9 IMPACT OF THE CORPORATE ALTERNATIVE MINIMUM TAX: A MONTE CARLO SIMULATION STUDY

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I. INTRODUCTION

The corporate attributes that tend to increase a firm's exposure to the minimum tax have been identified by Harter (1986). Although Harter's analysis was based on the House version of the minimum tax, his observation remains valid that a firm with a low marginal profitability and a high rate of growth in depreciable assets is more likely to be on the minimum tax. Similar results were noted by Lucke, Eisenach, and Dildine (1986). Based on a multiyear simulation study of several hypothetical representative firms, they found that the chances of being subject to the AMT depends on the nature of the mix of assets held by the firm, and are greatest in the first several years after the imposition of the tax.

Because of the assumed constancy of the parameters in their model, whatever minimum tax exposure their representative firms faced was immediate, relatively short in duration, and gave rise to an AMT credit which was rapidly utilized once the firm went off the minimum tax. In most of the cases they examined the net impact of the minimum tax on corporate tax liabilities was found to be relatively modest. Their results (which reflect the Senate version of the minimum tax) indicate that although a number of factors (a high concentration of depreciable assets, a high degree of financial leverage, rapid growth, etc.) can increase a firm's exposure to the AMT, the ability to credit the excess AMT payments significantly reduces the burden of this tax. In short, their study appears to suggest that the impact of the AMT is largely a transient one, and for many firms (especially the more established ones), is relatively unimportant. However, once both positive and negative annual fluctuations in income are considered, firms may be more frequently subject to the AMT, although the duration of their exposure may be shorter.

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In addition to their neglect of stochastic economic fluctuations, neither of these prior studies considered the possible response of the firm to the imposition of the AMT. Because a firm's exposure to the AMT is rather sensitive to its investment and financing decisions, the results obtained may thus be somewhat misleading. Indeed, the entire pattern of the firm's investment and financial decisions may have to be specified before the impact of the AMT can be fully determined. The most relevant pattern to consider would be that which maximizes the value of the firm. A significant part of this study thus examines how the optimal levels of investment and leverage vary as a function of changes in tax policy under uniform (non-stochastic) and stochastic economic conditions. These results, which are of interest in their own right, will then be used to examine the adequacy of the Office of Tax Analysis' (OTA's) AMT revenue estimates.

II. THE CORPORATE ALTERNATIVE MINIMUM TAX

A. The Nature of the Tax

The Tax Reform Act of 1986 introduced a new corporate alternative minimum tax (AMT).[1] The AMT is essentially a parallel system of corporate taxation, with its own depreciation and other tax accounting methods. Because the AMT liability is calculated as if the corporation had been subject to the AMT in all post-1986 years, even a corporation that only infrequently is subject to the AMT must routinely keep track of the adjusted basis of its depreciable assets, its stock of unused net operating losses, and all other tax attributes under both systems of taxation.

If a corporation's "tentative" minimum tax (calculated after AMT net operating loss deductions and foreign tax credits) exceeds the firm's regular tax (calculated after regular net operating loss deductions and foreign tax credits), the firm is viewed as facing the AMT. In such case, the firm must pay the tentative minimum tax, reduced (but not by more than 25%) by any allowable investment tax credits. The excess of the tentative minimum tax over the regular tax (to the extent attributable to timing differences) is allowed as a tax credit (AMT credit) against future regular (but not AMT) tax liabilities.

If the regular tax exceeds the tentative minimum tax, the firm is viewed as facing the regular tax. In this case, the firm pays the regular tax, less any available general business or AMT tax credits. Such credits (with the exception of the investment tax credit) cannot reduce the tax below the tentative minimum tax; the ITC can reduce the gross tax to 75% of the tentative minimum tax.

The base of the AMT is calculated by adjusting the firm's taxable income, adding certain tax preferences, and reducing the resulting alternative minimum taxable income (AMTI) by a $40,000 exemption (which is reduced by 25% of AMTI in excess of $150,000). The various adjustments are designed to replace many of the regular tax accounting methods with AMT accounting methods. In particular, for personal assets (equipment, vehicles, etc.) acquired after 1986, AMT depreciation is calculated using a 150% declining balance method over the mid-point ADR service life, and straight line depreciation over 40 years is required for real property acquired after 1986.[2]

A "book income" tax preference, equal to one-half the excess (if any) of the firm's book income over its AMTI (calculated before consideration of the book income preference) is included for 1987-89. For post-1989 years, this book income tax preference is scheduled to be replaced with an "adjusted current earnings" tax preference. Certain other tax preferences, largely reflective of the preferences under the old "add-on" corporate minimum tax, are also included. Although the "book income" tax preference is likely to be a significant component (at least in the near term) of the disparity between AMTI and taxable income for many firms, for the purpose of this paper this preference (and all other tax preferences) are ignored.

B. Interaction With the Regular Tax

It is known that the book income reported by corporations frequently varies from one year to the next in a seemingly random manner. More precisely, percentage changes in book income of plus or minus fifty percent or more are not uncommon, and a positive gain of such magnitude by one firm in an industry can often arise in the same year that another firm in that same industry reports a comparable percentage loss. Analysis of OTA's Corporate Tax Panel indicates that similar fluctuations in taxable income also arise, although not necessarily in synchronization with the fluctuations in book income.[3]

The relationship between the corporate AMT and the regular tax suggests that the impact of the AMT might be quite sensitive to such fluctuations. Because the regular tax rate (34%) exceeds the AMT tax rate (20%), a corporation which experiences an increase in income unaccompanied by a corresponding increase in AMT adjustments or tax preferences (arising, for example, from an unanticipated increase in sales which is assumed by the firm to be temporary, and thus not accompanied by a commensurate increase in investment in depreciable assets) will tend to face the regular tax, and be able to utilize its accumulated AMT credits. Conversely, in a bad year the corporation is more likely to face the minimum tax (and thus generate additional AMT credits which may be used in future years).

This sensitivity of the AMT to changes in the firm's economic environment may create difficulties for conventional revenue estimation studies. In estimating the impact of the AMT on tax liabilities, OTA utilizes its Corporate Tax Model, which estimates the future tax liabilities of nearly 90 thousand corporations from their tax return data from a single prior base year.[4] In this estimation process, adjustments are made for an anticipated behavioral response by the firms to the changes in tax laws, and for expected economic growth between the base year and future years. However, these adjustments generally take the form of overall scaling factors, which cannot capture the impact of fluctuations in the income of individual firms.

The AMT may also create difficulties for effective tax rate studies, in which attention is focused on marginal investment. Because of the AMT, it is more likely that each year's investment and financing decisions will affect the taxation of the income generated by past and future year's investments.[5] For example, it may affect the statutory tax rate applicable to the depreciation deductions associated with prior investments. Therefore, it may no longer be appropriate to consider the incentive to invest using a constant statutory rate, as is typically assumed in measures of marginal effective tax rates. Moreover, because of the uncertain nature of a firm's future exposure to the AMT, the investment and financing behavior of firms cannot be adequately captured by a purely deterministic analysis.

C. Objectives of This Paper

This paper reports the results of several numerical experiments designed to provide some insight on the impact of the AMT, especially under fluctuating economic conditions. These experiments were performed on a corporate Monte Carlo simulation model which was developed for this purpose. In particular, they were designed to answer the following questions:

- How would the imposition of the AMT (on top of all other 1986 Tax Reform Act changes) affect a firm's investment and financing decisions?
- Does the avoidance of the minimum tax represent optimal tax planning?
- Would the AMT significantly increase average effective tax rates?
- Do extrapolations which exclude stochastic fluctuations in the earnings of individual firms significantly impair OTA's AMT revenue estimates?

While the answers are far from definitive, they present a picture of the AMT that may be somewhat at variance with conventional wisdom. The details of this picture may change as more extensive modeling of the AMT is performed, but it is not likely that fundamentally different answers will be obtained. In the next section of this paper, the corporate Monte Carlo simulation model is described. The results of this model for a non-stochastic and stochastic economy are compared in section four, where the response of the firm to the AMT is ignored. In section five the behavioral response of the firm to the AMT is examined, and its tax implications are discussed. Section six examines the importance of utilizing stochastic modeling in estimating AMT revenues over the initial five-year budget period. Finally, based on the results of the study, some answers to the above questions are provided in the last section.

III. THE MONTE CARLO SIMULATION MODEL

In order to study the impact of the AMT on the "typical" firm, a model is required of such firm which is capable of providing realistic investment and financial decision rules under a wide variety of conditions. Although the specific decision rules incorporated in the model used in this study are consistent with those noted in Hayashi's (1982, 1985) papers on the Q theory of investment, the results of the model must be viewed as merely suggestive of the more complex interactions between the financial and investment decisions of actual firms. Nevertheless, the model appears to be a useful addition to OTA's toolkit. In particular, by allowing the interaction between changes in corporate tax policy and the investment and financial decisions of hypothetical firms to be studied in a dynamic context, the model can provide helpful insights. These insights may be used to enhance the quality of the results obtained from multi-period application of OTA's empirically based, but essentially static, Corporate Tax Model.

The Monte Carlo Simulation Model is based on the following assumptions:

- The firm owns an existing stock of homogeneous real assets (and, depending upon the parameters chosen, may also be viewed as holding a corresponding stock of homogeneous financial assets). In one version of the model all of the firm's real assets are depreciable assets; in a second version, only 75% are depreciable.
- The depreciable assets have a 12 year mid-point ADR life, a 7 year modified ACRS property class, and a 10% per year rate of economic depreciation.
- The nominal pre-tax rate of return (net of depreciation) generated by the depreciable assets is taken to be a discrete random variable, R. Unless otherwise noted, the value of this variable for any firm in any period is assumed to be equally likely to be 7% (R-) or 13% (R+), and to be independent of its prior values and also independent of its value for other firms.
- The nominal pre-tax rate of return generated by the financial assets is fixed at 9%.
- The firm may also borrow funds at 9% (unless its debt to equity ratio exceeds 30%; see below). Thus, if the firm both owns a stock of financial assets and borrows funds, only the net amount of outstanding financial assets is relevant.
- If the firm's managers wish to change the annual rate of growth of the firm's real assets, G, from its assumed "natural" value of 4%, they will incur an investment adjustment cost. This cost is assumed to be proportional to the beginning of the period stock of real assets, with a proportionality factor equal to 12.5 times the square of the difference between the chosen growth rate and 4%.[6]
- The firm's managers may make an initial choice of two possible values of G (G+ and G-). Once these two values are specified, the growth rate in each future year will be either G+ or G-, depending upon whether the firm is experiencing a "good" or "bad" year. Thus, a growth rate G+ is used if the 13% rate of return has been realized, and a growth rate G- is used if the 7% rate has been realized. The initially specified

values of G+ and G- are assumed to have been chosen so as to maximize the expected value of the firm, as noted below. It is also assumed that the growth rate of the firm's real assets was 5% in all past (pre-1987) years.

- Once the firm's investment in real assets is specified, the firm's managers must address the problem of financing such investment. They utilize the following rules:
  - A "targeted" portion of the next period's stock of real assets is financed by debt (or equivalently, the stock of real assets is mixed with a targeted portion of financial assets). The balance of the investment is financed by retained earnings. As in the case of the growth rate, the firm's managers are assumed to make an initial choice of two target debt to equity ratios (B+ and B-). Each future year's target ratio of debt to equity (or financial assets to total assets) is either B+ or B-, depending upon the realized rate of return. Thus, the target ratio of B+ is used if R+ is realized, while the target ratio B- is used if R- is realized. The initial decision parameters for the firm are thus the values of G+, G-, B+, and B-.[7]
  - After the required level of retained earnings is determined, any excess cash generated during the period is remitted to the firm's shareholders as dividends. However, if there are insufficient earnings to finance the investment, the level of the debt to equity ratio is allowed to increase beyond the target values (B+ or B-), provided it remains less than a critical value, B_c, taken to be 50%.
  - If the after-tax cash flow is insufficient to keep the debt to equity ratio below 50%, the firm is assumed to acquire new equity until this critical ratio is reached. Share repurchases are ignored.[8]
- The firm faces greater interest costs if the achieved ratio of debt to equity exceeds the firm's "natural" ratio of 30%.[9] These costs are also assumed to be proportional to the beginning of the period stock of real assets, with a proportionality factor given by .25 times the square of the excess (if any) of the prior period debt to equity ratio over 30%.[10]
- The pre-1987 debt to equity ratio is taken to be 30%, so that with a $1,000 assumed initial stock of real assets, the initial equity is $769.20.
- The firm's managers seek to maximize the expected after-tax net present value of the claims of the firm's shareholders. In particular, they maximize the sum of the expected net present after-tax value of the dividend stream over a fifty year horizon and the discounted value of the firm's net equity at the end of that period. A derivation of this objective function is presented in the Appendix.

° In evaluating these discounted present values, the discount rate used by the marginal investor is assumed to be 8%.

Some general comments on the limitations of this model of the firm may be in order. First, like most models, it is rather mechanical, and thus tends to exaggerate certain behavioral features. For example, for reasons that are not well understood, firms sometimes raise equity capital while paying dividends; such behavior is not possible in this model. Second, it treats dividends as a "residual", and thus dividend payouts fluctuate with earnings. In fact, perhaps as a signaling device, dividends are generally observed to be relatively stable over time, whereas the levels of external financing are more uneven than suggested by the model. Third, the pre-tax rates of return and the investor's discount rate are assumed invariant to a change in tax policy. This assumption may be reasonable in the short term, but is not likely to be valid over the much longer period (50 years) that is used in much of the analysis. Finally, the model restricts the choice of decision parameters to only the four initially chosen values G+, G-, B+, and B-, rather than allowing different growth rates and leverage factors to be chosen each period. The model likewise restricts the economic conditions facing the firm to be those characterized as being equally likely to result in a 13% or a 7% pre-tax rate of return (or, in the non-stochastic case, in a uniform 10% rate of return). Because of these simplifications, the results of the model may be expected to present a somewhat understated picture of the importance of allowing for the behavioral response of firms to a change in tax policy, and a somewhat overstated picture of the impact of the changes in tax policy and economic conditions on the financial success of the firm.

IV. RESULTS FOR NON-STOCHASTIC VERSUS STOCHASTIC CONDITIONS

In this section, the behavior of the firm under non-stochastic and stochastic economic conditions as compared. Specifically, it is first assumed that the the pre-tax rate of return on the firm's real assets is a constant 10% (the mean of the assumed equally likely stochastic returns of 7% and 13%). The results for this case are then contrasted with those for the stochastic case. In both cases, the behavioral response of the firm to the imposition of the AMT is ignored. Thus, the decision parameters are chosen to maximize the value of the firm's equity in the absence of the minimum tax.

A. The Case of an "Airline"

In the non-stochastic case, there are only two decision parameters which must initially be specified: the growth rate G+ = G-, and the target debt to equity ratio B+ = B-. Using an optimization routine incorporated in the model, it is found that a 5.54% growth rate and a 33.5% debt to equity ratio maximize the value of the equity of a firm with only depreciable real assets in the absence of the minimum tax.[11]

The optimal values of the decision parameters for this case (Case 1), and other cases to be described below, are noted in Table 9.1. For each case illustrated in this table, values of the financial variables resulting from the choice of the specified decision parameters are presented. A number of variables which reflect the presence of the minimum tax (and a corresponding set reflecting its absence) are shown. Thus, the value of the firm's equity (EQVALMT), the number of times during the 50 year period the firm faces the minimum tax (NMT), the discounted net present value of the tax payments incurred and the dividends remitted over the 50 year period in the presence of the minimum tax (TAXDMT and DIVDMT, respectively), the fraction of net AMT payments incurred which the firm is able to credit against the regular tax

Table 9.1 **Optimal Decision Parameters in the Absence of the Minimum Tax and the Resulting Financial Performance Under Non-Stochastic (R+ = R- = 10%) and Stochastic (R+ = 13%, R- = 7%) Economic Conditions**

Variable	Airline: Case 1: Non-Stochastic Conditions	Airline: Case 2: Stochastic Conditions	Nondurable Goods Manufacturer: Case 3: Non-Stochastic Conditions	Nondurable Goods Manufacturer: Case 4: Stochastic Conditions
G+ (percent)	5.54	5.59	4.88	4.95
G- (percent)	5.54	5.48	4.88	4.89
B+ (percent)	33.5	33.8	33.5	33.5
B- (percent)	33.5	33.2	33.5	33.5
EQVALMT	$816.65	$810.72	$753.18	$752.55
NMT (years)	11.00	27.76	3.00	5.53
TAXDMT	$348.94	$352.49	$416.26	$420.15
DIVDMT	$579.96	$575.15	$580.21	$576.23
CREDUMT (percent)	100.00	87.36	100.00	100.00
REV5MT	$96.00	$ 86.72	$91.44	$94.74
EQVALNOMT	$836.62	$838.33	$753.33	$755.34
TAXDNOMT	$328.47	$330.48	$416.13	$417.78
DIVDNOMT	$599.93	$601.86	$580.36	$579.02
REV5NOMT	$65.72	$65.80	$91.42	$90.22
TINV	$38.766.44	$38.733.96	$34.937.92	$25.342.89
RATEMT (percent)	16.8	17.13	22.15	22.17
RATENOMT (percent)	15.92	15.95	22.15	22.03
MTREV5	$30.28	$20.92	$ .02	$4.52
REVDMT	$20.47	$22.01	$ .13	$2.37

over the 50 year period (CREDUMT), and the total tax revenues collected from the firm during the next five years in the presence of the minimum tax (REV5MT) are noted.

In addition to these variables, which reflect the presence of the AMT, the value of the firm's equity (EQVALNOMT), the discounted present value of the taxes paid and the dividends remitted over the 50 year period (TAXDNOMT and DIVDNOMT, respectively), and the total tax revenues collected from the firm over the next five years (REV5NOMT) in the absence of the minimum tax are noted. In addition, the total gross investment by the firm during 50 year period (TINV), which depends only upon the specified growth rates, and not the presence or absence of the minimum tax, is also shown.

Four additional variables which measure the relative impact of the AMT are also presented for each case in this table. The firm's average effective tax rate in the presence and absence of the minimum tax are noted (RATEMT and RATENOMT, respectively). These represent the ratio of the discounted present value of the tax payments during the 50 year period over the corresponding discounted present value of the economic income earned. Finally, both the increased net tax revenues due to the minimum tax during the next five years (MTREV5), and the discounted net AMT revenues over the 50 year period (REVDMT), are shown.

Thus, with the growth rate and debt to equity ratio set at the optimal levels noted, the first case in Table 9.1 shows that such firm faces the minimum tax in 11 of the 50 years examined. It thus corresponds to a representive "airline" (at a zero growth rate) in the taxonomy of Lucke et al.[12] The firm fully utilizes its AMT credits generated during the 50 year period. As shown in this table, its average effective tax rate in the absence of the the minimum tax is 15.92%, and 16.88% in the presence of the minimum tax (a 6.2% increase). Over the first five years, the additional tax revenues collected due to the minimum tax are $30.28 (a 46.1% increase). However, the discounted tax revenues due to the AMT paid over the 50 year period are $20.47 (a 6.2% increase), which is less than the five year total largely because of the utilization in the later years of the AMT credits generated in the initial years. The 6.2% increase in discounted tax payments is twice as great as the 3.1% increase obtained by Lucke et al., who, however, in addition to the differences in model parameters noted in footnote 12, also assume an 11% discount rate in contrast to the 8% discount rate used here.

In order to examine the consequences of the assumed stochastic economic conditions, the model was next run such that the rate of return each year was randomly chosen in accordance with its assumed (binary) distribution. The resulting financial results were tabulated. By replicating this procedure one thousand times, a frequency distribution of the tabulated variables was obtained. The model was designed to either output each of these values into an SPSS data file for detailed statistical analysis, or to directly output the range, mean, and variance of the calculated values.

By maximizing the mean (expected) value of the firm's equity with respect to all four initial decision parameters (G+, G-, B+, B-), it was found that different pre-determined growth rates and different targeted debt to equity ratios apply in "good" years (in which the firm realizes a 13% pre-tax rate of return on its real assets) and in "bad" years (in which the firm realizes a 7% pre-tax rate of return on its real assets). In particular, for the "airline" in the absence of the minimum tax, a 5.59% growth rate and a 33.8% debt to equity ratio in "good" years and a 5.48% growth rate and a 33.2% debt to equity ratio in "bad" years are optimal, as noted for Case 2 in Table 9.1. As may be expected, the average of these two growth rates, and the average of these two debt to equity ratios, are approximately the same as the Case 1 values.

Table 9.1 shows that the mean average effective tax rate for this case is 15.95% in the absence of the minimum tax and 17.13% in its presence (a 7.4% increase). On average, the "airline" faces the minimum tax much more frequently under stochastic conditions than under non-stochastic conditions (about 28 times as compared to 11 times over the 50 year period). The additional tax revenues due to the AMT during the first five years are $20.92 (a 31.8% increase). The AMT also leads to a $22.01 increase in the discounted present value of the taxes paid over the 50 year period (a 6.7% increase), with 87.4% of the AMT credits generated able to be utilized.

These results show that although an "airline's" frequency of exposure to the AMT is significantly increased under stochastic conditions, the five-year revenue impact of the AMT is reduced (because the firm more rapidly flips between the minimum and regular tax). However, because it cannot as fully utilize its AMT credits, the impact of the AMT on the firm's tax liabilities over the entire period examined is somewhat greater under stochastic conditions.

B. The Case of a "Nondurable Goods Manufacturer"

Also shown in Table 9.1 are the corresponding results for the second version of the model, in which the firm's depreciable assets comprise only 75% of its real assets (Cases 3 and 4). In Case 3, under non-stochastic economic conditions and in the absence of the minimum tax, the optimal growth rate is 4.88%, and the optimal debt to equity ratio is 33.5%. With these parameters, the firm faces the minimum tax in only 3 of the 50 years. It thus corresponds to a "nondurable goods manufacturer" in the taxonomy of Lucke et al.[13] Because of its ability to fully utilize the AMT credits generated, the AMT does not appreciably increase its average effective tax rate (22.15%), although it does pay $0.02 more in tax revenues in the first five years and $0.13 more in discounted tax payments over the 50 year period. A negligible increase in the discounted present value of the net AMT tax payments was also found by Lucke et al. for such firm.

The corresponding results under stochastic economic conditions for the "nondurable goods manufacturer" are presented in Case 4 of Table 9.1. In the absence of the AMT, the optimal growth rate for such firm is 4.95% in a "good" year and 4.89% in a "bad" year, while the optimal debt to equity ratio is 33.5% in both "good" and "bad" years. In this case the average frequency of exposure to the AMT is increased to 5.53 years. In contrast to the non-stochastic case, the AMT results in a significant ($4.52, or 5%) increase in tax payments over the first five years. Despite the ability of the "non-durable goods manufacturer" to fully utilize its AMT credits in both cases, under stochastic conditions the AMT results in a measurable ($2.37, or 0.6%) increase in the discounted value of the firm's tax liabilities over the entire period examined.

V. RESPONSE OF THE FIRM TO THE AMT

In the previous section, the initial decision parameters were assumed chosen so as to maximize the expected value of the firm's equity in the absence of the minimum tax. In this section, the corresponding results are presented under the assumption that these parameters are chosen so as to maximize the value of the firm's equity in the presence of the AMT. By comparing the results of this section with those of the previous section, the behavior of the firm in responding to the AMT may be studied.

A. The Behavior of an "Airline"

Turning first to the case of an "airline" under non-stochastic economic conditions, a growth rate of 5.22% and a 32.8% debt to equity ratio are found to maximize the value of the equity in the presence of the AMT. These parameters, and the resulting financial variables, are shown as Case 1 in Table 9.2 (which has the same format as that of Table 9.1).

In this case the firm faces the minimum tax in 10 of the 50 years, fully utilizes the AMT credits generated over the 50 year period, pays an additional $16.97 in taxes due to the AMT during the first five years (a 24.0% increase), and incurs a discounted present value of $13.97 in additional tax payments over the 50 year period because of the AMT. As a result, it experiences a 17.17% average effective tax rate in the absence of the minimum tax and a 17.87% average effective tax rate in its presence.

Comparing the results for Case 1 in Table 9.1 with those in Table 9.2 shows that the somewhat lower growth rate and lower debt to equity ratio chosen by the firm in response to the AMT significantly reduces the tax revenues attributable to the AMT paid by the firm during the first five years (from $30.28 to $16.97, a 44.0% decrease) and over the 50 year period (from $20.47 to $13.97 in discounted tax payments, a 31.2% reduction). However, the behavioral response does not significantly reduce the firm's exposure to the AMT (which declines from 11 years to 10 years). Moreover, despite the reduction in net AMT payments, the response of the firm does not reduce the firm's total tax payments. In fact, after responding to the presence of the

Table 9.2 **Optimal Decision Parameters in the Presence of the Minimum Tax and the Resulting Financial Performance Under Non-Stochastic (R+ = R- = 10%) and Stochastic Economic Conditions (R+ = 13%, R- = 7%)**

	Airline		Nondurable Goods Manufacturer	
Variable	Case 1: Non-Stochastic Conditions	Case 2: Stochastic Conditions	Case 3: Non-Stochastic Conditions	Case 4: Stochastic Conditions
G+ (percent)	5.22	5.24	4.87	4.90
G- (percent)	5.22	5.06	4.87	4.89
B+ (percent)	32.8	33.0	33.5	33.3
B- (percent)	32.8	32.0	33.5	33.1
EQVALMT	$820.20	$817.11	$753.19	$752.61
NMT (years)	10.00	26.49	3.00	5.53
TAXDMT	$354.86	$360.51	$416.09	$421.23
DIVDMT	$615.78	$619.12	$581.17	$578.01
CREDUMT (percent)	100.00	91.20	100.00	100.00
REV5MT	$87.76	$88.92	$91.52	$95.15
EQVALNOMT	$834.17	$834.76	$753.32	$755.33
TAXDNOMT	$340.89	$344.55	$415.96	$419.00
DIVDNOMT	$629.75	$636.64	$581.17	$580.73
REV5NOMT	$70.79	$71.07	$91.50	$90.75
TINV	$34,208.63	$33,294.32	$24,838.00	$25,088.67
RATEMT (percent)	17.87	18.29	22.18	22.26
RATENOMT (percent)	17.17	17.42	22.17	22.12
MTREV5	$16.97	$17.85	$.02	$4.40
REVDMT	$13.97	$15.96	$.13	$2.23

minimum tax, the discounted present value of the taxes paid in the presence of the minimum tax over the 50 year period ($354.86, from Case 1 of Table 9.2) exceeds the discounted value of the taxes that would have been paid in the presence of the minimum tax when the decision parameters are chosen in the absence of the AMT ($348.94, from Case 1 of Table 9.1) by 1.7%. While this result is inconsistent with tax minimization, it is not inconsistent, as noted below, with maximization of the value of the firm.

Thus, the optimal response of an "airline" to the AMT under non-stochastic conditions is not to completely avoid the AMT, but rather to reduce both its exposure to the AMT and its net AMT payments. In doing so, the firm reduces its total investment over the 50 year period by 11.8%. Because of the reduced investment, the firm's total tax payments are slightly higher, but these higher tax payments are more than offset by the higher dividend payments (the discounted present value of which increase by 6.2%). Although the resulting 0.4% increase in the value of the firm's equity (from $816.65 in Case 1 in

Table 9.1 to $820.20 in Table 9.2) is not large, it does confirm the value to the firm of the reduced level of investment in the presence of the minimum tax, despite the slight increase in total taxes.[14]

In order to determine the impact of the AMT on an "airline" when the behavioral response of the firm is allowed for, the tax variables in the presence of the minimum tax for Case 1 in Table 9.2 must be compared to the corresponding variables in the absence of the minimum for Case 1 in Table 9.1. For example, the 15.92% average effective tax rate in the absence of the minimum tax (Table 9.1) should be compared with the 17.87% average effective tax rate in the presence of the AMT (Table 9.2). In contrast to the 6.2% increase noted in the previous section when the response of the firm is ignored, when the response of the firm is considered the AMT results in a 12.3% increase in the average effective tax rate for an "airline" under non-stochastic economic conditions.

Likewise, comparing the present value of the taxes paid in the absence of the minimum tax ($328.47, from Case 1 in Table 9.1) with the present value of the taxes paid in its presence ($354.86, from Case 1 in Table 9.2), shows that the AMT leads to an 8.0% increase in total tax payments when the response of the "airline" to the AMT is allowed for. In a similar fashion, it may be seen that when the response of the firm is considered, the AMT is found to result in a 33.5% increase in taxes paid during the first five years (in contrast to the 46.1% increase noted in the previous section when the response of the firm is ignored).

As under non-stochastic economic conditions, in responding to the AMT under stochastic conditions the firm reduces its level of investment and its financial leverage. Thus, as noted in Case 2 of Table 9.2, a 5.24% growth rate and a 33.0% debt to equity ratio in "good" years are found to be optimal for an "airline" under stochastic conditions in the presence of the minimum tax, and a 5.06% growth rate and a 32.0% debt to equity ratio in "bad" years. With these parameters, the average effective tax rate in the absence of the minimum tax is 17.42%, and 18.29% in its presence. In this case the mean frequency of exposure of an "airline" to the minimum tax is approximately 26.5 times in the 50 year period. The mean of the additional tax revenues due to AMT over the first five years is $17.85, and the mean discounted present value of the taxes paid over the 50 year period due to the AMT is $15.96, reflecting the fact that on average 91.2% of the AMT credits generated are utilized during the 50 year period.

Comparison of the results for these variables in the absence of the minimum tax (from Case 2 in Table 9.1) with their corresponding values in the presence of the minimum tax (from Case 2 in Table 9.2) shows that when the response of the "airline" under stochastic conditions is considered, the AMT increases the mean average effective tax rate by 14.7% (in contrast to the 7.4% increase noted in the previous section when the response of the firm is ignored). Likewise, the AMT is found to increase the initial five year tax payments by 35.1%, and the mean discounted present value of the taxes paid by 9.1%. In responding to the AMT, total gross investment is reduced by 14.0%, and the discounted present value of the dividends paid is increased by 2.9%. As was the case under non-stochastic economic conditions, the response of the firm may be seen to significantly reduce the net AMT payments (by 14.7% over the first five years, and by 27.5% over 50 years).

Despite the reduction in net AMT payments, the discounted present value of the total taxes paid over the 50 year period in the presence of the minimum tax is actually increased ($360.51 for Case 2 in Table 2 vs. $352.49 for Case 2 in Table 9.1). However, comparison of the value of the firm's equity in these two cases ($817.11 vs. $810.72) indicates that despite the somewhat greater total taxes paid, the reduced level of investment in response to the AMT increases the value of the firm. Moreover, the mean exposure to the minimum tax when the firm responds to the AMT is about the same as when it does not (26.5 years vs. 27.8 years, respectively).

In other words, as in the non-stochastic case, the optimal response of an "airline" to the minimum tax under stochastic economic conditions does not call for avoidance of the minimum tax. Rather, by reducing its growth rate and debt to equity ratio (especially in "bad" years), a significant reduction in the level of net AMT payments may be achieved, despite the modest reduction in the firm's frequency of exposure to the minimum tax.

B. The Behavior of a "Nondurable Goods Manufacturer"

In the presence of the minimum tax, the optimal growth rate for the "non-durable goods manufacturer" under non-stochastic economic conditions is 4.87%, and the optimal debt to equity ratio 33.5%, as noted in Case 3 in Table 9.2. For these parameter values, the average effective tax rate is found to be 22.18% in the presence of the minimum tax, and 22.17% in its absence.

Comparison of Cases 3 in Tables 9.1 and 9.2 shows that the response of the firm to the AMT results in 0.4% less gross investment, a 0.1% increase in the discounted value of the dividends paid, and a negligible decrease in both the net five-year AMT payments and the discounted present value of the net AMT taxes paid over the 50 year period. Comparison of the average effective tax rate and the taxes paid in the absence of the minimum tax from Case 3 in Table 9.1 with the corresponding variables in the presence of the minimum tax from Case 3 in Table 9.2 shows that, after taking the behavioral response into account, the AMT increases the average effective tax rate and the five year tax payments of a "non-durable goods manufacturer" by 0.1%.

Since the "nondurable goods manufacturer" is barely affected by the AMT under non-stochastic economic conditions, it is not surprising that taking the response of the firm to the AMT into account does not change this result. Because the AMT was found in the previous section to have a greater impact on such firm under stochastic economic conditions, the response of the "non-durable goods manufacturer" to the AMT might also be expected to be of greater importance under stochastic conditions. The results for the "nondurable goods manufacturer" when the decision parameters are chosen to reflect the minimum tax under stochastic economic conditions are presented in Case 4 in Table 9.2. In the presence of the minimum tax. the optimal growth rates are 4.90% for a "good" year and 4.89% for a "bad" year. with a 33.3% debt to equity ratio in a "good" year and a 33.1% debt to equity ratio in a "bad" year.

Comparing the results for Case 4 in Tables 9.1 and 9.2 shows that the use of slightly lower growth rates and leverage allows the "nondurable goods manufacturer" to reduce the additional taxes paid over the initial five years due to the AMT by 2.7% (from $4.52 to $4.40). and to reduce the present value of the additional taxes paid over 50 years by 5.9% (from $2.37 to $2.23). However. the firm's frequency of exposure to the AMT remains unchanged. Allowing for the firm's behavioral response. its mean average effective tax rate is increased due to the AMT by 1.0%. its initial five year tax payments are increased by 5.5%. and the discounted present value of the taxes paid by the firm over 50 years is increased by 0.8%. In responding to the AMT. the firm reduces its investment by 1.0%. and the net present value of its dividend payments is decreased by 0.2%.

Thus. as in the case of an "airline". the behavioral response of the "nondurable goods manufacturer" to the AMT is to reduce its growth rate and financial leverage. In so doing. its net AMT payments are reduced. but its frequency of exposure to the AMT is not altered. When such response is allowed for. a greater impact of the AMT is noted (e.g.. a 1.0% vs. a 0.6% increase in average effective tax rate under stochastic conditions). although even this measure indicates that the "nondurable goods manufacturer" is only slightly affected by the AMT.

VI. CONVENTIONAL AND STOCHASTIC AMT REVENUE ESTIMATES.

In this section the importance of stochastic modeling in estimating the revenues collected from the AMT is addressed. However. to simplify the analysis. the behavioral response of the firm is partially ignored. In particular. the AMT revenues will be obtained from the difference between the taxes paid by a firm during the first five years in the presence and absence of the minimum tax. holding the decision parameters equal to those found optimal under stochastic economic conditions in the presence of the AMT.

The following (somewhat simplistic) paradigm of the conventional revenue estimation process is adopted: a set of tax data for a single year (the base year) is obtained. and the income and expense items for each firm in the set are assumed to be extrapolated to each of the following five years in a uniform manner. Specifically. the growth rate and financial leverage observed for each firm in the base year is assumed to apply in all future years. The effects of a change in tax policy are imputed by superposing the new tax law on top of the uniformly extrapolated pre-tax earnings for each firm.

This paradigm, together with the assumption of uniform firm size, implies that the average five year net AMT liability as obtained from the conventional revenue estimation process corresponds to the weighted average of the five-year net AMT liabilities for firms with different (but constant) pre-tax rates of return, with a weight based on the relative distribution of such rates of return among the firms in the base year data set. The "actual" average five-year net AMT liability under stochastic conditions corresponds, however, to the mean of the stochastic five-year net AMT liability as obtained from Monte Carlo simulations.

A. Extrapolation of the Financial Results for an "Airline".

Although only the five-year budget period is relevant for the revenue estimates, the financial results for the first 12 years as extrapolated for an "airline" are examined in this section in order to illustrate certain features of the AMT. Thus, the first portion of Table 9.3 presents the results for an "airline" which always realizes a 13% rate of return on its real assets (i.e., always has a "good" year), and the second portion presents the corresponding results for an "airline" which always realizes a 7% rate of return (i.e., always has a "bad" year). As noted, the initial decision parameters are taken to be those which maximize the value of the firm's shares under stochastic economic conditions in the presence of the minimum tax (see Case 2 in Table 9.2).

A number of features exhibited in Table 9.3 are worth noting. First, the firm which realizes a constant 13% return (which shall be referred to hereafter as a "13%" firm) is able to maintain its target 33% debt to equity ratio, and thus, by the logic of the model, pays a dividend each year. Second, in the presence of the minimum tax, the 13% firm faces the AMT in three of the 12 years (years 2, 3 and 7), and is able to utilize the AMT credit generated in the following years. Third, by dividing each year's tax paid by the economic income earned, an annual average effective tax rate may be defined. The maximum tax rate experienced by a "13%" firm (28.35% in year 5) is less than the statutory regular tax rate (34%).

In the case of an "airline" which realizes a 7% rate of return (referred to hereafter as a "7%" firm), the results are different. First, the "7%" firm cannot maintain its targeted 32% debt to equity ratio (which grows to 37.5% by the tenth year). Thus the "7%" firm ceases to pay dividends after the second year. Second, the "7%" firm faces the minimum tax in each of the twelve years. Third, the annual average tax rate, obtained by dividing the tax paid by the economic income earned, increases beyond the 20% statutory minimum tax rate in the third through ninth years. This is due to the fact that the lower depreciation on the firm's pre-1987 assets is not allowed to offset the depreciation adjustments for its post-1986 assets.

This aspect of the AMT was noted by Christian, Schutzer, and Nilles (1986). The magnitude of this effect decreases with higher pre-tax rates of return.

Table 9.3 **Financial Results for an "Airline" Earning a Constant Pre-tax Return: The 7% and 13% Cases**

	Year 1	2	3	4	5	6	7	8	9	10	11	12
At 13%:												
With Minimum Tax		*	*				*					
Debt Equity Ratio	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%
Cash Generated	$207.31	$216.29	$227.63	$239.55	$252.11	$265.32	$279.22	$293.85	$309.25	$325.45	$342.51	$360.45
New Debt	$30.35	$13.68	$14.40	$15.16	$15.95	$16.78	$17.66	$18.59	$19.57	$20.59	$21.66	$22.81
Gross Investment	$152.40	$160.39	$168.79	$177.63	$186.94	$196.74	$207.05	$217.90	$229.31	$241.33	$253.98	$267.28
Tax Paid	$19.14	$19.34	$23.48	$28.31	$36.69	$34.11	$32.75	$32.23	$34.25	$36.60	$38.52	$40.54
Dividends	$66.12	$50.24	$49.76	$48.77	$44.42	$51.25	$57.08	$62.31	$65.25	$68.11	$71.68	$75.43
Economic Income	$107.31	$111.05	$116.87	$122.99	$129.44	$136.22	$143.36	$150.87	$158.78	$167.10	$175.85	$185.07
Average Tax Rate	17.84%	7.42%	20.09%	23.02%	28.35%	25.04%	22.84%	21.36%	21.57%	21.90%	21.91%	21.91%
AMT Credits		$.13	$.68				$1.35	$.53				
Without Minimum Tax												
Debt Equity Ratio	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%	33.00%
Cash Generated	$207.31	$216.29	$227.63	$239.55	$252.11	$265.32	$279.22	$293.85	$309.25	$325.45	$342.51	$360.45
New Debt	$30.35	$13.68	$14.40	$15.16	$15.95	$16.78	$17.66	$18.59	$19.57	$20.59	$21.66	$22.81
Gross Investment	$152.40	$160.39	$168.79	$177.63	$186.94	$196.74	$207.05	$217.90	$229.31	$241.33	$253.98	$267.28
Tax Paid	$19.14	$19.21	$22.93	$28.98	$36.69	$34.11	$31.40	$33.05	$34.78	$36.60	$38.52	$40.54
Dividends	$66.12	$50.37	$50.30	$48.09	$44.42	$51.25	$58.43	$61.49	$64.72	$68.11	$71.68	$75.43
Economic Income	$107.31	$111.05	$116.87	$122.99	$129.44	$136.22	$143.36	$150.87	$158.78	$167.10	$175.85	$185.07
Average Tax Rate	17.84%	17.30%	19.62%	23.56%	28.35%	25.04%	21.90%	21.91%	21.90%	21.90%	21.91%	21.91%
At 7%:												
With Minimum Tax	*	*	*	*	*	*	*	*	*	*	*	*
Debt Equity Ratio	32.00%	32.00%	32.00%	32.19%	34.20%	35.29%	36.16%	36.83%	37.27%	37.50%	37.50%	37.27%
Cash Generated	$147.83	$154.10	$161.90	$169.95	$178.00	$185.87	$194.20	$203.07	$212.55	$222.73	$233.68	$245.51
New Debt	$23.92	$12.89	$14.81	$19.15	$24.62	$24.58	$24.47	$24.26	$23.93	$23.39	$22.61	$21.55
Gross Investment	$150.60	$158.22	$166.23	$174.64	$183.47	$192.76	$202.51	$212.76	$223.52	$234.83	$246.72	$259.20
Tax Paid	$4.31	$7.00	$10.48	$14.47	$19.15	$17.69	$16.16	$14.58	$12.95	$11.28	$9.58	$7.86
Dividends	$16.84	$1.77	$.00	$.00	$.00	$.00	$.00	$.00	$.00	$.00	$.00	$.00
Economic Income	$47.83	$49.04	$51.52	$53.99	$56.18	$57.88	$59.73	$61.80	$64.13	$66.79	$69.86	$73.39
Average Tax Rate	9.01%	14.27%	20.34%	26.80%	34.09%	30.56%	27.06%	23.59%	20.19%	16.89%	13.71%	10.71%
AMT Credits	$4.31	$11.31	$21.78	$31.72	$38.58	$48.18	$60.66	$71.69	$81.19	$89.04	$95.12	$99.30
Without Minimum Tax												
Debt Equity Ratio	32.00%	32.00%	32.00%	32.00%	32.32%	32.07%	32.00%	32.00%	32.00%	32.00%	32.00%	32.00%
Cash Generated	$147.83	$154.10	$161.90	$170.09	$178.70	$187.48	$197.17	$207.22	$217.70	$228.72	$240.29	$252.45
New Debt	$23.92	$12.89	$13.54	$14.22	$17.31	$13.91	$15.92	$17.33	$18.21	$19.13	$20.09	$21.11
Gross Investment	$150.60	$158.22	$166.23	$174.64	$183.47	$192.76	$202.51	$212.76	$223.52	$234.83	$246.72	$259.20
Tax Paid	$.00	$.00	$.00	$4.58	$12.53	$8.63	$4.70	$4.96	$5.21	$5.47	$5.75	$6.04
Dividends	$21.15	$8.77	$9.21	$5.10	$.00	$.00	$5.89	$6.83	$7.18	$7.54	$7.92	$8.32
Economic Income	$47.83	$49.04	$51.52	$54.10	$56.73	$59.10	$61.91	$64.74	$67.70	$70.88	$74.33	$78.09
Average Tax Rate	.00%	.00%	.00%	8.47%	22.09%	14.60%	7.59%	7.66%	7.70%	7.72%	7.74%	7.73%

*Years in which the firm faces the AMT are noted with asterisk.

This may be seen by comparing the average tax rate for the "13%" firm in year seven (when it faces the AMT), which is only 2.84 percentage points in excess of the 20% statutory AMT rate, with the 14.09 percentage point excess for the "7%" firm (in year five). Even this 34.09% maximum tax rate for the "7%" firm is barely above the 34% statutory rate for the regular tax, and is unlikely to reach the values suggested by Christian et al. (who implicitly assume a very low 1.5% pre-tax rate of return in much of their paper by ignoring the income, but not the depreciation, generated by the pre-1987 assets). Nevertheless, this feature reflects the fact that the base of the AMT differs from economic income.

B. Revenue Estimates for an Airline

The variables relevant to the issue of the importance of stochastic fluctuations in five year AMT revenue estimates are presented in Table 9.4. These include the five year taxes paid by the "13%" and "7%" firms with and without the AMT (and the resulting five year AMT revenue pick-up, obtained as the difference between these two amounts), the stock of unused AMT credits available at the end of the fifth year, and the AMT credit utilization rate for the five-year period. Also shown in Table 4 is the average of these results for the two fixed-return cases, together with the mean value of the stochastic variables and the percentage differences between these average and mean values. Table 9.4 shows that the five-year total tax payments for the "13%" firm are the same with and without the AMT ($126.96), since the AMT

Table 9.4 **Five-Year AMT Revenue Estimates From Conventional (Approximate) and Stochastic (Exact) Procedures, and Percentage Differences**

Tax Variable	13% Firm	7% Firm	Average (Approx.)	Mean (Exact)	Percentage Difference
Airline:					
Tax Paid with AMT	$126.96	$55.41	$91.19	$88.92	2.55%
Tax Paid without AMT	$126.96	$17.11	$72.04	$71.07	1.36%
AMT Revenue	$.00	$38.30	$19.15	$17.85	7.28%
AMT Credit Balance	$.00	$38.58	$19.29	$18.22	5.87%
AMT Credit Utilization	100.00%	.00%	50.00%	15.02%	232.89%
Nondurable Goods Manufacturer:					
Tax Paid with AMT	$147.71	$54.49	$101.10	$95.15	6.25%
Tax Paid without AMT	$147.71	$35.52	$91.62	$90.75	.95%
AMT Revenue	$.00	$18.97	$9.49	$4.40	115.57%
AMT Credit Balance	$.00	$19.06	$9.53	$7.28	30.91%
AMT Credit Utilization	100.00%	.00%	50.00%	69.89%	-28.46%

credits generated in years 2 and 3 are utilized in year 4. By contrast, the "7%" firm incurred an additional $38.30 in tax payments due to the AMT during the first five years. The average net five year AMT payment for the two fixed-return cases ($19.15) somewhat overstates the mean value as obtained from the Monte Carlo simulations ($17.85). As a result, it may be inferred that the conventionally calculated average five-year AMT revenues overstate the actual revenues (the mean of the stochastic values) by 7.3%.

At first glance, it would appear that the conventional AMT revenue estimation process may not be significantly impaired by the absence of explicit stochastic modelling.[15] However, because the mean stochastic value of the five-year AMT credit utilization rate is only 15.02%, this result may not be of general validity. The ability to utilize previously generated AMT credits adds to the potential disparity between the conventional and stochastic AMT revenue estimates. A greater difference in estimated AMT revenues might thus be observed for a firm which, on average, faces the minimum tax somewhat less frequently over the first five years than an "airline". This hypothesis is tested by examining the revenue estimates for a "nondurable goods manufacturer".

C. Revenue Estimates for a "Nondurable Goods Manufacturer"

The financial results for a "nondurable goods manufacturer", where the decision parameters are those found to be optimal under stochastic conditions in the presence of the minimum tax (Case 4 of Table 9.2) are somewhat different from those noted above for an "airline". In the case of a "nondurable goods manufacturer", the "13%" firm does not face the AMT in any of the first twelve years, while the "7%" firm faces the AMT in each of the first eleven years (but not in the twelfth year). As in the case of an "airline", the debt to equity ratio of the "7%" firm quickly exceeds the target value, and thus the firm does not pay any dividends after the third year. The maximum average tax rate for the "7%" firm is 30.75% (10.75 percentage points above the 20% AMT statutory rate).

Table 9.4 presents the total tax revenues paid by the "13%" and "7%" firm during the first five years, both with and without the minimum tax. It also shows the AMT credit balance at the end of the five year period, and the five-year AMT credit utilization rate (which is taken to be unity in the case of the "13%" firm, which does not face the AMT during this period). The mean value of the AMT credit utilization rate is 69.9%. This is a much greater utilization rate than was observed for the "airline" and thus a greater difference between the conventional and stochastic revenue estimates may be anticipated for such firm. Indeed, comparison of the average of the two fixed-return cases with the mean stochastic value as shown in the table indicates that the conventional five year AMT revenue estimate ($9.49) overstates the mean stochasic value ($4.40) by 115.6%.

These disparate results for the "airline" and the "nondurable goods manufacturer" clearly indicate that the importance of utilizing stochastic revenue estimation depends upon the nature of the firm. If firms which face the minimum tax are more like an "airline", it is likely that no significant five-year revenue estimation error would result from the conventional estimation procedure. However, if most firms resemble the "nondurable goods manufacturer", serious errors might arise, despite the lower AMT payments attributable to such firms. While the results may thus be somewhat ambiguous with respect to the importance of incorporating stochastic modelling in estimating AMT revenues over a five year period, significant errors almost certainly would result from the neglect of stochastic fluctuations when calculating the relative impact of the AMT on tax liabilities over periods much greater than five years. Thus, for example, the average of the "13%" and "7%" present values of the discounted excess AMT payments for an "airline" over the 50 year period examined is $41.32, which is approximately 158% greater than the actual (mean stochastic) value of $15.96. This is a much greater disparity than the 7.3% overstatement of the initial five-year AMT revenues noted for such firm, and is largely due to the inadequate picture of the actual AMT credit utilization provided by averaging the results of the two fixed-return cases.

VII. CONCLUSIONS

The numerical experiments described in this paper were performed to shed additional light on the impact of the corporate AMT, especially under stochastic economic conditions. While the results are somewhat ambiguous regarding the importance of stochastic modelling in estimating AMT revenues over a five year budget period, they clearly reveal the importance of allowing for both stochastic fluctuations and the behavioral response of firms when evaluating the overall impact of the AMT.

More specifically, a corporation with the characteristics of an "airline" faced the AMT in 11 of the 50 years examined under non-stochastic conditions, but is on average exposed to the AMT in nearly 28 of the 50 years examined under stochastic conditions. Likewise, a corporation with the characteristic of a "nondurable goods manufacturer" faces the AMT in only 3 out of the 50 years under non-stochastic conditions, but on average is exposed to the AMT in nearly 6 of the 50 years under stochastic conditions.

In response to the AMT, firms are likely to reduce their average growth rate and their target debt to equity ratio, although the magnitude of the response varies with their degree of exposure to the AMT. Thus the "airline" reduced its total investment over the 50 year period examined by 11.8% under non-stochastic conditions, and by 14.0% under stochastic conditions. Much smaller reductions in investment (0.4% and 1.0%, respectively) were found for the "nondurable goods manufacturer", which is only barely affected by the AMT.

Although the behavioral response reduced both the firm's exposure to the minimum tax (very slightly in the case of the "airline", but somewhat more significantly in the case of the "nondurable goods manufacturer") and the magnitude of the resulting net AMT payments, the optimal response cannot be characterized as an attempt to avoid facing the AMT. Moreover, because of the reduced level of investment in depreciable assets in response to the AMT, in some cases the firm's total tax payments increased slightly (despite the significant reduction in net AMT payments). While such result may appear perverse to those accustomed to think in terms of tax minimization, it is consistent with the maximization of the value of the firm's equity, which is taken to be the objective of the firm in this paper.

Conventional simulation studies (see, e.g., Lucke et al.) suggest that the impact of the AMT on corporate tax liabilities will be relatively modest, largely because the higher payments will rapidly be credited against future regular tax liabilities. However, such view is based on a comparison between the tax liabilities with and without the AMT under arbitrary assumptions about the firm's (assumed fixed) growth rate and financing decisions. As the results of this study indicate, a much greater impact of the AMT is found when the response of the firm to its tax environment is considered. Thus, for example, when the firm is allowed to optimize its investment and financing decisions to reflect the presence or absence of the AMT, the AMT is seen to increase the average effective tax rate of an "airline" by 12.2% under non-stochastic conditions, and by 14.7% under stochastic conditions. By contrast, had fixed investment and financial parameters been assumed, the resulting increase in the average effective tax rate would have been about one half of these values.

The importance of stochastic extrapolation in estimating AMT revenues over a five year budget period is not clearly demonstrated. In the case of an "airline", which is subject to relatively high AMT payments, the conventional five-year AMT revenue estimate overstated the actual value by only 7.3%. However, the conventional AMT revenue estimate resulted in a 115.6% overstatement for a "nondurable goods manufacturer" (although the net AMT payments for such firm are relatively modest). The magnitude of the disparity between the conventional and stochastic revenue estimates may be partially explained by the difference in the mean AMT credit utilization rates; a higher utilization rate portends a greater disparity in revenue estimates.

APPENDIX

In this Appendix, the objective function noted in Section III will be derived. A shareholder's after tax rate of return R_t is a mix of dividend income and capital gains:[16]

$$R_t = (1-m)D_t/V_t + (1-z)(V^{\circ}_{t+1}-V_t)/V_t. \qquad (9.A1)$$

where D_t denotes the dividends paid in period t, V_t is the total value of the firm in period t, V^o_{t+1} is the period t+1 value of the shares outstanding in period t, m is the investor's marginal tax rate on dividend income, and z is the investor's marginal effective tax rate on capital gains.

The total value of the firm in period t+1, V_{t+1}, is the sum of V^o_{t+1} and the value of new shares issued in period t, V^N_t. If the rate of return, R_t, may be taken to be a constant (ρ), then Equation (9.A1) may be written as:

$$V_t = (1+\rho/1\text{-}z)^{-1}[\delta D_t - V^N_t + V_{t+1}], \qquad (9.A2)$$

where $\delta = (1\text{-}m)/(1\text{-}z)$. Equation (9.A2) may be solved iteratively, under the condition that $(1+\rho/1\text{-}z)^{-j}V_{t+j} \rightarrow 0$ as $j \rightarrow \infty$. Thus,

$$V_t = \Sigma^{\infty}_{j=0} (1+\rho/1\text{-}z)^{-(j+1)}[\delta D_{t+j} - V^N_{t+j}]. \qquad (9.A3)$$

Equation (9.A3) is the well known "fundamental value equation" for the firm. The firm's managers may be expected to make investment and financial decisions which maximize V_t. In performing our Monte Carlo simulation we shall be evaluating the individual terms in the sum on the right hand side of Equation (9.A3) for each of the approximately one thousand trial runs. It would obviously be helpful to be able to terminate the sum after a reasonable (say T) number of terms. Had Equation (9.A2) merely been iterated forward to period t+T, we would find:

$$V_t = \Sigma^{T-1}_{j=0} (1+\rho/1\text{-}z)^{-(j+1)}[\delta D_{t+j} - V^N_{t+j}] + (1+\rho/1\text{-}z)^{-T}V_{t+T}. \qquad (9.A4)$$

Thus, if a reasonable approximation can be obtained for V_{t+T}, the computational efforts required can be significantly reduced. By making a few additional assumptions regarding the behavior of the firm in period t+T and later years, such an approximation may be obtained. In particular, we shall suppose that for period T and all later periods the firm earns only the (certain and constant) marginal return, that it maintains a constant debt to equity ratio Θ, and that its dividend payout grows at a constant growth rate g. Since the firm is assumed to be paying dividends in year T and all later years, it follows from our model that it does not issue any new stock in any of these years ($V^N_{t+T+j} = 0$ for all j).[17]

From Equation (9.A3) we may thus express the value of the stock in period t+T in terms of the dividend payment in that period and in all later periods:

$$V_{t+T} = \Sigma^{\infty}_{j=0} (1+i\delta)^{-(j+1)} \delta D_{t+T}(1+g)^j = \frac{\delta D_{t+T}}{(i\delta - g)}. \qquad (9.A5)$$

In our model dividends are a residual:

$$D_{t+T} = X_{t+T} - R_{t+T} - T_{t+T} - B_{t+T} - (I_{t+T} - B_{t+T+1}). \qquad (9.A6)$$

where X_{t+T} is the pre-tax operating earnings, R_{t+T} is the interest payment on the beginning of the period debt (B_{t+T}), I_{t+T} is the gross investment, and T_{t+T} is the tax liability, all for period t+T. Because of our model assumptions, each of these terms are proportional to K_{t+T}, the capital stock in period t+T.[18] Thus, we may write Equation (9.A6) for D_{t+T} as:

$$D_{t+T} = \{[r^* - i(1-\delta)(\Theta/1+\Theta)](1-t^*) - g - (i\delta - g)\Theta/1+\Theta\}K_{t+T}. \qquad (9.A7)$$

where r^* is the (certain and constant) pre-tax rate of return, i is the interest rate, Θ is the debt to equity ratio, and t^* is the average effective tax rate. Substituting this expression into Equation (9.A5), we obtain:

$$V_{t+T} = \delta\left[\left(\frac{r_o - g}{i\delta - g}\right) - \frac{\Theta}{1+\Theta}\right] K_{t+T}. \qquad (9.A8)$$

where the first bracketed expression on the right hand side of Equation (9.A7) has been denoted by r_o. Our assumption that the firm earns only marginal returns in period T and later years implies that this rate of return equals $i\delta$ so that Equation (9.A8) may be written:

$$V_{t+T} = \delta\left[1 - \left(\frac{\Theta}{1+\Theta}\right)\right] K_{t+T} = \delta\,(K_{t+T} - B_{t+T}) = \delta E_{t+T}. \qquad (9.A9)$$

where E_{t+T} is the period t+T equity value of the firm. By substituting this expression for V_{t+T} into Equation (9.A4), we finally obtain our objective function:

$$V_t = \Sigma_{j=o}^{t-1}(1+\rho/1-z)^{-(j+1)}[\delta D_{t+j} - V^N_{t+j}] + (1+\rho/1-z)^{-T}\delta E_{t+T}. \qquad (9.A10)$$

FOOTNOTES

[1] The alternative minimum tax technically refers only to the excess of the tentative minimum tax over the regular tax. In this paper, such excess shall be denoted as "net AMT", while the phrase "alternative minimum tax" (or AMT) shall be used to refer in a conceptual sense to the entire minimum tax (and not merely its excess over the regular tax).

[2] Other adjustments have the effect of repealing the completed contract method of accounting for long term contracts and the installment method of accounting for the sale of goods for AMT purposes. Neither of these adjustments are relevant for the examples considered in this paper.

[3] The Corporate Tax Panel, which was developed by Paul Dobbins, contains complete multi-year tax data (covering the period 1970-82) for approximately 6,000 firms. A greater than 50% increase in tax net income is observed in 28.4% of the cases, and a corresponding increase in book net income in 25% of the cases. A greater than 50% decrease in tax net income is observed in 21.7% of the cases, and a corresponding decrease in book net income in 16.3% of the cases. A significant correlation between the annual changes in tax and book net income is evident.

[4] As described in Nester (1977), the Corporate Tax Model is essentially a tax calculator which utilizes an I.R.S. Statistics of Income corporate tax file as an initial data base. Tax law changes are programmed into the calculator. Such changes are either calculated directly from the original file values (as in the case of a change in tax rates) or exogenously determined (such as changes in depreciation deductions, which are imported from OTA's Depreciation Model; see the paper by Gerardi, Milner, Whitaker, and Wyscarver in this *Compendium*).

[5] The possibility that current investment may alter the taxation of the income generated by prior (and future) investment is already a feature of tax law. See, e.g., Hughes and McFetridge (1985) for a discussion of the implications of the incremental R&E tax credit on investment, or Auerbach (1986) for an analysis of the net operating loss provisions on investment. While the NOL provisions have been incorporated in the model used in this paper, the R&E credit has been ignored.

[6] A quadratic investment adjustment cost function has been used by Summers (1981) and by Poterba and Summers (1983) in their studies of the importance of dividend taxation, which were also based on the Hayashi model of the firm. While the specific parameters characterizing the adjustment cost function used in this paper and those in each of these earlier papers differ somewhat from each other, the resulting adjustment costs are all of the same magnitude.

[7] Although the model allows the firm's level of investment and its level of debt (or financial assets) to vary (in a pre-determined manner) in accordance with the realized profit margin, it does not allow the firm to "fine-tune" its investment plans according to whether it might or might not otherwise face the minimum tax. The model thus does not fully replicate the tax planning available to firms, and might therefore overstate the impact of the AMT.

[8] Shoven (1986) has stressed the increasing importance of share repurchases as a mechanism for distributing cash from the corporation to its shareholders. His analysis of the tax advantage of this mechanism neglects the possibility that such repurchases might be treated as dividend distributions under I.R.C. Section 302. Moreover, the tax advantage of such mechanism has been reduced by the Tax Reform Act of 1986. Nevertheless, the neglect of this alternative use of corporate funds must be recognized as a limitation of the model.

[9] Fullerton and Gordon (1983) note that the average 1973 debt to capital ratio across all industries is approximately .4, which in turn implies an average debt to equity ratio of .67. However, this value, which is based on market (rather than book) values of the firm's debt and equity securities, reflects in part the high debt ratios for financial institutions; lower ratios are observed for most of the manufacturing sectors. As used in this paper, "debt" actually refers to the excess of the firm's interest bearing financial liabilities over its interest yielding investments. The corresponding .3 "natural" debt to equity ratio used in the model is the average ratio for manufacturing firms, as obtained (after adjustment for deferred taxes and other reported non-interest bearing liabilities) from the 2nd quarter 1986 Quarterly Financial Report published by the U. S. Department of Commerce (1986).

[10] Alternative leverage cost functions have been used in other studies, e.g., Gordon and Malkiel (1980) and Fullerton and Gordon (1983), and have generally been viewed as reflecting the risk premium associated with the increasing possibility of bankruptcy with greater leverage.

[11] The investment adjustment cost function and the financial leverage cost function are responsible for "interior" solutions being obtained from the model. In their absence, both the firm's optimal growth rate and its debt to equity ratio would tend toward infinity.

[12] The "airline" in the paper by Lucke, et al. is characterized as having 15% of its property in inventories and land, 10% in real property, 10% in computer equipment (6-year ADR mid-point life), and 65% in aircraft (12 year ADR mid-point life). In the case noted in this paper, more of the firm's property (100% vs. 85%) is assumed to be depreciable, and a higher nominal growth rate (5.54% vs 4%) and lower nominal pre-tax rate of return (10% vs. 11%) are also assumed. However, the lower debt to equity ratio (33.5% vs. 42.9%) and the different asset mix assumed results in an equal frequency of exposure to the AMT under non-stochastic conditions. Whereas Lucke et al. sought to explicitly model a representative airline, it is only because of this equality that the firm modeled in this paper is referred to as an "airline".

[13] In the paper by Lucke et al., 20% of the property of the "nondurable goods manufacturer" is non-depreciable. The balance of the property consists of real property (30%), special tools with a 4-year ADR mid-point life (5%), machinery with a 10 year ADR mid-point life (20%), and machinery with a 12 year ADR mid-point life (25%). As in the case of the "airline", the lower debt to equity ratio and difference in asset mix appears to offset the differences in the other assumed parameters (as noted in footnote 12), resulting in an equal frequency of exposure to the AMT. It is only because of this equality that the firm represented in the second version of the model of this paper is referred to as a "non-durable goods manufacturer".

[14] Likewise, by comparing the value of the firm's equity in the absence of the minimum tax for the initial (Case 1 in Table 1) decision parameters ($836.62), with the corresponding value for the new decision parameters ($834.17 for Case 1 in Table 2), the advantage of the initial parameters over the altered parameters in the absence of the minimum tax may be confirmed.

[15] In order to investigate the robustness of this result for an "airline", the corresponding error under alternative stochastic conditions has been examined. In cases where the independence of the returns across firms is maintained, the average pre-tax return kept at 10%, and the decision parameters for Case 2 of Table 2 are used, this result appears somewhat sensitive to the assumed distribution of pre-tax returns. For example, a 0.7% error was observed with 12% and 9% pre-tax rates of return (the 9% return being twice as likely), and a -.6% error was observed in the case of an 11% and 8% rate of return (the 11% return being twice as likely). However, with a 12% and 6% pre-tax rate of return (with the 12% return twice as likely), a -23.0% error was observed. Moreover, if the returns for different firms are correlated, a greater error may easily arise. For example, if 13%, 11%, 9%, and 7% pre-tax rates of return are equally likely (with the 13% or 9% returns occurring in "good" years, and the 11% or 7% returns occurring in "bad" years, and with "good" or "bad" years equally likely), a -31.1% error would arise if the initial data year were a "good" year, and a 28.7% error would arise if the initial data year were a "bad" year. Such errors largely reflect the failure in this case of projecting future economic conditions on the basis of a single year's data.

[16] We are following, to the extent possible, the discussion and notation of Poterba and Summers (1985). References to the future value of the firm's outstanding shares or future dividend payments should be understood as the expected value of such variables.

[17] Under these assumptions, the investor's required return ρ for year $t+T$ and later years may be taken to be $i(1-m)$, where i is the nominal pre-tax interest rate (assuming that the marginal tax rate on interest income is the same as that on dividend income).

[18] This is not quite valid. The tax liability in period $t+T$ may well involve terms (e.g., the stock of unused AMT credits) which are not proportional to K_{t+T}.

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