibility is using a mover-stayer model to describe the data, allowing some firms to be "stayers" in the taxable state. This might be explored in future work.

9. The steady-state probabilities are defined as follows: $q_{LL} = q_{LT}(1 - p_{TLT})/p_{LLT}$, $q_{LT} = q_{TL} = 1/[2 + p_{LTT}/(1 - p_{TTT}) + (1 - p_{TLT})/p_{LLT}]$, and $q_{TT} = q_{TL}p_{LTT}/(1 - p_{TTT})$.

10. The transition probabilities in this table are not directly comparable to those in table 10.5 for two reasons. First, in looking at COMPUSTAT data over a period of many years, we confront the problem of missing values for the tax-loss variables. We assume (very conservatively) that all missing values correspond to taxable years; this substantially overstates the chance of escaping from the tax-loss state. Second, the sample selection problem alluded to in the text with respect to firms which merged or went bankrupt is likely to be much more important in this analysis of transitions over a long time-period than in our previous tabulations, which spanned only four years. The net effect of this bias is unclear.

11. An asset need not have a negative total tax liability for this to occur. Consider a project with negative taxable earnings in its early years, followed

by significant taxable income later in its life. Even if the project's tax payments have a positive net present value, the cost of forgoing tax benefits in the near term may exceed the gain from postponing tax liabilities later in the project.

12. Previous work treating this endogeneity has considered only very simple models; see, for example, Auerbach (1986).

13. The notation $L^s$ refers to $s$ consecutive years of tax-loss carryforwards.

14. By focusing on expected returns, we are implicitly assuming that tax-status risk is entirely nonsystematic. In practice, most firms are more likely to experience tax-loss carryforwards during recessions; this imparts a potentially important systematic component to these tax streams.

15. We also truncate project returns and accrued tax liabilities after forty years. The results are insensitive to these truncations.

16. This overstates the effect of carryforward provisions. When a nontaxable firm incurs a tax liability, there are two possibilities concerning its current income: it may be negative, adding to previous losses, or it may be positive but completely offset by previous losses. In the former case, the additional tax liability (if negative) will add new losses to be carried forward. If the additional tax liability is positive, it will reduce the new losses carried forward. In either case, the tax liability will have a limit of fifteen years during which it can be realized. After that time, the marginal impact on the stock of loss carryforwards disappears. In the case where the firm is currently offsetting some of its previous tax losses, however, the situation is more complicated, since the marginal impact of the accrued tax liabilities will be to increase or decrease the working off of old loss carryforwards. The marginal contribution of a new gain or loss to the tax losses carried forward therefore has fewer than $N$ years to expiration.

17. An additional restriction which has been changed over the years governs the extent to which firms can use investment tax credits to offset taxable income before credits. To model this provision, we would have to modify our analysis to include an intermediate state between taxable and nontaxable, in which a firm pays taxes but has tax credits carried forward. Unfortunately, because our data limitations prevent us from estimating transition probabilities with respect to this state, we must omit it.

18. Ideally, the rate used to discount the components in the carryback shadow price would be the after-tax rate of return for the project. However, this would have required an iteration procedure which seemed inappropriate given the parameter's minor role.

19. This fraction undoubtedly overstates the share of taxable firms in the population as a whole, since we generate smaller estimates of aggregate tax losses than the IRS tabulations suggest.

20. We assume that when structures are purchased they are depreciated only once. Gordon, Hines, and Summers (1987) conclude that "churning" is not profitable for corporations, although it may be attractive to partnerships. We also ignore asset-related differences in leverage capacity. If structures can carry more debt than equipment, as is commonly supposed, then loss-carryforward firms may face greater disincentives to purchasing structures than we have reported.

21. For examples of previous calculations of industry-specific ETRs, see Auerbach (1983), Fullerton (1985), or Fullerton and Henderson (1984).

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## Comment David F. Bradford

Economists have often noted the consequences for incentives to invest that follow from the nonrefundability of the corporation income tax. As we usually model it, a firm that shows a current loss on its tax books is unable to take advantage of the deduction of depreciation allowances (or of other deductions, such as interest payments, for that matter)—a disincentive to invest. On the other hand, for a firm that expects to have a tax-loss position in the future, the positive payoff from an incremental project undertaken in the present may be reaped free of tax, giving an extra boost to investment incentives. Examples can readily be constructed of large variation in incentives according to the tax-loss position of the firm.

It is another matter to determine the practical importance of these variations, the project undertaken here by Auerbach and Poterba. As the authors convincingly explain, the task is more daunting than one might have expected. This is partly because data on the occurrence of tax-loss carryforwards are buried in tax returns that are not accessible to the public. It is also because the tax law is complex, as are the options available to the firm to deal with the situation. I shall comment on the approaches Auerbach and Poterba took to both the observational and the analytical difficulties.

A loss in a given year, understood as a negative amount of income calculated according to the usual tax rules, can be carried back and applied against positive levels of the tax base ("income") in the previous three years. For these cases, the tax is, in effect, refundable. To be unable to use currently negative taxable income to save on current taxes, the firm must be in a "tax-loss carryforward" position. In this situation, the firm cannot take an immediate deduction against taxable income but may carry the loss forward to apply it against profits any time in the next fifteen years. The divergence here from refundability derives in part from the possibility that there will be insufficient positive income during the next fifteen years and in part from the time value of money: saving a dollar of taxes in the future is worth less than saving a dollar now.

The major empirical undertaking in this paper is to analyze the experience of actual firms. Since tax-return data, other than on a highly aggregated basis, are not available, the authors have applied their ingenuity to uncovering substitutes. Firms do report some information

David F. Bradford is the associate dean of the Woodrow Wilson School and professor of Economics and Public Affairs at Princeton University, and a research associate of the National Bureau of Economic Research.

about their tax situations in annual reports and 10-K filings with the SEC. Unfortunately, the most readily available collected set of data from corporate accounts, the COMPUSTAT data base, reports tax-loss carryforwards on a different basis than do tax accounts. Actual annual reports and/or 10-K statements include data that come closer than do those reported on the COMPUSTAT tape to providing tax-loss carryforwards according to tax accounting conventions, but the figures must be collected from each firm for each year individually. The authors have therefore organized an army of research assistants to collect figures from these decentralized sources. These data are used both on their own, for the evidence they provide about the significance of tax-loss carryforward status, and as the basis for assessing the reasonableness of results obtained by using COMPUSTAT data as though they were true tax data.

Auerbach and Poterba's principal empirical finding is that loss-carryforward status is rather persistent. Transition probabilities estimated on the basis of individually collected data for 1983 and 1984 suggest that a firm with no loss carryforward in a year has a probability of 97.4% of being in the same position the next year and a firm with a loss carryforward has a probability of 91.3% of carrying a loss forward again in the next year. The second-order transition data indicate that the probability that a firm that has had two "good" years (i.e., has avoided tax-loss carryforward status for two successive years, years that could have had negative taxable income before loss carryback) will at least not have such a bad next year as to drop into tax-loss carryforward status is 97.7%; a firm with two past bad years will have another one (i.e., insufficient positive profit to soak up past loss carryforwards) with a probability of 91.7%. (All these figures are from table 10.4.)

Two problems should be noted about the data supporting Auerbach-Poterba's empirical findings. They may in part explain the finding that the aggregate of loss carryforwards in the authors' sample is substantially below aggregate estimates based on IRS data. One problem they point out themselves: there are divergences between the particular way divisions of firms are consolidated for tax and annual report purposes. They do not attempt to assess the importance of the resulting bias. I do not know how the accounts are kept. It seems implausible that the unit chosen for financial reporting purposes calculates a hypothetical taxable income; rather the tax status of the actual component firms (reflecting the consolidation chosen for tax purposes) is presumably allocated somehow to the financial reporting unit. If so, there may be no bias in the Auerbach-Poterba transition estimates, which are based on equity value weights. If the financial reporting unit does calculate a hypothetical tax position, the use of financial accounts would bias the transition probabilities in the direction of increasing the apparent importance of tax-loss carryforward status, since it will generally be in the interest of firms to choose an aggregation for tax purposes that eliminates carryforwards, whereas carryforwards are of little importance for financial reporting.

A second, and I should think more serious, source of bias in the other direction was pointed out to me by Roger Gordon and has to do with the selection of firms for inclusion in the COMPUSTAT data set. Firms in the COMPUSTAT file have to have survived to the date of observation. Presumably, firms with tax losses are likely candidates for merger with profitable firms, and if it is the profitable firm that carries on there is a potential bias in the data against the appearance of tax-loss carryforwards. Furthermore, because the firms chosen by Auerbach-Poterba for closer examination were those showing tax-loss carryforwards on the COMPUSTAT tape, any such bias would carry over as well to the data they gathered from direct inspection of company reports. This may lead to misstatement of the persistence of loss carryforwards.

To put the empirical findings to use in assessing the effect of the carryforward rules on investment incentives, Auerbach-Poterba make the extreme assumption that carryforward status is an exogenous stochastic event, generated by a second-order Markov process. That means all one needs to know to determine the probability distribution of future carryforward status is the status in the two immediately preceding periods. Even with this rather strong simplification, accounting for the contingent quality of carrying losses backward and forward makes simulating the cash flow consequences at the company level for an equity-financed investment difficult. I find the details of Auerbach-Poterba simulation technique hard to follow, but I believe it can be described as calculating the after-tax consequences of undertaking a typical investment in equipment or structures for each of the possible evolutions of a company's tax-carryforward status, weighting these together by the probabilities generated by the second-order Markov process (as a function of initial conditions) to produce the expected cash flow from each of the two investments. In each case the assumed before-tax rate of return is 6% real, and the "expected effective tax rate" is the difference between 6% and the internal rate of return on the company's expected cash flow.

To me the most interesting "bottom line" results are to be found in table 10.8, which shows the expected effective tax rates under tax laws in effect in 1965, 1975, and 1985 for firms starting from a position of two successive taxable years, two successive loss-carryover years, and for firms that are always taxable (and for which there is therefore a perfect loss offset). The effective tax rates for the first two classes reflect the balance between the disadvantages of reduced value of deductions and increased value of otherwise taxable receipts in loss-carryforward years. Owing to the latter effect, the expected effective tax rates of firms in either initial condition may be lower than those of firms with perfect loss offset, and in every case the currently taxable firm derives an increase in investment incentive from the greater weight on the probability of future receipts that are nontaxable than on deductions that cannot be currently used.

Timing is important to these results and it may be asked whether they give a sufficiently rich picture of the effect of the carryforward provisions. The investment opportunities considered consist simply of current purchase of either equipment or structures (defined by different exponential depreciation rates and by different tax treatments). However, there are other possibilities. For example, if a program of regular annual investment of a dollar per year were substituted for a simple current investment of a dollar in the analysis, the law with immediate loss offset would presumably generate a lower effective tax rate in every case. Another important class of investment possibilities consists of alternative starting dates for projects, especially postponement of investment activity, that might be considered. The incentive effects of the tax-loss carryforward provisions on these choices may be much stronger than those on the simple choice between currently investing or not. There are also many other ways than by adjusting real investment activity that a firm might react to the prospect of being in a tax-loss carryforward position in the future; restructuring financial arrangements (such as by taking more advantage of leasing) and even ownership arrangements (merging with a profitable firm) are examples.

In short, there remains much that might be done to build on the excellent foundation work, both empirical and analytical, that Auerbach and Poterba have accomplished.