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ABSTRACT

The Tax Reform Act of 1986 was expected to cause an overall decline in business fixed investment and a shift in the composition of investment away from machinery and equipment, which previously had received an investment tax credit. Yet neither investment relative to GNP nor equipment investment relative to total investment declined during the period 1987-89. This paper's analysis of investment at the level of individual industries and assets helps reconcile the recent pattern of investment and the predicted effects of the Tax Reform Act. We find that the trend toward investment in equipment predated the Act, and that recent investment in equipment has fallen short of what would have been expected on the basis on nontax factors alone. Using a new technique to identify the impact of taxation on investment, we confirm the importance of tax policy using the cross-section pattern of equipment investment since 1986.

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1. Introduction

One of the most surprising aspects of U.S. macroeconomic performance in the late 1980s was the strength of nonresidential fixed investment. The Tax Reform Act of 1986 was generally believed to have raised the tax wedge facing new investment (Auerbach 1987). This was particularly so for investment in machinery and equipment, most of which previously had qualified for the 10% investment tax credit repealed by the 1986 Act. Many predicted that the provisions of the Act would lead to a significant decline in investment. Yet, the share of GNP devoted to nonresidential fixed investment has not fallen since 1986.

Perhaps even more striking is the pattern of investment during the past few years, which has evidenced a strong shift toward investment in machinery and equipment, and away from structures. In 1985, nonresidential structures investment represented 4.1% of GNP, and producers' durable equipment 8.4%. By 1989, these respective percentages were 3.0% and 9.3%, meaning that there has been a shift of roughly 1% of GNP (and about 8% of business fixed investment) from the construction of nonresidential structures to the manufacture of business machinery and equipment.

At first glance, these figures suggest that the Tax Reform Act has not had the impact that was predicted, perhaps because the effects of the Act on tax burdens were incorrectly estimated or the responsiveness of investment to such changing incentives overstated. Indeed, this was the conclusion of our earlier work on the subject. In Auerbach and Hassett (1990a), we estimated a simple structural model for U.S. aggregate equipment investment and for aggregate nonresidential structures investment which took account of the estimated impact of taxes, financial costs and projected profitability, essentially a "q"-model relating investment to the underlying determinants of q rather than a measure based on market value itself. The models estimated through 1985 underpredicted equipment investment and significantly overpredicted investment in structures for the period after 1986; the unexplained residuals for this period far outweighed the estimated impact of the 1986 tax changes, which ought to have increased investment in structures and reduced that in equipment.

While these results suggest that taxes may not have played a very significant role in affecting post-1986 investment behavior, they still leave us with the puzzle of why investment shifted so strongly toward equipment, a question that clearly deserves further analysis.

In this paper, we extend our past research in two ways. First, our investigation focuses on the behavior of investment at the more disaggregate asset and industry levels, where there is evidence of trends and heterogeneity in behavior that aggregate equations are likely to miss. Second, we take advantage of the variation in tax provisions across industries and assets to gain an additional way to evaluate the impact of tax policy on investment behavior after 1986. We argue below that such an approach may be more suited to assessing the impact of taxation on investment behavior than a typical time series approach, since in an unstable policy environment it may be difficult even to measure the incentives that tax policy historically provided.

Tables 1 and 2 show how different investment performance has been in recent years for different types of equipment and structures, respectively. For example, investment in Mining, Exploration Shafts and Wells fell precipitously due to the sharp drop in the price of crude oil, while real purchases of computers and related equipment nearly doubled between 1985 and

1989. However, even in other categories of equipment and structures the same pattern of stronger growth in equipment has occurred. For example, investment in industrial equipment grew by 16% between 1985 and 1989, while purchases of industrial buildings grew by just 2%. This suggests that the growth in equipment spending and the corresponding decline in structures investment is too widespread to be explained by idiosyncratic shocks to particular industries. However, as we shall discuss below, the recent shift in investment from structures to equipment of recent years is really part of a much longer historical pattern, and is not necessarily inconsistent with tax policy having played a role.

After examining investment behavior by asset and industry for the period 1953-89, we reach the following conclusions:

1. The equipment boom after 1986 was consistent with nontax fundamentals, in that an unrestricted forecast of equipment investment based on the period 1953-85 projects such a boom;

2. In fact, the forecasts overpredict actual investment in equipment for most asset classes and industries, suggesting that taxes could have played a role in limiting the boom's strength;

3. This hypotheses is supported by cross-section results that show a significant relationship between the 1986 tax change and the overprediction of post-1986 equipment investment;

4. No such cross-section evidence can be adduced in support of the variation in structures investment across industries and asset classes.

Put simply, the equipment boom since 1986 appears to be a continuation of a long-term, secular shift in investment from structures to equipment that swamps the tax incentives of the 1986 Act. The impact of these incentives is, however, discernable in the behavior of investment in producers' durable equipment.

2. Patterns of Investment Behavior

It is customary to analyze fixed investment behavior by looking at aggregate investment data or data on total investment in equipment and structures. In our analysis below, however, we consider investment behavior at the more disaggregate levels of industry and asset class.

Our decision is motivated not only by the desire to take advantage of interasset and interindustry variation to identify the impact of tax factors, but also by the view that the determinants of investment may be very different for different types of equipment or structures. The composition of what we call "equipment" or "structures" is very different now than it was in 1953.

For each of the 36 categories of equipment and structures that we shall analyze, Table 3 presents the estimated rate of economic depreciation and the fraction of total nonresidential fixed investment accounted for by that class in 1953, 1985 and 1989.[1] The fraction of total investment represented by equipment has grown from 55% to 76% of all business fixed investment during this period. While this shift seems to have accelerated in recent years, one can see from looking at the data for individual asset classes that the recent spurt is largely attributable to the growth in computers, which by 1989 accounted for roughly one-third of equipment investment and one-quarter of all nonresidential fixed investment (compared to less than 1% in 1953).

But the changing composition of investment is also clearly visible between 1953 and 1985. In addition to computers, sharp increases may also be observed in the fraction of investment accounted for by communications equipment and instruments. On the other hand, the share of investment in such heavy equipment as tractors and railroad equipment has fallen sharply, and there has been a shift in nonresidential building from industrial to commercial construction.

These changes in the composition of investment relate to both the changing technology of production and the changing composition of output, as well. This is seen quite clearly in the declines observed in assets used intensively in agriculture, such as tractors and agricultural machinery, and, indeed, because of the decline in the production of structures themselves, in the drop in purchases of construction machinery. Table 4 presents fractions of investment by industry comparable to those in Table 3 for 1953 and 1989, confirming the shift in investment demand. Of the seven industrial groups listed, the first three (agriculture, mining and construction) dropped significantly in importance. The next two, manufacturing and transportation, communication and utilities, also accounted for a smaller share of investment in 1989 that 1953. The last two groups, wholesale and retail trade and finance, insurance, real estate and services, came to account for a much greater share of both equipment and structures investment in 1989 than in 1953.

The observed shifts in the composition of assets purchased and the industrial composition of demand should have altered the process determining aggregate investment. For example, the shorter lifetimes of equipment and, particularly, the very rapid depreciation rate of computers, has made investment in the aggregate "less durable". In theory, this would suggest a less central role for the cost of capital (net of depreciation) in the investment decision. This lesser durability of capital may also have contributed to a decline in the importance of factors normally associated with the purchase of durable goods, such as liquidity constraints and irreversibility and, indeed, the accelerator effect to which the volatility of investment is often attributed. Such volatility may also have been reduced by the shift in investment demand from such industries as agriculture and mining to trade and services. Focusing on assets and industries themselves helps us to control for these factors.

3. Theory and Estimation Strategy

In order to evaluate the impact of changes in tax policy on investment, one would like to have a correctly specified structural model of investment behavior which includes an exogenous variable or variables reflecting the influence of taxes, the coefficient of which would indicate the strength of the impact of taxation. One could test the validity of such a proposed structural model by forming out-of-sample predictions during periods of significant change in the tax variable, such as the recent years following the Tax Reform Act of 1986.

The adoption of this approach is significantly hampered by two important factors. First, structural models of investment behavior, particularly models to explain investment in structures, have not performed especially well.[2] Second, a properly specified measure of the impact of taxation on investment is based on the expectations by investors of future tax rate changes, and these are not easily observable or even predictable. Hence, even if the model were correct, the coefficient of the tax variable would be difficult to estimate.

As an illustration of this last point, consider the investment decision of the firm in the simple neoclassical model of investment (Jorgenson 1963), in which the firm purchases capital goods in a world of certainty, and without adjustment costs or delivery lags. The familiar decision rule chosen by the firm (see, for example, Auerbach 1983) is to set its capital stock so that the marginal product of capital equals a shadow rental price of capital, say c:

$$(1)\qquad c = q(1-\Gamma)[\ r + \delta - \frac{\Delta(q(1-\Gamma))}{q(1-\Gamma)}\ ]/(1-\tau)$$

where q is the relative price of capital goods (in terms of output), r is the real interest rate, δ is the asset's rate of economic depreciation, τ is the corporate tax rate (if the investing firm is a corporation) and Γ is the present value of tax savings from depreciation and other investment incentives, such as investment tax credits,

$$(2)\qquad \Gamma_t = k_t + \sum_{s=t}^{\infty} (1+r+\pi)^{-t}\ \tau_s\ D_s(s-t)$$

In expression (2), k is the investment tax credit, D(a) is the depreciation allowance permitted an asset of age a (discounted with a nominal rate that includes the inflation rate, π), and the subscripts which index these and the corporate tax rate are necessary because the tax system may change over time. Note that changes in tax policy, particularly in the investment tax credit, can have powerful effects on c through the term $\Delta q(1-\Gamma)/q(1-\Gamma)$, which is the effective inflation rate of the relative price of capital.

While a model based on perfect foresight and no adjustment costs is clearly too simple, expression (2) does provide useful intuition about the impact on the incentive to invest in more complex settings. For example, if the firm faces convex adjustment costs and uncertainty with respect to changes in investment tax credits and depreciation provisions, then the approximate impact of taxes on current investment obtained by linearizing the model (see Auerbach and Hines 1988) is a weighted average of current and future values of the term:

$$(3) \qquad c = q(1-\Gamma)[\ r + \delta - E_t(\frac{\Delta(q(1-\Gamma))}{q(1-\Gamma)})\ ]/(1-\tau)$$

where all expectations are based on the information available at the current date of investment, t. Thus, there are two changes from expression (1). First, future costs of using capital matter because the firm smooths its investment in reaction to the costs of adjustment. Second, uncertainty about the future means that expected, rather than actual future tax parameters influence investment today. In combination, the two factors together make measurement of the current tax incentive to invest more difficult, for one must know expectations not only of, say, tomorrow's investment tax credit (as would be the case if there were no adjustment costs), but also those for years well into the future.

In an unstable policy environment, the ex post values of the user cost of capital, formed from (1) using tax provisions that eventually applied, may bear little relationship to those that were expected when investment decisions were made: changes in tax rates and investment tax credits that occur at a later date may or may not have been fully anticipated. In principle, a solution is to follow the now common approach of specifying that, under the rational expectations hypothesis, the ex post value of a future value of c formed from (1) is distributed with an error around its true expected value. One may then use instruments from the appropriate information set to eliminate the errors-in-variables problem in the investment equation.

We believe there is merit in this approach, and have adopted it in our own recent attempts at structural modelling (1990a,b). Yet, it is hard to know how good the instruments are at explaining the expected tax change (which itself is unobservable). In many cases, tax changes are enacted or discussed seriously well before they take effect, but expectations based on such announcements are not likely to be picked up by available instruments.[3] This is an issue of efficiency rather than consistency, but in a small sample such as ours this inefficiency may be a serious problem.

However, one can take advantage of this lack of predictability of the expected tax rate. Suppose that the "true" model of investment behavior is:

$$(4) \qquad I = X\beta + c\gamma + \epsilon$$

where I is some measure of investment (we use the investment-capital ratio below), c is the unobserved user cost of capital, X is a vector of explanatory variables and ϵ is a stochastic disturbance. If the explanatory variable c is not generally observable, and one omits it from the estimation of equation (4), then the coefficient vector of X will not converge to β, but rather to $b = \beta + \Pi\gamma$, where Π is the vector of coefficients from the auxiliary regression of c on X. That is, the equation actually estimated will be:

$$(5) \qquad I = Xb + \nu$$

where the disturbance term $\nu = \epsilon + (c - X\Pi)\gamma$.

Now, suppose for the moment that there are some few observations for which c is observable. Using these observations alone, we may estimate the coefficient γ by regressing the residuals of the first-stage regression in (5) on the variable $(c - X\Pi)$, estimating the relationship:

(6) $\nu = (c - X\Pi)\gamma + \epsilon$

where an estimate of Π is obtained from the full sample by regressing the ex post values of c on X.[4] Weakness of this auxiliary relationship would mean that one essentially could enter c directly as an independent variable in expression (6). In fact, the weaker the predictability of c the better for this approach; if c were perfectly predictable using X the coefficient γ would not be identified in the second-stage regression.[5]

A good argument can be made that the years just after the passage of the Tax Reform Act of 1986 may constitute a period in which the "true" cost of capital was observable, in that the ex post values of c could arguably have been anticipated, even if they were not predictable using simple equations. When the tax law was changed in 1986, greater emphasis than usual was placed on the fundamental nature of the change and the notion that the changes in tax rules should be viewed not as part of a program of activist fiscal policy. Indeed, after a five-year period (1981-85) during which there were three significant tax acts[6], there have been no such significant changes regarding investment in the more than four years since the 1986 act's passage.

Hence, one may be justified in placing the ex post values of c directly into expression (6), adjusted for any component predictable using the vector X. While there are too few observations to estimate this relationship using any single investment series, we can take advantage of the variation in c across assets and industries to pool observations, under the assumption that γ is the same for different investment relationships. This is the essence of the approach we take below, but the strategy still requires a specification of the model given in (1).

Our choice of model is guided by the objective of the present experiment and the results of our own past estimates of structural models. We need a model in order to derive predictions for investment after 1986, which can be compared to actual investment behavior and changes in tax incentives. But simple structural models of aggregate investment do not seem capable of tracking recent investment behavior very well, and the components of aggregate investment with which we are concerned in this paper clearly are affected by a very diverse set of determinants, some of which may be difficult to model.

However, as we are less concerned in this paper with identifying the "true" structural model of investment than with having a model that explains historical investment behavior reasonably well, we opt here for an unrestricted reduced form equation for each investment series that includes variables likely to help predict investment in that category. Such equations track investment behavior within sample reasonably well.

In summary, our modelling approach is to estimate reduced form equations to explain investment by asset and industry over the pre-1986 period, leaving out tax variables which, we have argued, historically are extremely difficult to measure. Using these equations, corresponding to expression (5) above, we form predictions of investment for the post-1986 period for several assets and industries. In the second stage, we relate the resulting cross-section of investment residuals to the post-1986 deviations in tax incentives from those predicted by the regressors in the first-stage investment equations.[7] [8]

4. Data

We study investment at the level of asset and industry. Our series on real (1982$) investment by asset and industry come from unpublished Bureau of

Economic Analysis (BEA) data, provided us by John Musgrave of BEA. These data provide annual observations from 1947 (in some cases earlier) through 1989, and also include corresponding values of net (of depreciation) capital stocks. In our empirical analysis we normalize each investment series by its own beginning of period capital stock. These data also include current dollar net capital stocks, which permits the calculation of implicit price deflators for each investment category.

This data set provides investment and capital stock information for 36 asset classes, listed in Table 3. It also provides data for 12 industries, with the 36 asset classes aggregated into equipment and structures. We group these industry data into the seven industry categories given in Table 4.

For each of the 36 assets, we use the rates of economic depreciation provided by Jorgenson and Sullivan (1981)[9] Our estimates of corporate tax rates and depreciation rules for each asset come from Auerbach and Hassett (1990b)[10].

The tax rules applicable to equipment and structures in any industry depend at least in part on the composition of that industry's capital stock. Suppose, for example, that relationship (4) holds for the investment-capital ratio for each asset in an industry with respect to its own cost of capital. Then the industry's total investment-capital ratio should relate to a term equal to a weighted average of the asset-specific costs of capital, with weights equal to the shares of each asset in the industry total.

In similar fashion, some of the determinants of investment in a particular asset will depend on conditions in the industries which use the asset. For example, strong computer investment may be partially explained by high profitability in the industries that use computers intensively, rather than by the low price of computers. Here, we need some measure of the industrial location of each asset, rather than the asset composition of each industry. To obtain both types of measure, we need estimates of the use of each type of asset by each industry. We derive such estimates using an algorithm described in the Appendix.

Other data, on interest rates, inflation rates, corporate and noncorporate profits and capital consumption allowances, are taken from CITIBASE and published NIPA sources.

5. Explaining Investment Trends

As we indicated above, we use a two-stage estimation approach, first fitting reduced form models of investment behavior for the pre-tax-reform period without including variables to measure the impact of taxes, then relating the out-of-sample post-tax-reform residuals to residuals in tax rate variables. The Tax Reform Act became law during 1986 and had provisions with different effective dates during the year. Thus, as the year 1986 is in a sense neither pre-tax-reform nor post-tax-reform, we omit it from our analysis, defining the period before the reform as 1953-85 and the post-reform period as 1987-89.

In this section, we discuss the specification and results of the first stage regressions based on postwar investment behavior through 1985. Using variables that theory suggests ought to influence investment, we found that the within-sample investment-capital ratios for each asset were reasonably well explained by reduced form equations including as independent variables a constant, a time-trend, the lagged own investment-capital ratio, the own relative capital goods price (based on the price deflator derived from beginning-of-period nominal and real capital stocks and the GNP deflator), the lagged ratio of before-tax cash-flow to capital for the industries using the asset[11], the lagged real interest rate (equal to the 3-month Treasury bill rate less the rate of change in the GNP deflator) and an oil price series.[12],[13]

With these equations, we forecast investment-capital ratios for each of the asset and industry investment series, using forecasts for the lagged investment-capital ratios for years after 1985. The forecasts by year and asset are shown in Table 5; those for different industries are shown in Table 6.

As each of these tables shows, the models overpredict investment for both equipment and structures in the aggregate for the period 1987-89, regardless of whether the investment equations are estimated for each asset separately or by aggregated into equipment and structures by industry.[14] Moreover, the overprediction is widespread.

Consider first the behavior by asset class given in Table 5. Investment in the biggest single category of investment, computers and related machinery, falls far below prediction. As Figure 1 shows, a look at investment behavior in this asset class over time readily indicates why: the investment capital ratio peaked in 1985, the last year before the Tax Reform Act of 1986. However, even if one eliminates this important asset class, as well as a less important one for which the predictions were implausibly high (construction machinery)[15], the equations still overpredict equipment and structures investment in the aggregate. In some cases, one can see influences of negative shocks in particular industries. However, for the period 1987-89, only two categories of equipment investment actually exceeded their predicted levels.

For structures, investment over the period was also broadly below predicted levels, as only gas pipelines and service-oriented structures (educational, religious and hospital buildings) exceeded the investment levels forecast. Aggregated by industry categories of equipment and structures, investment fell short of prediction in every category, which is not surprising given the relative unimportance of all of the asset categories in which investment grew faster than predicted.

Given these surprisingly strong predictions of investment in equipment, we experimented with a number of alternative specifications of the first-stage investment equations to see how sensitive the out-of-sample results were to the choice of regressors. Inclusion of lagged changes in industry or aggregate output had little effect on within-sample or out-of-sample predictions. However, omitting the trend did reduce the extent of out-of-sample overprediction somewhat. For the sake of comparison, we present out-of-sample forecasts for asset investment based on this alternative specification in parentheses. Aside from eliminating the ridiculous prediction for asset category 6 (see footnote 15 above), omission of the trend reduces the predicted investment for most categories of equipment, although a substantial overprediction for most categories remains. While we do not advocate choosing a prediction equation after observing out-of-sample performance, we do find it reassuring that the general pattern is robust. One can certainly argue with the investment forecasts for particular assets and industries, but the overall picture is striking: investment, in general, performed worse than predicted by the reduced form equations based on the period 1953-85. Of course, there are many possible explanations for this result in addition to the Tax Reform Act of 1986. To distinguish among explanations, we analyze the pattern of this post-1986 performance, comparing the prediction errors of our individual investment equations to the changes that might be explained by the provisions of the Act.

6. Estimating the Impact of the Tax Reform Act of 1986

Having generated forecasts of 1987-9 investment for the 36 asset classes and 14 industry equipment and structures categories, we need measures of the tax incentives facing such investment.

Theory tells us that the tax wedge facing new investment is included in the cost-of-capital term given in expression (3), which also depends on the required rate of return and the relative price of capital goods. Since these latter variables are already accounted for in our predictive equations for investment, we construct a separate "tax wedge" variable based on (1) for fixed values of the real interest rate and the relative capital goods deflator of .04 and 1, respectively. That is, for each investment category, we construct as a measure of the tax wedge facing new corporate investment the variable:

$$(7) \qquad T = (1-\Gamma)[.04 + \delta - \frac{\Delta(1-\Gamma)}{(1-\Gamma)}]/(1-\tau)$$

with the present value of tax savings from depreciation, Γ, also calculated using a 4% real discount rate, based on actual tax rates τ and depreciation schedules applicable in each year and the assumption that each of these will remain fixed after 1990.[16] We also assumed that the inflation rate after 1989 would remain constant at its 1989 value. For industry investment, we use values of δ and Γ based on our matrix of estimated capital stock weights.

Since the value in (7) is based on corporate investment, we could recalculate it using some measure of the average marginal tax rate on noncorporate investment as well, and take a weighted average using our estimate of the share of noncorporate investment in each industry and, implicitly, each asset. However, this procedure would not have a major impact on our estimates of T, since corporate and individual tax rates are not very different (the top two personal brackets are 28% and 33%, versus the corporate tax rate of 34%).

On the other hand, the 1986 act did introduce a variety of provisions aimed at curtailing tax shelters and other activities producing tax deductions for noncorporate entities such as partnerships, as opposed to corporate investors. For example, real estate investors now face limitations on the deductibility of losses that their investments generate. There is evidence that such changes may have had powerful effects on investment in rental housing (Auerbach and Hassett 1990a, Poterba 1990), and they could be important in influencing certain categories of nonresidential investment as well, such as the building of commercial structures.

As the effects of such provisions on marginal tax rates are likely to be quite complex and difficult to model, we will simply include the noncorporate share of investment for each of the categories as explanatory variables in the cross-section analysis, letting the data indicate whether there is any systematic relationship between post-1986 performance and the degree to which investment takes place outside the corporate sector.

We consider the cross-section behavior of equipment and structures separately. The coefficient of the tax wedge term theoretically should depend on the speed of adjustment to tax changes; one would expect the reaction of equipment investment to be much faster. Moreover, the tax shelter provisions aimed at noncorporate investment, the impact of which we have not explicitly modelled, were aimed primarily at certain types of structures investment.

Table 7 present results for equipment by asset class, and Table 8 presents those for structures. Results based on industry breakdowns were qualitatively similar, but the small number of industries (seven) provided limited degrees of freedom and typically larger standard errors.

The first column of Table 7 provides the results of the basic, unweighted regression of the equipment investment forecast errors for 1987 from Table 5 on the effective marginal tax rates for the same year, T (based on equation 7), purged of the components predictable using the regressors in the investment equations. This is an estimate of expression (6) above. Recall that our theory says that the coefficient of the tax rate surprise term is an estimate of the sensitivity of investment to the unobservable expected tax rate itself in the underlying investment equations. The dependent variable should equal a random, zero-mean disturbance plus the tax rate effect for which the first-stage regressions fail to control. Hence, the constant estimated in the second-stage regressions should have an expected value of zero.

In light of the theory, the equation fits almost "too well." The constant has a point estimate of 0.00, the equation has a high adjusted R^2, and the coefficient of the marginal tax rate term is very significant.[17] Taken at face value, this equation suggests that the entire gap between actual and predicted equipment investment in 1987 was due to the tax rate changes that occurred. The negative estimated relationship is clear from the plot of investment and tax rate surprises given in Figure 2. One might suspect that these results are being driven by the couple of assets with very large errors. Leaving out assets 6 (construction machinery) and 11 (computers) does reduce the coefficient of the tax rate surprise by about one-half, but it remains significant, and the constant becomes more negative. Alternatively, weighting the estimates by the relative importance of the assets in total investment (using for each observation's weight the square root of its 1985 capital stock) produces the estimates in column 3 of the table, with a tax wedge coefficient quite similar to that in column 1 but the constant more negative.[18]

These first three equations suggest that the variation in investment across categories of equipment is quite sensitive to changes in marginal effective tax rates. In recent years, a vein of research has emphasized instead the importance of average tax rates in suggesting that investment may be very sensitive to the internal cash flow of a business.[19] To test this theory, we constructed an alternative tax variable, meant to measure the ratio of tax payments to capital for each asset, smoothed for fluctuations in profitability.[20] This variable should provide a measure of the reduction in cash flow associated with tax payments in a particular year. For a variety of reasons, such tax payments may vary independently of effective marginal tax rates. Hence, if taxes matter because of their impact on cash flow, rather than directly on investment incentives, this variable, rather than the marginal tax rate used in the first set of regressions, should exert a negative influence on investment. As column 4 of Table 7 shows, this is not the case. Indeed, the ratio of taxes paid to capital, purged of its predictable component, has a coefficient that is insignificant and has the wrong sign.

As noted above, some of the 1986 tax changes affected corporate and noncorporate investors differently. While this is likely to matter more for structures, we also consider the potential impact on equipment investment. Column 5 presents the basic specification, with the fraction of noncorporate investment estimated for each asset added as an explanatory variable. As the table shows, this adds little to the regression.

All of the results for equipment thus far are for the year 1987. Predictions for the years 1988 and 1989, or for the combination of the three years, do involve some additional problems. First of all, investment data for 1988 and 1989 are still preliminary. Recent revisions of 1987 and 1988 data produced considerable changes in certain investment categories, particularly computers.[21] Second, the power of the tests using later years' data may be lower, since the portion of the tax rate term that can not be predicted using the regressors of the first-stage investment equation is likely to be smaller for 1988 and 1989. Recall that these are not truly "surprises" to investors, simply the components of the tax rate terms that are not already picked up in the initial investment equations. Since 1987 was the first year of a transition period, there were some one-year effects included in the effective tax rate on investment in 1987 that were absent in 1988 and 1989 (see footnote 13).

This latter effect appears to be present in column (6) of Table 7, which presents results for the basic specification based on averages for the years 1987, 1988 and 1989. While the point estimates are quite similar to those in column 1, the t-statistics and adjusted R^2's are lower. The investment and tax rate "surprise" series, plotted in Figure 3, show the same general pattern as those for 1987 given in Figure 2, but with both series somewhat smoother.

However, leaving out the two asset classes with wildly inaccurate forecasts (construction machinery and computers) produces (see column (7) of the table) results that are very close to those based on the same assets for 1987 alone.

Given the sensitivity of the first-stage equipment regressions to the inclusion of a trend, we also ran second-stage regressions to explain the alternative forecast errors (given in parentheses in Table 5) produced without including a trend among the explanatory variables. Two of these regressions are presented in the last two columns of Table 7. The first repeats the basic regression in column (1). The absence of the strong residual for asset #6 appears to have weakened the relationship. However, omitting the one remaining outlier, computers, produces a very significant result. (Virtually the same estimates are obtained if one also omits asset #6.) Similar results hold for other specifications; if computers are omitted from the analysis, the coefficient of the tax wedge is generally quite negative and signficant. As a final check of the robustness of our findings, we also reestimated the first-stage equations (with and without trend) for a sample period ending in 1980, and used these equations to forecast investment after 1985. Truncating the sample period in this way did not alter the results qualitatively.

Thus, the results for equipment suggest that the 1986 tax changes may have exerted a significant effect on investment and help explain why equipment investment was not even stronger during the past few years. How plausible are these results? One way to address this question is to consider the plausibility of the coefficient of the marginal tax rate variable. In the different specifications presented in Table 7, this coefficient ranges between -.43 and -1.00. In our own recent work (1990b), in which we attempted to estimate the coefficient of the tax rate variable itself using a structural approach based on aggregate time series for equipment, the point estimates were roughly half this size. However, given the interpretation that the structural model places on the coefficient, even the larger estimates are not unreasonable in terms of the underlying theory.[22]

The pattern of structures investment after 1986, on the other hand, proves much more difficult to explain. Table 8 provides estimates based on the 14 types of structures comparable to those presented for equipment in Table 7. As the table shows, it is not possible even to get a positive adjusted R^2 in attempting to explain the pattern of investment shocks.

There are several factors that seem to be producing this difference. An examination of Table 5 indicates that one difference is the much smoother nature of structures investment. The shocks to structures investment are typically smaller in absolute value. Part of this smoothness may be due to the longer gestation lag and higher adjustment costs facing structures investment. In addition, the interasset changes in taxation associated with changes in depreciation schedules tend to be smaller than for equipment, largely because depreciation itself is a smaller factor for long-lived investment. Finally, there are additional tax factors that have not been taken into account. For example, a large portion of the assets in categories 25, 26 and 27 are owned by tax-exempt organizations, while assets in categories 30-34 are in many cases owned by regulated utilities, which are subject to a variety of special rules. However, leaving either or both classes of assets out does little to improve the estimates for the remaining categories of structures.[23] While an asset type having a greater fraction of its capital stock outside the corporate sector does produce the predicted negative coefficient (in column 4), this effect, too, is estimated quite imprecisely.

7. Conclusions

The results in this paper suggest that the Tax Reform Act of 1986 may have exerted a considerable impact on equipment investment after its passage. The strong performance of equipment investment during the late 1980s actually fell short of what simple reduced form models would have predicted based on behavior through 1985, and the pattern of the overprediction corresponds well to the pattern of changes in marginal effective tax rates facing new equipment investment.

The results for structures investment are considerably less informative, but the findings as a whole help to explain the puzzle of the pattern of investment behavior since 1986. Viewed from an historical perspective, the strong performance of equipment investment in recent years simply continues the evolution of the composition of the nation's nonresidential capital stock. In this context, the performance of equipment investment has not been especially strong relative to structures investment, and the investment rates for both equipment and structures, taking account of the estimated impact of the tax changes, are not out of line with predictions.

Appendix: Estimating the Industrial Composition of Investment

To estimate the tax rules that apply to each industry's investment, we need to know the composition of that industry's capital stock. Our data set includes annual capital stocks by asset class and by industry for equipment and structures. However, it does not provide a full breakdown of each industry's equipment and structures capital stocks.

Detailed data on investment are available for selected years, however, from the BEA's capital flow tables. The most recent table currently available is for 1977, given in Silverstein (1985). The 1977 capital flow table uses the same 36-asset categorization for nonresidential investment. While it also follows the same industrial categorization as the annual BEA series on investment, the two data sources differ in the industries to which certain types of investment are allocated. To overcome this ambiguity, we group industries.[24] Thus, we have capital stocks by asset, industry (equipment) and industry (structures) annually and, for a single year, investment by asset and industry.

For selected years from 1953 to 1985, we use the capital flow table to estimate capital stocks by industry and asset class using an RAS iterative scaling method, following an approach used by Fraumeni and Jorgenson (1980). This method finds a solution to the cell entries (capital by asset and industry) consistent with the row and column totals (capital by asset, capital by industry), using the 1977 capital flow table as a starting point.

First, we scale each row of the capital flow table (representing one of the 36 assets) up or down so that its total equals the capital stock of that asset class for that year. Then, we scale each column of the table (there are 14 columns in all, each one representing either equipment or structures capital for one of the seven industry groups) so that its total equals the total equipment or structures capital stock for that industry and year. We then iterate this procedure until we have a capital stock matrix that is consistent with both the row and column totals. Annual estimates of the capital stock matrices are obtained from these selected years' calculations using linear interpolation.

Table 1

Nonresidential Equipment Investment: 1985-89
(billions of 1982 $)

Category	1985	1986	1987	1988	1989
Office, Computing and Accounting Machinery	65.0	73.1	85.2	100.5	115.9
Other Information Processing and Related Equipment	54.3	55.6	58.3	61.9	63.1
Industrial Equipment	64.6	62.3	62.4	69.5	74.9
Transportation and Related Equipment	61.5	59.9	61.1	68.5	63.8
Other Equipment	58.6	57.4	60.0	64.4	66.0
Total	304.0	308.3	327.0	364.8	383.7
Fraction of GNP	.084	.083	.085	.091	.093

Source: Survey of Current Business, July 1989 and 1990, Tables 1.8 and 5.7.

Table 2

Nonresidential Structures Investment: 1985-89
(billions of 1982 $)

Category	Year 1985	1986	1987	1988	1989
Industrial Buildings	15.0	12.7	12.2	12.8	15.3
Commercial Buildings	53.3	49.4	46.6	47.1	46.5
Public Utilities	25.1	25.7	22.3	21.8	21.3
Mining Exploration, Shafts and Wells	35.2	20.7	18.4	18.0	15.7
Other Structures	20.9	21.6	23.3	22.7	23.6
Total	149.5	130.1	122.8	122.4	122.4
Fraction of GNP	.041	.035	.032	.030	.030

Source: Survey of Current Business, July 1989 and 1990, Tables 1.8 and 5.5.

Table 3

Assets and Their Characteristics

	Rate of Economic Depreciation	Percent of Real Investment (1982$)		
		1953	1985	1989
Equipment				
1. Furniture and Fixtures	.1100	0.023	0.030	0.030
2. Fabricated metal products	.0917	0.022	0.018	0.017
3. Engines and turbines	.0786	0.013	0.004	0.002
4. Tractors	.1633	0.029	0.011	0.011
5. Agricultural machinery, except tractors	.0971	0.031	0.012	0.015
6. Construction machinery except tractors	.1722	0.026	0.021	0.019
7. Mining and oilfield machinery	.1650	0.019	0.005	0.006
8. Metalworking machinery	.1225	0.050	0.033	0.031
9. Special industry machinery n.e.c.	.1031	0.053	0.026	0.039
10. General Industrial including materials handling, equipment	.1225	0.041	0.036	0.035
11. Office, computing and accounting machinery	.2729	0.009	0.145	0.250
12. Service industry machinery	.1650	0.021	0.017	0.017
13. Electrical transmission, distribution, and industrial apparatus	.1179	0.035	0.026	0.023
14. Communications equipment	.1179	0.021	0.069	0.074
15. Electrical equipment, n.e.c.	.1179	0.005	0.015	0.017
16. Trucks, buses, and trailers	.2537	0.050	0.066	0.057
17. Autos	.3333	0.021	0.023	0.012
18. Aircraft	.1833	0.006	0.022	0.024
19. Ships and boats	.0750	0.015	0.003	0.003
20. Railroad equipment	.0660	0.034	0.003	0.005
21. Instruments	.1473	0.014	0.051	0.051
22. Other nonresidential equipment	.1473	0.010	0.020	0.021

Table 3 (continued)

Structures	Rate of Economic Depreciation	Percent of Investment 1953	1985	1989
23. Industrial buildings	.0361	0.065	0.033	0.027
24. Commercial buildings	.0247	0.053	0.118	0.089
25. Religious buildings	.0188	0.014	0.005	0.005
26. Educational buildings	.0188	0.012	0.003	0.004
27. Hospital and institutional buildings	.0233	0.009	0.011	0.012
28. Other nonresidential buildings, excluding farm	.0454	0.018	0.020	0.018
29. Railroads	.0176	0.031	0.008	0.004
30. Telephone and Telegraph	.0333	0.018	0.015	0.012
31. Electric light and power	.0300	0.063	0.034	0.022
32. Gas	.0300	0.022	0.002	0.011
33. Petroleum Pipelines	.0450	0.010	0.001	0.001
34. Farm nonresidential structures	.0237	0.023	0.004	0.003
35. Mining exploration, shafts and wells	.0563	0.108	0.080	0.028
36. Other nonresidential nonbuilding structures	.0290	0.004	0.006	0.006
Fraction Equipment		0.548	0.656	0.759

Sources: Rates of Economic Depreciation are taken from Jorgenson and Sullivan (1981), who present rates for a 34-asset class breakdown. One of these classes appears in our data broken down into 3 classes, (asset numbers 13-15), to each of which we assign the same depreciation rate.

Percent of Investment: Unpublished BEA data, supplied to us by John Musgrave of BEA.

Table 4

Industry Investment

	% of Investment				% Corporate (1977)
	Equipment		Structures		
	1953	1989	1953	1989	
1. Agriculture	12.9	2.7	4.9	1.7	16
2. Mining	4.5	0.9	24.7	12.2	69
3. Construction	6.3	1.5	0.1	0.1	68
4. Manufacturing	30.7	20.2	13.3	12.0	98
5. Transportation, Communication and Utilities	23.9	17.2	31.9	22.0	93
6. Wholesale and Retail Trade	8.2	16.0	4.6	14.1	81
7. Finance, Insurance, Real Estate (Nonresidential) and Services	13.5	41.4	20.6	37.4	46

Sources: Investment: unpublished BEA data

Corporate share of investment: based on ratio of NIPA capital consumption allowances in corporate and noncorporate sectors of the industry

Table 5

Investment Behavior After 1986, by Asset Class
(predictions in parentheses omit trend)

	1987			1987-1989		
Equipment	Actual	Predicted		Actual	Predicted	
1. Furniture and Fixtures	.193	.239	(.217)	.187	.241	(.211)
2. Fabricated metal products	.102	.148	(.136)	.112	.162	(.144)
3. Engines and turbines	.045	.094	(.074)	.043	.111	(.076)
4. Tractors	.194	.306	(.234)	.215	.292	(.234)
5. Ag. machinery, except tractors	.104	.143	(.096)	.126	.169	(.100)
6. Constr. machinery, exc. tractors	.199	.773	(.304)	.210	.522	(.294)
7. Mining and oilfield machinery	.091	.230	(.060)	.114	.238	(.098)
8. Metalworking machinery	.107	.145	(.108)	.114	.157	(.114)
9. Special ind. machinery, n.e.c.	.132	.123	(.133)	.166	.122	(.129)
10. General Industrial machinery	.117	.152	(.148)	.122	.154	(.145)
11. Office, computing & accting mach	.457	.751	(.712)	.451	.774	(.718)
12. Service industry machinery	.228	.297	(.251)	.232	.302	(.326)
13. Electrical transmission, etc.	.073	.094	(.094)	.074	.094	(.094)
14. Communications equipment	.171	.191	(.208)	.172	.180	(.211)
15. Electrical equipment, n.e.c.	.269	.353	(.322)	.268	.359	(.317)
16. Trucks, buses, and trailers	.246	.356	(.350)	.246	.325	(.321)
17. Autos	.083	.195	(.182)	.078	.171	(.155)
18. Aircraft	.171	.164	(.164)	.167	.157	(.158)
19. Ships and boats	.034	.049	(.028)	.035	.069	(.026)
20. Railroad equipment	.032	.059	(.056)	.045	.070	(.067)
21. Instruments	.231	.296	(.275)	.228	.311	(.277)
22. Other nonresidential equipment	.204	.207	(.232)	.208	.198	(.230)
Total Equipment	.176	.258	(.233)	.180	.255	(.232)
(excluding categories 6 & 11)	.142	.186	(.174)	.147	.185	(.209)
Structures						
23. Industrial buildings	.050	.060	(.052)	.055	.067	(.056)
24. Commercial buildings	.088	.110	(.113)	.084	.102	(.105)
25. Religious buildings	.042	.042	(.049)	.042	.039	(.050)
26. Educational buildings	.058	.034	(.031)	.052	.033	(.030)
27. Hospital and inst. buildings	.047	.038	(.045)	.051	.034	(.045)
28. Other nonresidential, exc. farm	.096	.147	(.135)	.094	.161	(.141)
29. Railroads	.032	.066	(.066)	.033	.067	(.067)
30. Telephone and Telegraph	.062	.073	(.082)	.056	.071	(.074)
31. Electric light and power	.052	.079	(.079)	.048	.085	(.082)
32. Gas	.047	.025	(.027)	.074	.025	(.030)
33. Petroleum Pipelines	.016	-.001	(-.037)	.018	.029	(-.009)
34. Farm nonresidential struc.	.019	.046	(.036)	.019	.061	(.048)
35. Mining expl., shafts & wells	.077	.144	(.125)	.079	.149	(.133)
36. Other nonresidential struc.	.075	.095	(.095)	.073	.100	(.096)
Total Structures	.064	.086	(.084)	.064	.088	(.085)

Table 6

Investment Behavior After 1986, by Industry

	1987		1987-1989	
	Actual	Predicted	Actual	Predicted
1. Agriculture				
Equipment	.113	.179	.129	.213
Structures	.023	.043	.023	.054
2. Mining				
Equipment	.070	.126	.087	.139
Structures	.072	.125	.074	.126
3. Construction				
Equipment	.171	.329	.179	.354
Structures	.041	.030	.041	.128
4. Manufacturing				
Equipment	.120	.134	.132	.148
Structures	.055	.069	.058	.079
5. Trans., Comm. & Util.				
Equipment	.131	.176	.129	.178
Structures	.051	.066	.051	.071
6. Wholesale and Retail Trade				
Equipment	.267	.333	.270	.313
Structures	.082	.106	.081	.097
7. FIRE and Services				
Equipment	.270	.335	.282	.331
Structures	.081	.100	.078	.098
Total Equipment	.176	.222	.184	.226
Total Structures	.064	.086	.064	.088

Table 7

Explaining Cross-Section Investment Behavior After 1986

Equipment, by Asset Class

Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Weighted	No	No	Yes	No	No	No	No	No	No
Period	1987	1987	1987	1987	1987	1987-9	1987-9	1987	1987
Outliers Excluded	No	6,11	No	No	No	No	6,11	No	11
Trend in 1st Stage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Explanatory Variable:									
Constant	-0.00 (-0.02)	-0.02 (-1.73)	-0.03 (-1.16)	-0.01 (-0.46)	-0.01 (-0.18)	-0.01 (-0.26)	0.00 (0.00)	-0.03 (-1.81)	-0.01 (-1.88)
User Cost	-0.99 (-5.62)	-0.43 (-3.31)	-0.82 (-3.13)	-0.85 (-4.27)	-1.00 (-5.39)	-0.83 (-1.88)	-0.65 (-2.87)	-0.54 (-1.64)	-0.65 (-4.23)
Taxes Paid	--	--	--	5.17 (1.27)	--	--	--	--	--
Fraction Noncorp.	--	--	--	--	0.02 (0.25)	--	--	--	--
$\bar{R}^2$	.59	.34	.56	.61	.57	.11	.28	.12	.46

(t-statistics in parentheses)

Table 8

Explaining Cross-Section Investment Behavior After 1986

Structures, by Asset Class

Model:		(1)	(2)	(3)	(4)	(5)
Weighted		No	Yes	No	No	No
Period		1987	1987	1987	1987	1987–9
Explanatory Variable						
Constant		−0.01 (−1.20)	−0.02 (−2.09)	−0.01 (−0.68)	−0.00 (−0.01)	−0.02 (−1.88)
Cost of Capital	−0.07	−0.13 (−0.40)	−0.19 (−0.79)	−0.16 (−0.56)	−0.09 (−0.72)	(−0.55)
Taxes Paid		—	—	1.77 (0.43)	—	—
Fraction Noncorp.		—	—	—	−0.03 (−0.66)	—
$\bar{R}^2$		−.07	−.20	−.14	−.12	−.06

(t–statistics in parentheses)

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Footnotes

1. All investment data used in the paper are real (1982 $) and gross of depreciation. The distinction between real and nominal investment is important, since there has been a significant decline in the relative price of certain capital goods, notably computers. We discuss this issue again below in considering the recent pattern of computer investment.

2. We provide a review of the recent literature in Auerbach and Hassett (1990b).

3. Indeed empirical evidence for the lack of predictability of the _ex post_ cost of capital has been used to support the theoretical argument that _anticipated_ tax rates should not vary over time (Judd 1989). We do not claim here that such _ex ante_ tax rates are constant, only that they are difficult to measure using available instruments.

4. The fact that the true values of c are not generally observable does not prevent us from estimating Π. We may obtain consistent estimates by regressing the ex post values of c, say c^*, on the vector X, under the rational expectations assumption discussed above that c^* is distributed around c with noise that is uncorrelated with the information set that includes X.

5. Indeed, the first stage R^2's for this auxiliary regression turn out to be quite low, in the neighborhood of .2 (with adjusted R^2's around .1).

6. These were the Economic Recovery Tax Act of 1981, the Tax Equity and Fiscal Responsibility Act of 1982, and the Deficit Reduction Act of 1984.

7. The methodology of regressing investment residuals on cost-of-capital residuals may suggest a similarity to previous empirical studies evaluating the effects of, for example, unanticipated money growth (see, e.g. Barro 1977), but this analogy is misleading. The residuals here are not surprises in the usual sense, merely unpredictable using the regressors in the investment equation.

An alternative to our two-step procedure would be to maximize the combined likelihood function. We prefer the simplicity of the approach used here. It has also been suggested to us that we consider treating the cost of capital as an unobservable, and use filtering techinques to evaluate our model. We feel this approach would be difficult to implement, as the stochastic process for the unobservable is difficult to specify.

8. While there are several differences in exact methodology, this approach is similar in spirit to the one taken by Bosworth (1985) to estimate the impact of the 1981 Economic Recovery Tax Act.

9. In recent work, Jorgenson and Yun (1989) have updated some of the Jorgenson-Sullivan estimates. However, their estimates are provided for a new, 51-asset scheme, rather than the 36-asset breakdown available to us.

10. In the years just before 1986, most equipment and some public utility structures qualified for the investment tax credit of 10%. Except for the most short-lived assets (primarily cars and light trucks), equipment was written off for tax purposes over a period of 5 years, while (after 1984) structures were generally permitted a tax lifetime of 19 years. Shorter lifetimes applied to public utility structures.

The Tax Reform Act of 1986 repealed the investment tax credit, set the corporate tax rate at 40% in 1987 and 34% thereafter, and established lifetimes for assets, based on the ADR midpoint lives used in the 1970s, of 3, 5, 7, and 10 years (using the 200% declining balance method) for most equipment, 15 and 20 years (using the 150% declining balance method) for most public utility structures, and 27.5 years for residential real estate and 31.5 years for nonresidential real estate (both using the straight-line method). Given the level of aggregation of our assets, most types of equipment fall into either the 5- or 7-year asset class.

11. This variable is defined for each industry as the sum of corporate and noncorporate profits before-tax plus capital consumption allowances, with each year's industrial distribution of an asset used to form a weighted average across industries for that asset.

12. For this series, we used the price of Household Fuel Oil, taken from Table C-59 of the 1990 Economic Report of the President.

13. The R^2's of the individual investment equations were in the range of .7, with adjusted R^2's, of about .6. The corresponding standard errors of estimate ranged from .015 to .040. The large out-of-sample forecast errors presented below suggest that the equations are not stable after 1986. Omission of an explicit tax effect is, presumably, one of the reasons for this.

Our ultimate findings of the importance of the tax variable do not depend crucially on our choice of sample; post-1986 forecasts based an equation estimated through 1980, for example, yielded similar results to those reported below.

14. For structures, these findings are almost identical to those of our earlier paper (1990a), despite the different methodology (a single aggregate equation in that paper versus disaggregate investment equations here, a structural model there versus a reduced form approach here). For equipment, however, the results are quite different. In our previous paper, we found that the structural model for equipment predicted behavior quite well for 1986 (which we do not consider here) and 1987, and underpredicted actual investment for 1988, regardless of whether the tax changes were taken into account. We believe this difference is attributable to the sharp changes in the composition of equipment investment that have occurred in recent years, a shift that justifies the present approach.

15. The very large error in predicting investment in construction machinery and, in Table 6, equipment in the construction industry, is attributable to the very erratic movement in cash flow in that industry around 1986. When the trend is omitted from the equation, the cash flow coefficient and hence the out-of-sample

prediction error is reduced substantially. In any event, this is an extremely small component of investment (see Tables 3 and 4), and omitting it from the analysis does not influence the results in an important way.

16. Since the corporate tax rate τ was not constant over the period (it equalled .4 in 1987 and .34 thereafter), the value of Γ changes between 1987 and 1988, making $\Delta(1-\Gamma)$ nonzero in 1987. This introduces more variation to the 1987 values.

17. As these are second-stage regressions, on might suppose that the calculated standard errors are incorrect. However Pagan (1984, p.233) shows that the standard errors of coefficients of "surprise" terms, such as the tax wedge variable, are in fact measured correctly when ordinary least squares is applied to the second stage.

18. We also considered an alternative generalized least squares correction, allowing for a common component in the stochastic disturbances across assets based on the within-sample residuals of the investment equations. This correction exerted a minimal impact on the estimates and standard errors, and its associated results are not reported.

19. See, for example, Fazzari, Hubbard and Peterson (1988).

20. To construct the variable, we first estimated the ratio of tax payments to capital for each asset and year, using the asset/industry weights constructed according to the algorithm described in the Appendix. Next, for each asset, we smoothed the series by regressing it on a constant and the industry's output-capital ratio and computing a value for each year based on the sample average output-capital ratio, equal to the actual series plus the coefficient of the output-capital ratio multiplied by the deviations of each year's output-capital ratio from the sample average.

21. The following are the levels of real investment in asset category 11 (Office, Computing and Accounting Machinery) taken from the August 1989 and August 1990 issues of the Survey of Current Business:

Year	SCB '89	SCB '90
1986	73.1	73.1
1987	95.5	85.2
1988	113.7	100.5

The downward revision of the overall level of equipment investment is smaller than that in this single category ($6.2 billion in 1987; $6.8 billion in 1988).

This revision helps explain why our earlier paper (1990a), which used the earlier version of the investment series, found investment in equipment in 1987 and 1988 to be consistent with the predictions based on past behavior, while our current investigation finds recent investment to have been well below our forecasts. However, the discrepancy is much too large to be accounted for by the roughly 2% decline in investment estimated for each year.

22. The structural model estimated in Auerbach and Hassett (1990b) is of a firm investing subject to quadratic adjustment costs. In the linearized version of the model, the coefficient of the user cost of capital, which corresponds to the tax rate variable used here, equals the ratio of the stable root of the investment equation divided by the cost of capital's "long-run" value multiplied by the elasticity of the marginal product of capital with respect to investment. For constant returns to scale production, this ratio converges to the term $1/(c^{*}\phi)$, where c^{*} is the average value of the user cost of capital and ϕ is the coefficient of the quadratic term in the adjustment cost function, typically estimated as the inverse of the coefficient in linear investment equations (e.g. Summers 1981). Such coefficients are typically around .03. Dividing by the sample average of about .2 for the marginal tax rate variable for equipment yields implied coefficients of around -.15, rather than -.4 to -1.0. However, these adjustment cost estimates are for aggregate investment, and one might expect that equipment investment is subject to weaker adjustment costs and reacts more quickly.

23. It is worth mention that these coefficients, like those for equipment, are larger in absolute value than those produced by our historical analysis of a structural model based on aggregate data.

24. In particular, while investments made by the nonprofit sector are included in the "Finance, Insurance and Real Estate" industry in the annual series, the capital flow table includes these investments in "Services". This makes it necessary for us to aggregate these two industry groups in our analysis. Given the large size of the resulting "industry" of Finance, Insurance, Real Estate and Services, we also aggregate some of the other BEA industries to maintain comparability, including Wholesale Trade and Retail Trade; Transportation, Communication and Utilities; and Durable Manufacturing and Nondurable Manufacturing. The remaining industries for which investment data are provided, Agriculture, Mining and Construction, are kept separate despite their relatively small size because of their very distinct characteristics.