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Tax Incentives and Equipment Investment

OVER THE PAST FORTY YEARS, tax treatment of income from capital in general, and income from producer's durable equipment in particular, has been changed in the United States an amazing number of times. Depreciation allowances have been accelerated and then retarded; depreciation methods have ranged from straight line to double-declining-balance; investment tax credits have been enacted, suspended, reinstated, eliminated, re-enacted, and most recently, repealed again. In addition, both corporate and personal tax rates have moved over a substantial range.

All of this tinkering with the tax structure is hard to justify on any economic basis; the long-run attitude of investors would be better served by a stable policy that insures that political risk will not be added to the already considerable uncertainty about future after-tax returns. Why the frequent changes in business taxation have occurred is not clear. In general, the trend in tax rates has been downward, and reaching political consensus on this trend has been an uneven and contentious process. Inflation has at times created serious distortions in effective tax rates, and changes in the tax code may have been aimed at mitigating these effects. Most importantly, various administrations have attempted to use tax stimulus for investment as part of their efforts to fine-tune economic activity through short-term fiscal policy changes.

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Whatever the source of all the variation in business taxation, one result is clear; changes in tax rates on income from equipment capital have been significant, and form a natural experiment that can be used to measure the effects of tax incentives on aggregate investment behavior. In the discussion below, I will analyze the results of this experiment with an eye toward the possible effect of the investment stimulus proposals that are being offered by the Clinton administration. I will focus exclusively on investment in producers' durable equipment and will not attempt to analyze nonresidential structures. Although equipment and structures are complements in many cases, they behave very differently, with structures following a boom-and-bust pattern that is not easily explained.[1] Because investment incentives are typically targeted on equipment, and structures data would probably detract from the analysis, I do not consider them further.

Tax Treatment of Income from Equipment Investment

Nearly all discussions of tax incentives for business investment employ a formula that relates the cost of using an asset for a given period of time (say, a year) to its purchase price, tax variables, and a discount rate. If q is the relative price of one unit of capital (the price of investment goods divided by the price of output), δ is the exponential rate of economic depreciation, r is the after-tax discount rate, k is the rate of investment tax credit, u is the tax rate on income from capital, and z is the present value of depreciation for tax purposes, then the expected cost per year per dollar of the asset, $E(c)$, measured in output terms, is

$$(1)\quad E(c) = E[\{q(1 - k - uz)(r + \delta) + \Delta[q(1 - k - uz)]\}/(1 - u)].$$

Expectations enter equation 1 in a wide variety of ways, primarily through the capital gains term, $\Delta[q(1 - k - uz)]$. Expected future changes in q, k, u, and z will all help determine the path of c. In addition, expected inflation may affect the discount rate, r. One approach to dealing with these expectational complications is to decide that they are too

1. See Clark (1979). In particular, investment in commercial structures (primarily office buildings and shopping centers) seems to follow a pattern linked to the availability of construction funds, rather than any rational estimate of future demand or excess capacity.

difficult to measure and dismiss them.[2] If it is assumed that r, q, u, k, and z are known and constant, then equation 1 reduces to

$$c = q(r + \delta)(1 - k - uz)/(1 - u). \tag{2}$$

Equation 2 is the standard static expectations formula used in many large econometric models.[3] Assuming that the after-tax real discount rate is constant, then the relative price of capital services, c, is separable into a relative price term and a tax term:

$$c = [q(r + \delta)]\,[(1 - k - uz)/(1 - u)]. \tag{3}$$

If the after-tax real discount rate moves over time, then the separation is only approximate because the present value of depreciation for tax purposes, z, varies with r. In the discussion below, I call the second term in equation 3 the tax term; it is the ratio of the relative price of capital services with taxes to the relative price of capital services with no taxes.[4]

Figure 1 plots the tax term for three classes of equipment investment in the United States from 1953 to 1992.[5] Note that a value of one for the tax term represents tax neutrality; this would occur when there is no tax credit and there are immediate write-offs of equipment expenditure (that is, when $z = 1$). Over the last forty years, the tax term for the three asset classes shown in figure 1 has varied widely: from 1.57 to 1.14 for engines and turbines; from 1.41 to 0.98 for service industry machinery; and from 1.13 to 0.99 for automobiles, the class that has shown the least variation. If, as is sometimes assumed, the demand for capital has a price elasticity of 1.0, these variations in tax rates should have generated large changes in the desired stock of capital equipment. In turn, changes in the stock demand should have generated even larger swings in the flow of invest-

2. Over the last ten years, there have been a number of attempts to take expectational effects seriously by estimating Euler equations for aggregate investment. The parameters from such models have so far turned out to be unstable and unreliable for forecasting. See Oliner, Rudebusch, and Sichel (1992).

3. See Hall and Jorgenson (1967) for a derivation and discussion of equation 2.

4. The tax term in the relative price of capital services is related monotonically to the effective tax rate used in the tax literature. It is modified to some degree for 1962–63 and 1982–85, when the tax credit was subtracted from the depreciable basis for eligible equipment.

5. Other types of equipment show similar variation in effective tax rates.

ment. Of course, tax incentives operate with a lag because capital expansion takes time and expectational changes might obscure the impact of tax alterations. Still, it seems reasonable to assume that tax changes as large as those in figure 1 would generate investment shifts that are discernible in the data. In the next two sections, I measure these tax effects, first using aggregate quarterly data and then using annual data disaggregated by asset class.

Estimates of the Effect of Tax Changes

Assuming static expectations and a Cobb-Douglas production function for aggregate output, Y, the desired capital stock at any point in time, K^d, is a simple function of output and the relative price of capital services,

$$K^d = \alpha Y/c, \tag{4}$$

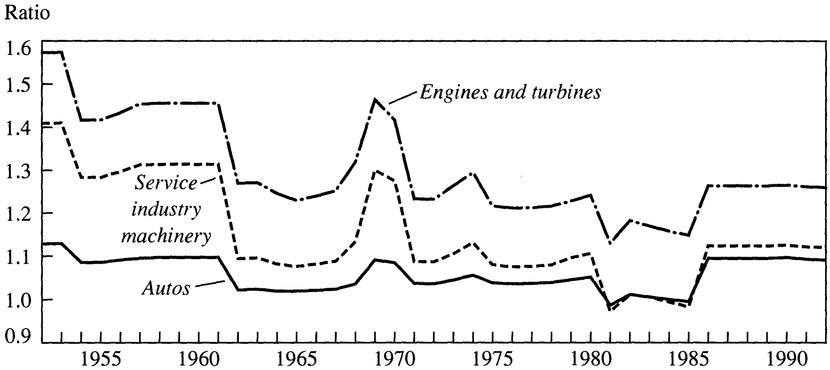
where α is the (constant) income share of capital equipment and c is the simplified version of the relative price of capital services in equation 2. To eliminate the effect of secular growth in output, both sides of the equation can be divided by trend or potential GDP (YP).[6] If the equation is written in terms of logarithms,

$$\ln(K^d/YP) = \ln(\alpha) + \ln(1/c) + \ln(Y/YP). \tag{5}$$

Over long periods of time, the cyclical output term, $\ln(Y/YP)$, should average out to zero, so equation 5 indicates that $\ln(K/YP)$ and $\ln(1/c)$ should exhibit equal percentage changes. In fact, over the past thirty or forty years, the equipment-output ratio has risen by a larger percentage than the rental price of capital services has fallen, as shown in figure 2. K/YP rose between 40 and 50 percent from about 0.3 in the 1950s and early 1960s to nearly 0.45 in the 1980s and early 1990s. At the same time, c fell between 20 and 30 percent, indicating an elasticity of substitution between capital and labor nearly double the standard assumption of 1.0. Another way to examine the elasticity of substitution is to test the hy-

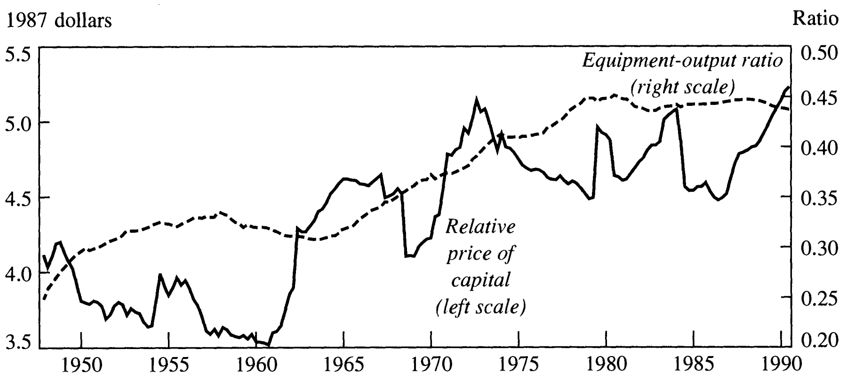
6. The YP series used below is experimental series from the Federal Reserve Board (1993).

Figure 1. The Tax Term for Three Types of Equipment Investment, 1953–92[a]



Source: Author's calculations using data provided by Jane Gravelle, Congressional Research Service (CRS).
a. The tax term is the ratio of the relative price of capital services with taxes to the relative price of capital services without taxes.

Figure 2. The Stock of Equipment Capital and the Relative Price of Capital, 1947–92[a]



Source: Author's calculations using unpublished data from the Federal Reserve, National Income and Product Accounts (NIPA), and data from Jane Gravelle, CRS.
a. The stock of equipment is the ratio of equipment to potential output. The relative price of capital services corresponds to equation 3 in the text, and is plotted as the reciprocal of this value at each point in time.

pothesis that ln (K/YP) and ln $(1/c)$ are cointegrated. Cointegration (and unitary elasticity) cannot be rejected at the usual significance levels (the p-value for a unit-root test is about 0.2), but the power of this test against the alternative of slowly diverging values is low.

To sharpen the estimates of how equipment spending reacts to its relative price (and utilization rate), equation 5 is modified in two ways.

First, distributed lags are added to model the apparently slow, smooth reaction of investment to price and output changes. Either a time-to-build or adjustment-cost setup will require such smoothing. Second, because the residuals estimated with their distributed lags exhibit two autoregressive roots—the first, almost exactly 1.0 and the second, around 0.95—the data are first-differenced and the equation to be estimated allows for first-order autocorrelation, as shown in equation 6.

$$\text{(6)} \qquad \Delta\ln (K/YP) = a + \Sigma\, b_s \Delta\ln (Y/YP)_{t-s} + \Sigma\, c_s \Delta\ln (1/c)_{t-s} + \epsilon_t + \rho\epsilon_{t-1}.$$

Because $\Delta\ln\,(K/YP)_t$ is approximately $\Delta K_t/K_{t-1}$ minus the (nearly constant) growth rate of potential GDP, equation 6 is a specification for percentage net investment. When $b_s = c_s$, equation 6 is essentially the neoclassical investment equation proposed by Hall and Jorgenson. When $c_s = 0$, equation 6 becomes an accelerator model. For unconstrained b_s and c_s, equation 7 allows the business cycle and the relative price of capital services to each affect investment, but does not require the elasticities or time pattern to be the same.[7]

Estimates of equation 6 are shown in table 1. As usual, the accelerator variables, $\Delta\ln\,(Y/YP)_{t-s}$, dominate in explaining the short-term variation in net investment.[8] Once the data are differenced, $\Delta\ln\,(K/YP)$ shows a standard business-cycle pattern, as illustrated in figure 3. Relative price effects are much more difficult to discern than they were in figure 2. If first-differencing is appropriate and equation 6 is the correct specification, then seen in terms of levels, the error term is a random walk with drift. Thus in table 1, the regressions estimate the extent to which $\ln(K/YP)$ can be distinguished from a random walk as a function of changes in relative prices. The sum of relative price coefficients is an estimate of how much of the rise of the equipment-output ratio can be attributed to relative price shifts, and how much must have originated elsewhere.

7. Separation of the output and relative price effects is in the spirit of Bischoff (1971), who rationalized the split with a putty-clay model of the capital stock. In fact, reactions to changes in prices and output could be different for a wide variety of reasons, particularly the speed at which current movements in each variable affect long-run expectations.

8. See Clark (1979) for an empirical comparison of these and related investment functions for equipment. I discuss neither a q model, which relates investment to the ratio of market price to replacement cost, nor a cash flow model because both models continue to fit the data poorly.

Table 1. Regressions Explaining Aggregate Equipment Demand, 1953:1–1992:3[a]

	Independent variables					
Constant	*Change in GDP gap(−)*	*Change in relative price of capital*	*All changes to tax code*	*ITC changes only*	R^2	*AR(1) serial correlation coefficient*
0.003 (0.002)	1.07 (0.22)	. . .	. . .	. . .	0.944	0.945
−0.016 (0.016)	1.01 (0.22)	0.012 (0.011)	. . .	. . .	0.950	0.935
0.002 (0.002)	1.14 (0.22)	. . .	0.21 (0.11)	. . .	0.952	0.947
0.003 (0.001)	1.08 (0.22)	. . .	. . .	0.34 (0.16)	0.948	0.939

Source: Author's regressions using National Income and Product Accounts (NIPA), unpublished Federal Reserve data, and unpublished data from Jane Gravelle, Congressional Research Service (CRS).

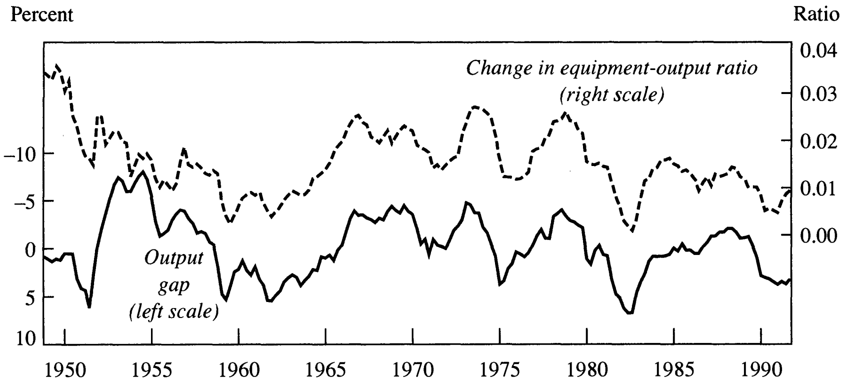
a. The regressions estimate variations of equation 6 in the text: $\Delta\ln (K/YP) = a + \Sigma\, b_s\, \Delta\ln (Y/YP)_{t-s} + \Sigma\, c_s' \,\Delta\ln (1/c)_{t-s} + \epsilon_t + \rho\epsilon_{t-1}$. The dependent variable is the change in the log of the equipment-output ratio. The numbers in parentheses are standard errors, and all coefficients reported (except the constant) are sums of a distributed lag.

When $\Delta\ln (1/c)$ is used as the relative price regressor in the second equation of table 1, the estimated price elasticity is very small: 0.01. Experiments with other, more complicated formulations of the relative price of capital services yielded similarly low price elasticities.[9] Narrowing the focus to the tax experiments over the past forty years gives more satisfactory results. Using overall tax changes as shown in the third equation of table 1, the sum of coefficients rises to 0.2 and becomes significant. When the investment tax credit is isolated, as shown in the last equation, the estimated elasticity rises to 0.34. This last regression is essentially an event study. Twice, in 1962 and 1971, an investment tax credit was enacted, and twice, in 1969 and 1986, it was repealed. The sum of coefficients on the ITC variable is an estimate of the long-run response of investment to these four changes.[10]

9. Possible variations for the relative price of capital services include the replacement of the constant after-tax discount rate (0.05), used for r in table 1, with a variable real discount rate based on such rates as bond yields and dividend yields. These regressions yield uniformly low relative price coefficients, indicating that if the real discount rate varies, it is difficult to measure or trace its effects.

10. The investment tax credit was also suspended for about five months in 1966–67, too short a time period for any observable effect. Including this suspension in the ITC regression variable increases its coefficient slightly.

Figure 3. Net Equipment Investment and the Output Gap, 1947–92[a]



Source: Author's calculations based on NIPA, and unpublished data from the Federal Reserve.
a. Net equipment investment is the change in the equipment-output ratio. Output gap is potential output minus output.

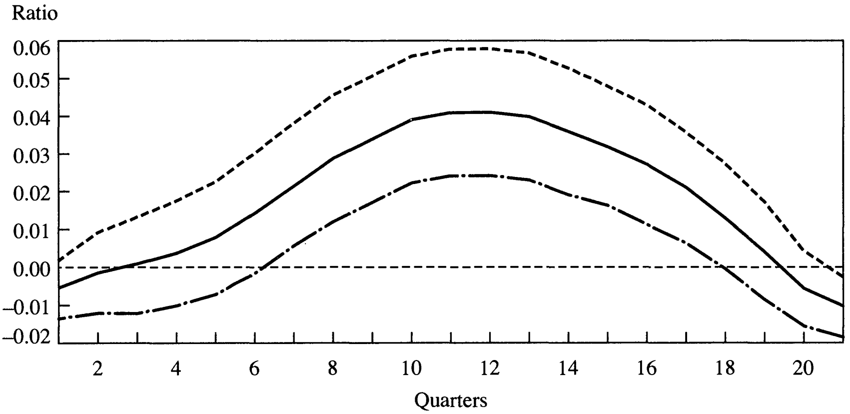
This last estimate is preferred, for two reasons. First, changes in the investment tax credit are accurately measured and clearly applicable to current equipment purchases. In contrast, income tax rate changes may not be expected to last the full life of some new assets. Second, changes in the credit are more exogenous than changes in interest or inflation rates, thus reducing simultaneous equation bias. The estimated distributed lag for the fourth row in table 1, along with error bounds of one standard deviation, are plotted in figure 4. The reaction of investment to a tax credit (or, in principle, to any other form of relative price reduction) is apparently delayed for at least a year, and the estimates are imprecise. Given both these observations, the investment tax credit is not appropriate for short-run fine-tuning of fiscal policy. While revenues spent on an investment tax credit will eventually produce some results, the amount and timing of the changes are uncertain.

The estimated response function shown in figure 4 is substantially different from those typically embedded in large-scale econometric models. For example, both the Federal Reserve Board's MPS model[11] and the Data Resources Inc. (DRI) quarterly U.S. model[12] allow the shape of the lag structure on output and relative prices to differ, but con-

11. Brayton and Mauskopf (1985).

12. Statement is based on proprietary DRI documentation. Also see Chirinko (1986) for a discussion of the effect of tax stimulus in various econometric models.

Figure 4. Response of Equipment Capital Stock to a 1 Percentage Point Increase in the ITC[a]



Source: Author's calculations using table 1.

a. The response of equipment investment follows the path of a distributed lag that corresponds to the results of the fourth row of table 1. The dashed lines represent one standard deviation from the path.

strain the long-run price elasticity to be 1.0,[13] much higher than the estimated value in figure 4. Both models seem to move the response forward in time, as well. Thus the results in table 1 indicate that the reaction of business fixed investment may be both smaller and later than the effects claimed by proponents of the tax credit who cite results from econometric model simulations.

In table 1, investment is modeled as a one-way process, with changes in output and relative prices moving exogenously and then affecting investment over a long period of time. Because output is clearly endogenous and feedback from output and investment could affect both relative prices and inflation, it is interesting to ask whether these feedback effects can magnify the importance of the tax or relative price variables. The answer, apparent in table 2, is "no." When a three-variable vector autoregression (VAR) with $\Delta \ln (K/YP)$, $\Delta \ln (Y/YP)$, and either $\Delta \ln (1/c)$, $\Delta \ln [(1 - k - uz)/(1 - u)]$, or Δk is estimated, the feedback from invest-

13. The long-run elasticity constraint of 1.0 is consistent with the observation that capital's share of income (both in the United States and other developed countries) has remained relatively constant over time. However, shares for particular subcategories have not. For example, in the United States, the apparent share paid to nonresidential structures has fallen substantially over the past forty years, and within the equipment category, relative shares for different asset classes have changed. It is unclear how much weight this indirect income share evidence should be given relative to the direct evidence in table 1.

Table 2. Impulse Response of Equipment Investment to Shocks in Output and Relative Prices[a]

Quarter	*Response of equipment investment to 1 percent shocks in:* GDP gap[b] (−)	Relative price of capital	All tax code changes	All ITC changes
1	0.00	0.00	0.00	0.00
2	0.10	0.01	0.00	0.00
3	0.18	0.01	0.00	0.00
4	0.25	0.01	0.01	0.00
5	0.27	0.01	0.02	0.01
6	0.26	0.01	0.02	0.01
7	0.23	0.01	0.02	0.01
8	0.20	0.01	0.02	0.01
12	0.11	0.01	0.01	0.01
20	0.04	0.00	0.00	0.00
Sum(1 to 20)	2.67	0.13	0.21	0.08

Source: Author's calculations using NIPA, unpublished Federal Reserve data, and data from Jane Gravelle, CRS.

a. This table shows, in a three-variable vector autoregression, the response of the change in the log of the equipment–output ratio to a 1 percent shock in the variables shown. All impulse responses estimated from three-variable vector autoregression use variables that take the following forms: $\Delta \ln (K/YP)$, $\Delta \ln (Y/YP)$, and, as the third variable, either $\Delta \ln (1/c)$, $\Delta \ln [(1 - k - uz)/(1 - u)]$ or Δk.

b. GDP gap responses shown are for vector autoregressions using log $(1/c)$; responses for VARs using all tax changes and only ITC changes are virtually identical.

ment to output magnifies the accelerator effect as output boosts investment, which in turn generates more output, and so on. It correspondingly diminishes the importance of relative prices. Whereas table 1 indicates an important role for the investment tax credit in the 1960s investment boom, the VAR cuts its estimated effect by more than half. Given the low precision with which the VAR coefficients are estimated, these results should not be overemphasized. I would merely interpret them as more evidence that the reaction of business investment to taxes and relative prices may be slow and erratic, and the long-run price elasticity of demand for equipment capital may be less than one.

Tax Effects on Equipment Investment Estimated from Disaggregated Data

Given the large assortment of types of capital equipment purchased by business, aggregation could cover up tax effects that are observable when different classes of equipment (with different tax treatment) are examined separately. This is particularly true when changes in the tax law have different effects on different types of equipment. For example, in 1981, the Economic Recovery Tax Act reduced the tax term $[(1 - k - uz)/(1 - u)]$ for office, accounting, and computing equipment by less than 7 percent, but cut it approximately 20 percent for ships and boats. The effects of this differential change might show up in panel data disaggregated by asset class, but could be lost when the asset classes are added together.

Table 3 presents summary statistics from equation 6 estimated with annual data for twenty different equipment classes. As was the case for aggregate quarterly data, the relative price coefficient rises as the focus is narrowed from all relative price changes to those attributable to the investment tax credit; I report only the latter results. For individual asset classes, levels of coefficient significance are generally lower than for the aggregates, both because of the lower frequency of data, and, more importantly, because the capital stocks within asset classes follow paths that are dictated by changing demand and technology, as well as relative prices. For example, both "ships and boats" and "mining and oilfield equipment" suffer significant declines after 1980, when the tanker market collapsed and the price of crude oil fell by more than 50 percent. Part of the recent spectacular rise in purchases of office, accounting, and computing equipment can be attributed to the plunge in the price of computers, but investment in communications equipment rose a similar amount without the same stimulus from falling relative prices.[14]

Despite these problems, some tentative conclusions can be drawn from table 3. First, the table presents evidence that the relative price of capital services has a long-run effect on the stock of capital equipment. The panel estimate of the relative price coefficient is more than one-half on an unweighted basis,[15] but falls to about one-quarter when the asset

14. Some of these unexplained trend problems might be remedied if investment in each class were disaggregated by two-digit industry code so that specific output indexes for each asset class could be constructed. Such an effort is far beyond the scope of this paper. Auerbach and Hassett (1991) report apparently larger tax effects than those in table 3 using partial one-digit disaggregation, but given the wide variety of explanatory variables in their study, it is not clear how much the limited industry split affected their results. Bosworth (1985) finds negligible tax effects across assets.

15. That is, when all equations in the panel are given equal influence on the common relative price coefficient.

Table 3. Regressions Explaining Net Investment Demand Disaggregated by Equipment Type, 1953–91[a]

	Independent variables				
Asset class	*Constant*	*Change in GDP gap(−)*	*All ITC changes*	R^2	*AR(1) serial correlation coefficient*
Automobiles	0.013[b]	2.35[c]	2.24[b]	0.56	0.66
Office and account. equip.	0.094	1.90	0.44	0.85	0.89
Trucks and buses	0.012	3.70[c]	1.61	0.84	0.56
Aircraft	0.038	2.75[b]	0.10	0.54	0.67
Construction	−0.010	3.04[c]	1.14	0.86	0.75
Mining and oilfield	−0.050	0.87	1.67	0.74	0.72
Service industry	−0.001	1.46[c]	−0.51	0.75	0.60
Tractors	−0.014	2.82[c]	1.61	0.74	0.74
General industrial	0.002	1.08[c]	0.49[b]	0.73	0.30
Metal working	−0.002	1.52[c]	0.37	0.73	0.51
Electric trans.	0.005	0.58[c]	0.32	0.70	0.56
Communications	0.052[c]	0.53	0.35	0.65	0.35
Electrical N.E.C.[d]	0.039[b]	1.27[b]	1.59[b]	0.68	0.70
Furniture and fixtures	0.013	1.04[c]	−0.20	0.73	0.75
Special industrial	−0.010[b]	1.02[c]	−0.12	0.68	0.52
Agricultural	−0.026	0.27	−0.03	0.85	0.93
Fabricated metal	−0.013	0.42	−0.06	0.89	0.89
Engines and turbines	−0.018	0.13	0.05	0.89	0.84
Ships and boats	−0.037	0.33	0.05	0.82	0.92
Railroad equipment	−0.037[c]	0.83	1.00[b]	0.71	0.62
Panel estimate	(−0.08, 0.10)	(−0.4, 3.1)	0.57[b]	(0.31, 0.86)	(0.44, 0.93)
Panel estimate excluding office and accounting	(−0.07, 0.10)	(−0.5, 3.5)	0.23[b]	(0.29, 0.87)	(0.45, 0.93)

Source: Author's regressions using unpublished data from the Bureau of Economic Analysis (BEA). The asset classes are listed in order of decreasing estimated depreciation rate as explained in Jorgensen and Sullivan (1981).
a. The regressions have the form of equation 6 in the text. The dependent variable is the change in the log of the equipment-output ratio.
b. Coefficient estimate has t-statistic between 2.00 and 2.99.
c. Coefficient estimate has t-statistic of 3.00 or greater.
d. Not elsewhere classified.

classes are weighted according to their standard error variances. These two values bracket the value obtained from aggregate data and strengthen the argument advanced earlier that the long-run price elasticity of demand for equipment capital may be only half as large as that assumed in many econometric models. Individually, seven of twenty classes have a relative price coefficient above 1.0, while fifteen of twenty classes have a coefficient greater than zero.

Second, it is apparent that the accelerator effect is concentrated in the demand for shorter-lived assets. The asset classes in table 3 are listed in order of decreasing estimated depreciation rate; almost all entries in the top three-quarters of the table have large and significant estimated output effects. The accelerator term for subsequent longer-lived entries is much smaller. This is not surprising; given the long planning horizon and useful life for twenty- or thirty-year assets, their purchase is less likely to be aligned with the business cycle.[16]

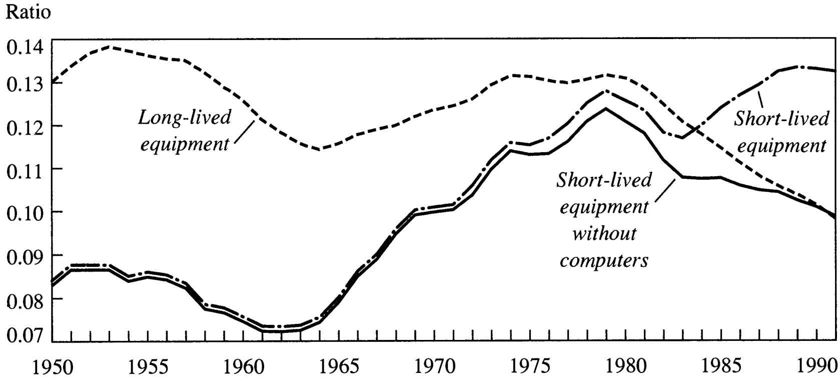
Third, disaggregation by equipment type reveals a divergence in the accumulation of short-lived versus long-lived capital. Figure 5 compares the evolution of capital-output ratios for equipment grouped by economic depreciation rates. Over the past forty years, the stock of short-lived equipment has grown relative to output, while the stock of longer-lived equipment has fallen. In the 1950s and early 1960s, frequent recessions caused the stocks of both short- and long-lived equipment to fall relative to output; faster growth and rising utilization in the remainder of the 1960s reversed this trend, with short-lived capital growing much more rapidly than long-lived capital. It is tempting to attribute this explosion in demand for shorter-lived capital to the investment tax credit enacted in 1962, which increased the bias in the tax law toward assets with shorter lives, as discussed below. Since 1979, the ratio of capital to output for both groups has fallen nearly monotonically (once the computer group is excluded)—despite the Economic Recovery Tax Act of 1981, which tended to benefit long-lived equipment investments, and the Tax Reform Act of 1986, which tended to reverse this effect.

Investment Stimulus Design

Although the shape and exact size of the effect of tax stimulus on investment is difficult to estimate, it is reasonable to assume that the long-run price elasticity is at least the 0.4 estimated in table 1, and that a reduction in the tax on income from capital will eventually boost investment. Given that assumption, a new question arises: What are the characteristics of the various types of tax breaks currently under discussion compared with those that have been used or proposed in the past? The standard candidates include investment tax credits, more generous de-

16. It is sometimes argued that the demand for long-lived assets should react to short-run changes in interest rates or output, given that purchase can be delayed or accelerated by a few months. Such assumed timing flexibility is probably unrealistic.

Figure 5. Equipment-Output Ratios for Short- and Long-Lived Equipment, 1950–91



Source: Author's calculations based on unpublished data from the Bureau of Economic Analysis (BEA) and the Federal Reserve Board.

a. Short-lived equipment includes autos, office and accounting equipment, trucks and buses, aircraft, construction equipment, mining equipment, service equipment, and tractors. Long-lived equipment includes furniture and fixtures, special industrial equipment, agricultural equipment, fabricated metal, engines and turbines, ships and boats, and railroad equipment.

preciation allowances, and reductions in the corporate tax rate.[17] Within each category, different nuances are possible. For example, the current Clinton administration proposal makes the investment tax credit incremental: that is, applicable only on investment that exceeds some base level calculated from past investment expenditures. Depreciation can be made more generous by allowing partial (or full) expensing of equipment in the year of purchase, as well as shortening the time interval for writing off the asset.

If static expectations are assumed, the theoretical effect of most of these tax variants can be analyzed by taking derivatives of the simplified relative price of capital services formula (equation 2), and a formula for the present value of tax revenues from a given investment, which is

$$T = [uc/(r + \delta)] - k - uz. \tag{7}$$

In equation 7, $c/(r + \delta)$ is the present value of gross revenue from a piece of equipment depreciating at exponential rate δ, so $uc/(r + \delta)$ is the present value of gross tax revenue, from which the investment tax credit, k, and the present value of tax write-offs, uz, must be subtracted. Differentiating equations 2 and 7 with respect to k and u yields

$$(\partial c/\partial k)/(\partial T/\partial k) = (\partial c/\partial u)/(\partial T/\partial u) = q\,(r + \delta). \tag{8}$$

17. See Gravelle (1992) for additional discussion of the issues addressed below.

Equation 8 states that *for a given piece of new equipment,* a dollar spent on either an investment tax credit or a corporate rate reduction reduces the rental price of capital services by exactly the same amount. This makes sense; potential purchasers of capital equipment care only about the present value of taxes that will be collected and not the form of the tax. The formula also indicates that the absolute change in the rental price of capital services per dollar of tax loss for changes in either k or u is directly related to its rate of economic depreciation. Given their high depreciation rate, short-lived assets have a higher user cost per dollar of investment; when the government grants tax relief that reduces c proportionately across assets, much of the benefit flows to shorter-lived equipment. Hence the observation that owners of such equipment get a disproportionate benefit.

To compare investment effects across asset classes, it is necessary to calculate $(\partial c/c)/\partial T$, the percentage change in c with respect to the present value of taxes. Dividing equation 8 by c,

$$(9)\quad [(\partial c/\partial k)/(\partial T/\partial k)]/c = [(\partial c/\partial u)/(\partial T/\partial u)]/c = (1 - u)/(1 - k - uz).$$

Because z is (usually) lower for longer-lived assets, equation 9 states that reductions in u or increases in k will increase the demand for short-lived assets more than for long-lived ones. The effects of various proposals on the shortest- and longest-lived asset classes discussed earlier (automobiles and railroad equipment) are shown in table 4. The baseline is current tax policy, with $u = 0.34$ and $k = 0$.

Note that a 7 percent investment credit generates a large reduction in effective tax rates—one that, averaged over differing assets, is roughly equivalent to almost 80 percent expensing of capital cost. But while the 7 percent credit has the same effect on capital costs for autos or railroad equipment, 80 percent expensing lowers capital costs more for the longer-lived asset. This results from the general bias in the tax structure against longer-lived equipment. Partial expensing moves the tax code toward neutrality in this respect.

The columns labeled BB (bang for the buck) in table 4 are theoretical values for the percentage change in the stock of equipment per dollar of present value of tax revenues lost. They are for new equipment only, calculated without regard for revenue losses on existing equipment. Because the value of the investment tax, k, and the present value of tax reductions due to depreciation, uz, enter the relative price of capital services formula in exactly the same way, the value for all forms of acceler-

Table 4. Theoretical Effects of Tax Changes on the Relative Price of Capital Services and Equipment Demand[a]

	Automobiles (depreciation rate = 0.333)			Railroad equipment (depreciation rate = 0.066)		
Tax proposals	*Change in relative price*[b]	*BB*	*BB**	*Change in relative price*[b]	*BB*	*BB**
Generic alternatives						
7 percent ITC[c]	−7.0	0.921	0.921	−7.0	0.898	0.898
80 percent expensing	−5.1	0.921	0.921	−8.2	0.898	0.898
0.34 to 0.30 corporate tax rate reduction	−1.3	0.921	0.307	−1.6	0.898	0.059
Clinton plan, big firm						
Graduated ITC[d]						
Full	−2.3	0.921	0.921	−7.0	0.898	0.898
Incremental, 80 percent	(−2.3, 0)	0.921	(4.6)	(−7.0, 0)	0.898	(4.5)
Temporary component in 1994	−6.2	...	...	−64	...	...
0.34 to 0.36 corporate tax rate increase	0.7	0.921	0.307	0.8	0.898	0.059

Source: Author's calculations.

a. All changes are measured from the baseline assumptions: $r = 0.05$, $u = 0.34$, $k = 0$, $q = 1.0$, inflation $= 0.03$, and the current depreciation schedule. BB is the bang for the buck when tax change applies only to new equipment. BB* is the bang for the buck when tax change applying to preexisting equipment is included.

b. Percentage change in relation price of capital.

c. Amount of tax credit excluded from depreciable base.

d. Parentheses indicate a range of uncertainty as discussed in the text.

ated depreciation is the same, and identical to the value for the ITC and corporate rate changes, as dictated by equation 9. The timing of the revenue loss is different for different options. The revenue loss for the ITC and partial expensing is immediate, while the standard forms of accelerated depreciation are "stimulate now, pay later" plans.

The numbers in the column in table 4 labeled BB* take account of preexisting equipment in calculating revenue loss. The BB* measure for the corporate rate increase is substantially lower than for the investment credit or accelerated depreciation because the lower corporate rate applies to returns on corporate investments made in the past, as well as returns on new equipment. The estimate given assumes a constant stock of a given type of equipment, so the ratio of new equipment to old is determined by the depreciation rate. A growing stock of equipment in either category would raise BB* to some extent. Over time, BB* for a corporate rate change will rise to the ITC level, as an increasing fraction of the capital stock will have been purchased under the new corporate rate.

The Clinton Plan

The Clinton administration has proposed a tax package aimed at stimulating equipment investment that is a combination of two of the items listed under generic alternatives in table 4, but also includes a wide variety of special features. For small firms, a graduated credit of 7 percent is proposed for 1993, falling to 5 percent after 1994.[18] For large firms (those with gross revenues of more than $5 million per year), the credit is both graduated and incremental, with 70 percent of base investment excluded in 1993 and 80 percent excluded in 1994. The credit for large firms is explicitly temporary, expiring in 1995. An incremental credit can, theoretically at least, raise the incentive to invest per dollar of tax loss. For example, if 80 percent of investment is excluded from eligibility for the credit, it seems like such an exclusion can quintuple the power of each tax dollar lost, as shown in table 4. But there are drawbacks. First, if the exclusion is based on past investment, some firms will be unfairly handicapped by extraordinary capital expenditures in earlier years. This effect can be reduced by using multi-year averages for computing the exclusion, but will still favor growing firms over stagnant ones. Over time, if the base is not adjusted, it gradually becomes irrelevant; if it is adjusted, firms recognize that today's investment reduces tomorrow's benefit, so the incentive is reduced. Then there is the leasing loophole problem. A company could create a new leasing company each year to buy its equipment, making all expenditures eligible for the credit, regardless of the incremental formula or past investment history. The Clinton proposal plans to avoid this by making lessees rather than lessors the recipients of the credit, but the regulations involved may be complex. And, because leasing is the standard way for growing companies with no tax liability to take advantage of the tax credit, additional distortion would be created.

The temporary nature of the proposed tax credit for large firms also creates some interesting incentives; in particular, large firms may try to move capital expenditures from the future into 1994, creating an investment pothole in 1995 and 1996. The elimination of the credit in 1995 creates a positive capital gain term in equation 1 because the expected value

18. Graduated means increasing with asset life. Three-year equipment gets one-third of the credit, five-year equipment gets two-thirds, seven-year equipment gets four-fifths, and longer recovery period equipment gets the full credit. This steep graduation more than offsets the bias toward shorter-lived equipment apparent in the top row of table 4.

of k drops from its graduated value back to zero, as shown in the last row of table 4. This capital gain has a potentially explosive effect on investment in 1994. Railroad equipment, listed in table 4, has an estimated economic depreciation rate of 6.6 percent per year; in 1993, its estimated user cost is 12.1 percent per year (with a 7 percent credit and 36 percent user cost rate). In 1994, user cost falls to 4.3 percent per year, counting the anticipated removal of the tax credit. This incentive to advance equipment spending from 1995 into 1994, combined with the apparent lagged reaction to relative price change in figure 4, may create an investment boom in 1994, followed by a bust in 1995. Again, the administration hopes to avoid this effect with recapture provisions for underinvestment in later years; in this case, the Treasury Department will be faced not only with writing and implementing a complex piece of legislation, but also with the prospect of penalizing firms whose circumstances have deteriorated after 1994.

The short-run divergence in cost-effectiveness between an investment tax credit and a corporate tax rate change raises the possibility that investment can be stimulated costlessly by introducing an investment tax credit and paying for it with a corporate rate increase, as envisioned by the Clinton plan. However, such a result is clearly myopic; raising the income tax rate on investments after they have been put in place might work the first time, and maybe even the second, but not in 1993, after almost forty years of constant tinkering with the tax code. Any firm contemplating an investment in new plant and equipment will make its decision based on expected rates of tax on profits over at least the life of the assets, or even longer if investment now is linked to investment later. Thus the net effect of an investment tax credit combined with a corporate rate increase to offset the revenue loss may in fact be negative, if it is viewed as an adverse signal about the government's attitude toward business.

The Equipment-Productivity Relation

So far, the evidence has indicated that the short-term relationship between tax policy and equipment investment is difficult to estimate precisely, and that the long-term reaction of investment to tax stimulus may be about half that assumed in most macroeconometric models. Furthermore, direct stimulus through an investment tax credit is biased toward equipment in general and shorter-lived equipment in particular.[19] Much of this negative assessment would be irrelevant if equipment spending had a strong positive effect on productivity growth, as has been claimed recently.[20] Such claims typically rely on the idea that newer vintages of capital have higher levels of productivity built in and add to the productivity of workers who learn how to operate them, so that higher rates of equipment investment raise productivity more than envisioned by standard growth accounting. J. Bradford De Long and Lawrence H. Summers, for example, show that for a wide cross-section of countries, equipment growth and productivity growth have a strong positive relationship from 1950 to 1990. If this cross-sectional effect can be applied to the United States in a time-series context, then favored tax treatment for equipment would be justified by its external boost to total factor productivity. On the other hand, if such effects are important only for developing countries moving toward the production frontier and are not relevant for countries like the United States, Germany, or Japan that are near the frontier, as claimed by Alan J. Auerbach, Kevin A. Hassett, and Stephen D. Oliner,[21] then tax distortions in favor of equipment investment are unlikely to aid U.S. productivity growth and could even hinder it by directing investment away from areas where its marginal productivity is highest.

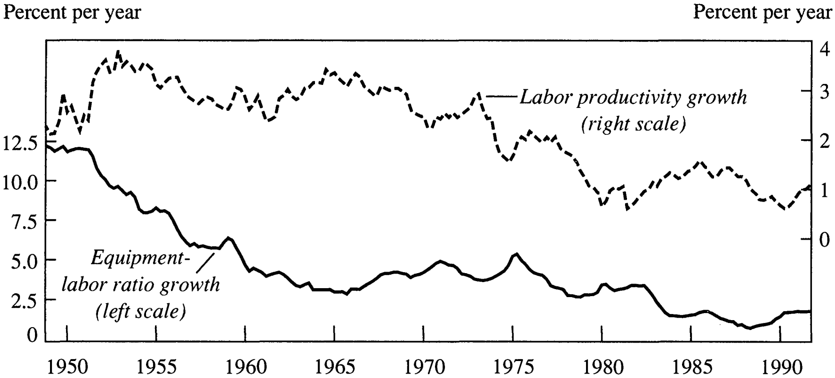
The time-series evidence for the United States does not indicate a disproportionate role for capital equipment in productivity growth. As indicated in figure 6, growth in both the output-labor ratio (labor productivity) and the equipment-labor ratio have fallen over the past forty-five years, but the patterns of decline have been opposite to the ones necessary to support the equipment turbocharger hypothesis. The growth of labor productivity remained high and relatively constant from 1947 to 1965, while the growth of the equipment-labor ratio slowed. Between the mid-1960s and late 1970s, labor productivity growth slowed, while the capital intensity of production grew. Finally, in the 1980s and early

19. This bias is reversed in the Clinton plan by the severe reduction in tax credit rates for shorter-lived equipment.

20. See De Long and Summers (1992).

21. Auerbach, Hassett, and Oliner (1992), using De Long and Summers' 1960–85 data, find that when the sample is restricted to OECD countries, equipment investment has no excess effect on productivity growth.

Figure 6. Growth in Labor Productivity and in the Equipment-Labor Ratio



Source: Author's calculations based on U.S. Bureau of Labor Statistics, *Productivity and Costs* (various issues), and NIPA. Both series have been exponentially smoothed.

1990s, productivity growth leveled off at a low rate, while growth in the equipment-labor ratio slowed further. Thus just looking at figure 6, one might conclude that the growth of capital intensity has a negative effect on productivity performance.

A better estimate of the effect of equipment investment on productivity growth can be obtained using the following partial adjustment model:

$$\ln H_t = a \ln H_t^* + (1 - a) \ln H_{t-1} + u_t, \tag{10}$$

$$\ln HP_t = \ln YP_t - f(t) - s_k \ln (K/HP)_t, \text{ and} \tag{11}$$

$$\ln (H^*/HP)_t = b \ln (Y/YP)_t, \tag{12}$$

where H_t is the hours of labor input in the private sector; H_t^* is the "desired" hours of labor input; $f(t)$ is the trend in total factor productivity (or labor productivity when the capital share, s_k, is set to 0); K_t is the net stock of equipment capital; Y_t is the output of the private business sector; and YP_t is potential or trend output.

Equation 10 states that hours partially adjust to a desired level every quarter; such a relationship can be derived from a quadratic adjustment cost model. Equations 11 and 12 then relate desired hours to current output, with $f(t)$ some smooth function for the trend in productivity growth. When equations 10, 11, and 12 are combined, they yield

$$\Delta \ln H_t = a \ln (Y_t/H_{t-1}) + a\{(b - 1) \ln (Y/YP)_t - [1/(1 - s_k)] f(t) - [s_k/(1 - s_k)] \ln (K/YP)_t\} + u_t. \tag{13}$$

Estimates for equation 13, with $f(t)$ specified as a linear spline, are given in table 5. The critical coefficient is the one for ln (K/YP); equipment capital's income share of output is between 15 and 20 percent, so standard growth accounting indicates that $s_k/(1 - s_k)$ should be between 0.18 and 0.25. When three derivative changes for $f(t)$ are specified (for 1966, 1973, and 1979), as shown in the third and fourth columns in table 5, the capital-output ratio coefficient is consistently negative, as expected from figure 6.[22] This negative estimate is not the usual cyclical one that occurs when labor productivity is regressed on the observed capital-output ratio; cyclical variations in output and hours are captured by equations 10, 11, and 12.

These observations coincide with those of Edward Denison, the dean of U.S. productivity analysts, who concluded that vintage effects are unimportant in explaining the evolution of productivity growth in the United States.[23] Denison argued that even if productivity is embodied in new capital, so that a decline in the average age of the capital stock boosts total factor productivity growth, the same decline also reduces the advantage of new capital over old. This reduces the impact of any vintage effects. Denison's analysis helps explain cross-sectional results that show a disproportionate role for equipment investment in countries that are moving toward the production frontier, but not for the United States, which cannot capture productivity improvement by importing new equipment. In developing countries, where thousand-year-old technology is being replaced, the gap between new and old equipment remains huge and Denison's offset is not important. In the United States, where even old equipment is modern by developing world standards, such is not the case. Given the weight of evidence against the conjecture that equipment investment boosts productivity growth more than investment in other assets, a return to the investment tax credit must be rationalized elsewhere.

A by-product of the productivity growth trend analysis above is an estimate of trend productivity improvement in the recent past. The regressions in the fifth and sixth columns in table 5 show that the large increases in productivity measured in 1991 and 1992 were largely cyclical. When the trend in labor productivity is allowed to change its growth rate in late 1989, the mean estimated increase is about 0.2 percentage points

22. If no change in total factor productivity growth is allowed, the effect of equipment growth is even more negative.

23. Denison (1979).

Table 5. Partial Adjustment Model Productivity Trend Estimates, 1953:1–1992:4[a]

Independent variable	Regressions (1)	(2)	(3)	(4)	(5)	(6)
Labor productivity	0.614	0.581	0.548	0.588	0.549	0.589
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
Equipment-output ratio	...	−0.17	...	−0.14	...	−0.13
		(0.07)		(0.09)		(0.09)
Trend[b]	2.62	2.85	2.91	2.88	2.91	2.88
	(0.21)	(0.26)	(0.26)	(0.28)	(0.26)	(0.28)
T66[b]	...	...	−0.61	−0.18	−0.61	−0.19
			(0.17)	(0.30)	(0.17)	(0.31)
T73[b]	−1.69	−1.75	−1.45	−1.59	−1.42	−1.56
	(0.16)	(0.16)	(0.24)	(0.28)	(0.24)	(0.28)
T79[b]	...	...	0.21	−0.04	0.16	−0.07
			(0.17)	(0.22)	(0.19)	(0.24)
T89[b]	...	...	...	...	0.20	0.17
					(0.39)	(0.38)
GDP gap (−)	0.22	0.27	0.22	0.27	0.23	0.28
	(0.08)	(0.07)	(0.06)	(0.07)	(0.06)	(0.08)
Summary statistic						
R^2	0.70	0.73	0.73	0.73	0.73	0.73
Durbin-Watson	2.31	2.13	2.12	2.12	2.13	2.12
AR(1) serial correlation coefficient	0.79	0.59	0.56	0.58	0.56	0.58

Source: Author's regressions using U.S. Bureau of Labor Statistics, *Productivity and Costs* (various issues), and NIPA.

a. The regressions are variations of equation 13 of the text, $\Delta \ln H_t = a \ln (Y_t/H_{t-1}) + a\{(b-1)\ln(Y/YP)_t - [1/(1-s_k)]f(t) - [s_k/(1-s_k)]\ln(K/YP)_t\} + u_t$, with variations in the trend in total factor productivity allowed for as indicated by the T variables. The dependent variable is the change in the log of hours of labor input. The numbers in parentheses are standard errors.

b. Coefficients and standard errors in units of percent per year.

a year. The *t*-statistic for the change is only 0.5. While it is possible that low inflation, more computers, and the end of the baby boom are having an effect on long-term productivity performance, it is much too early to make any definitive judgement.

Conclusion

Most empirical analyses relating tax policy to equipment investment have failed to find strong, independent effects that are as large as those imbedded in many macroeconometric models. By focusing on past changes in the investment tax credit, I obtained an estimate of 0.4 for the long-run demand elasticity of equipment capital with respect to its relative price. It was difficult to estimate the timing of this reaction, but it is apparently delayed by at least a year, making tax stimulus a poor instrument for fine-tuning investment demand over the business cycle. Moreover, given the lack of empirical evidence that equipment investment improves productivity growth in the United States more than investment in other assets, moves to shift the business tax burden away from equipment are likely to hinder, rather than enhance, long-term productivity growth. In addition to these general problems, the Clinton administration's investment tax credit proposal faces a wide variety of difficulties that will make both its implementation and eventual impact problematic.

Comments and Discussion

Daniel E. Sichel: This paper takes us on a timely tour of the empirical evidence of the effects of investment tax credits on equipment spending, a topic that has been a subject of the Brookings Panel on several occasions in the past. In my comments, I will briefly summarize the main argument of the paper and then turn to a more detailed evaluation and critique of the evidence presented.

After laying out a standard derivation of the effect of tax changes on the user cost of capital, Peter Clark presents aggregate time-series evidence indicating a role for the investment tax credit (ITC) that is much more limited than in many large-scale econometric models. Wisely, he focuses exclusively on equipment spending, leaving aside the analytical swamp of structures investment. In the third section of his paper, he focuses on data disaggregated by type of asset. Clark argues that this evidence bolsters the view that the ITC has had only a limited effect in the past. The latter part of the paper identifies some of the issues relevant for designing an investment stimulus program, and, in a very timely piece of analysis, lays out the specifics of President Clinton's ITC and corporate tax proposals. Finally, the paper turns to the normative issue of whether an ITC would be a good thing from society's point of view, if ITCs had a significant effect.

The paper's conclusion can be succinctly summarized; Clark's evidence indicates that changes in the ITC have had only a limited and delayed effect on equipment investment, and, furthermore, that even if they did, an ITC is unlikely to have socially beneficial effects.

Now, let me back up and work through the evidence and arguments one by one. In his first section, Clark shows that over the years, tax changes have had a substantial effect on the user cost of capital, suggesting a prima facie case that tax changes should have had substantial effects on investment spending. However, the aggregate time-series evidence in the second section barely supports the prima facie case. I suspect that few readers would be surprised by most of the results here. In this section, Clark estimates several models of investment, all of which have the standard neoclassical model as their starting point. In the standard specification for equipment spending, the coefficient on the cost of capital is small and insignificant. Clark's preferred specification uses the change in the *level* of the ITC as a regressor, rather than the change in the *log* of the cost of capital as in the earlier regressions. For this ITC variable, he estimates a coefficient of 0.34. Because this variable is not entered in logs, however, its coefficient is only an approximation to an elasticity. Working through the algebra of the approximation, it turns out that the approximation is off by 30 to 40 percent, implying that the estimated elasticity is actually closer to 0.2. Thus, I take the aggregate time-series evidence as basically consistent with the conventional wisdom that it is difficult to dominate a simple accelerator model, as Clark has shown in an earlier Brookings paper.[1]

However, these results, and much of the macroeconomic empirical investment literature, leave a large unanswered question. Namely, do tax incentives really have a limited effect, or are the aggregate models simply unable to pick up their full effects because of the host of problems that plague macroeconomic investment equations?

For example, if the ITC has generally been used as a fiscal stimulus measure—and if Congress is somewhat slow to enact an ITC when the economy first tips into recession—then ITCs could have been put in place just before investment was about to enter a cyclical recovery anyway. With such a pattern, it would be extremely difficult to disentangle the effects of an ITC from the effects of the accelerator process.

More generally, a basic identification problem plagues estimates of the cost of capital coefficient in many time-series investment models. Consider the case of a very low cost of capital. If it is low because the supply of credit has shifted out, then one would expect to see the "usual" negative correlation between the cost of capital and investment as firms move down their investment demand curves, enjoying low-cost credit and undertaking new projects. On the other hand, if the cost of capital is low because other forces in the economy are shifting back the

1. Clark (1979).

demand curve for investment—for example, a cyclical downturn—then the low cost of capital might be correlated with low or declining levels of investment. Again, disentangling the cost of capital effects from the cyclical effects could be quite difficult. Finally, aggregation across assets and firms with different characteristics may preclude finding any effect of an ITC on aggregate equipment spending. Because of these widely acknowledged problems with aggregate investment equations, many economists continue to believe that tax incentives for investment have important effects, despite the aggregate time-series evidence.

To an extent, the question about aggregation can be answered by looking at disaggregated data, as is done in the third section of the paper. Such evidence could be especially important because, in the past, substantial differences have occurred in the tax treatment of different types of assets. In this section of the paper, Clark estimates investment equations for twenty different types of equipment, presenting both single-equation OLS estimates and a panel estimate. Just as for the aggregate time-series evidence, these results show a modest effect of the ITC on spending for many types of equipment.

However, here I'm not sure that the experiment is the most powerful that can be constructed. For example, suppose an important effect resulted from the repeal of the ITC in 1986. This effect would be expected to show up in the years following the repeal, and an event study might be more informative. In fact, this is precisely what Alan J. Auerbach and Kevin A. Hassett do in a 1991 Carnegie-Rochester paper.[2] These authors also use disaggregated data, estimating investment models for each different asset type. Then, for the year 1987, after the ITC was repealed, they examine whether the prediction errors by asset type line up with unexpected changes in tax incentives by asset type. They find a strikingly close correspondence and suggest that tax incentives could have quite large effects on investment spending and that these effects would not necessarily show up in the aggregate data.

Clark raises some questions about the interpretation of the Auerbach and Hassett results, and their evidence should not be taken as the definitive word on this issue. Nevertheless, their study of the 1986 tax changes does suggest that the jury probably should still be out on the question of the effect of tax incentives on investment. In addition, with

2. Auerbach and Hassett (1991).

an increasing amount of work being done on firm- and establishment-level data, opportunities exist to further examine the effects of tax incentives on investment with some of this very disaggregated data.

In the fourth section of the paper, Clark focuses on tax incentive design, comparing an ITC to changes in expensing provisions to changes in the corporate tax rate. The paper includes some interesting tables showing the "bang for the buck" for each of these different provisions; that is, what percent change in the cost of capital is induced for a dollar of lost tax revenue from each different provision. This seems like a sensible way to frame the discussion of tax incentives, and also highlights one of the appeals of an ITC; as a fiscal stimulus measure, it can potentially generate a substantial kick without too much revenue loss.

This paper also provides a useful description of President Clinton's proposal, which includes some elements that have not been tried before: namely, an incremental ITC and an ITC that treats "small" and "large" businesses differently. I take Clark's main point here to be that these new provisions are likely to suffer from serious implementation problems, requiring complex regulations and inducing firms to hire legions of tax lawyers to circumvent the intent of the legislation. I suspect that these implementation problems will sway few readers one way or another about whether Clinton's proposed ITC is a good idea. Those who favor an ITC on other grounds would likely see these barriers as surmountable, although they might regret creating extra employment opportunities for tax lawyers. On the other hand, I suspect that those who oppose an ITC on other grounds will find these implementation problems quite burdensome.

The final section of the paper turns from positive economics to normative economics. Even if one believes that an ITC has a sizable effect, the question still remains of whether an ITC is beneficial from society's point of view. Here, I find Clark's argument right on the mark. One of the strongest normative arguments in favor of an ITC comes from a Brookings paper by J. Bradford De Long and Lawrence H. Summers.[3] They provide cross-country evidence that equipment investment yields supernormal returns, leading to higher growth than expected from standard growth models for countries that invest heavily in equipment. However, as Clark points out, this evidence has been substantially un-

3. De Long and Summers (1992).

dermined by Alan J. Auerbach, Kevin A. Hassett, and Stephen D. Oliner, who find that the De Long and Summers results do not apply to the developed countries that presumably are already near their production possibility frontiers.[4] Clark also presents some time-series evidence for the United States suggesting that equipment investment has not yielded supernormal returns beyond the usual effects from capital deepening.

So where does this leave us? Clark's argument is that, first, ITCs have had a limited and delayed effect on equipment spending in the past, and that, second, even if they did have an effect, it might not be socially beneficial. Taking the second point first, it seems that—from a normative viewpoint—an ITC cannot be justified with supernormal returns to equipment investment. There are, though, other possible justifications. For example, an ITC may be an effective fiscal stimulus with a large bang for the buck. Alternatively, imperfections may exist elsewhere in the tax system or in other markets so that in a world of second best, an ITC might be an improvement over the current state of affairs. For example, housing capital is subsidized, so an argument might be made for subsidizing business fixed capital, too. Market or political failures also might occur elsewhere that prevent the United States from saving and investing enough, providing a possible argument for an ITC. These justifications, however, must be weighed against the revenue losses and the costs of making the tax code more cumbersome.

As to the first point about the effectiveness of ITCs, I suspect that—despite the time-series evidence—many economists and policymakers will continue to believe that altering the cost of capital will have important effects on investment. The evidence here probably is not convincing enough to bring the jury in and get a clear verdict that investment is one of those cases in which prices and taxes have limited effects.

General Discussion

Participants were divided in their opinions of the effect of an investment tax credit (ITC) and how to test for it. William Nordhaus found the paper's evidence persuasive in showing that the traditional Cobb-Doug-

4. Auerbach, Hassett, and Oliner (1992).

las assumption of unitary elasticity of substitution overstates the responsiveness of investment demand to the cost of capital. He also suggested that the lags in adjustment are much longer than are captured in traditional investment equations. These lags render the ITC useless for fiscal fine-tuning of an economy. Instead of the ITC, Nordhaus suggested using the innovative system of auctionable investment permits originally proposed by Leonard Ross. This proposal, like the newly implemented system of pollution permits, would eliminate uncertainty about the magnitude of the stimulus. Although the cost would be uncertain, as long as the market for permits cleared, policymakers would always be sure that they would hit their national investment target. Martin Baily agreed that the accumulation of evidence favored the view that the effect of changes in the cost of capital on investment was not as immediate, or the elasticity as large, as for changes in output. However, this did not mean that the effects were zero or postponed forever. Indeed, Baily observed, the results in the paper suggest that the ITC had an impact, while the author's concern about bunching of investment in anticipation of the end of the investment credit suggested that he also believed that the effects would be stronger than the econometric results in the study suggested. Benjamin Friedman pointed to figure 2 in the paper as visual evidence of a correlation between investment and price of capital, evidence that was missed in the difference equation. Friedman also questioned Clark's skepticism about getting a noticeable twist effect from introducing an ITC and simultaneously increasing the corporate tax rate, arguing that the temporal incidence of the two ways of changing the cost of capital was quite different.

Robert Hall expressed great skepticism about the use of time-series evidence to infer the response of investment to the cost of capital. Output and interest rates are endogenous. Because both output and interest rates are likely to respond positively to investment, the coefficient on output is likely to be biased upward, while the coefficient on interest rates is likely to be biased downward. He noted that even if one accepted Clark's view that the Federal Reserve targeted short-term interest rates—creating, in effect, a horizontal LM curve—the output effect would be overestimated even more. William Brainard pointed out that Clark's results were consistent with Hall's view; the coefficient on the ITC alone was much greater than for the cost of capital, which includes the interest rate. Robert Hall questioned whether even the ITC variable by itself is genuinely exogenous because ITCs are imposed or removed in response to prevailing conditions.

Agreeing on the econometric difficulties with time series analysis, several participants suggested that event studies were an important source of information and offered anecdotal evidence in support of the effectiveness of the ITC. Robert Hall reported that, in his experience, company executives always take the ITC into account when calculating hurdle rates of return on investment projects. James Tobin emphasized that the evidence suggested that, while the ITC itself may not have a large long-term effect, the expectation of an ITC being imposed or removed may have substantial effects.

Robert Hall expressed concern that the main effect of an ITC is to promote inefficient rent-seeking behavior. Nordhaus suggested that some might favor the distributional consequences of the ITC initially proposed by the Clinton administration because small businesses receive tax preference. But Clark noted that the effects of the proposal were distributionally perverse because owners of small businesses are on average wealthier than the ultimate owners of large corporations, who, for the most part, are individuals with average salaries who own shares indirectly through their pension plans.

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