What Is Behind the Capital Spending Boom?

Business-fixed investment (BFI) has grown, on average, at a much faster pace so far in this recovery than in previous recoveries. In particular, business equipment spending, by far the largest component of BFI, rose 39 percent over the last seven quarters since the recession trough in 1982-IV, compared with about 16 percent average growth over the corresponding period of earlier postwar recoveries (Chart 1). Many analysts argue that the unusual strength of business investment is the result of changes in business tax policy enacted under the Economic Recovery Tax Act (ERTA) of 1981 and the Tax Equity and Fiscal Responsibility Act (TEFRA) of 1982.[1] These changes are widely believed to have boosted business investment spending by lowering the cost of investing in plant and equipment. In addition, some argue that tax policy changes have created a highly optimistic climate about the future course of general economic conditions and this new wave of optimism or "animal spirits", so the argument goes, is an important element behind the recent investment boom.

If the view that the recent investment boom resulted from the 1981-82 business tax changes is correct, it has important implications for any further reforms of business taxation. In particular, the repeal of several important provisions of the 1981 ERTA, as proposed by the Treasury, would be expected to have a significant adverse impact on business investment Some analysts, in fact, believe that the current debate on tax reforms is already beginning to discourage business investment.[2]

We examined the effects of the 1981-82 business tax changes on investment by using two standard econometric models—one is fashioned after the FMP model; the other, after the BEA model. (Note that in neither case, however, did we use exactly the same specifications as the one presently in use at the Federal Reserve Board or at the Bureau of Economic Analysis. For details, see the appendix.) More specifically, we compared the out-of-sample forecasting performance of these models in the recent period with that in earlier periods. Our presumption was that if changes in long-term expectations and new animal spirits have unleashed significant amounts of further investment spending, the standard models would underpredict actual business investment. More generally, their forecasting performance would be considerably weaker after tax policy changes than before. In addition, we looked at the direct influence of changes in business tax policy on investment through their effects on capital cost variables in the standard models.

Our analysis indicates that the conventional econometric models track BFI spending as well in the 1980s as in earlier periods. This suggests that the recent behavior of capital spending is not materially different from past experience However, our analysis does suggest that business tax changes under ERTA/TEFRA significantly reduced capital costs below what would have existed under the pre-1981 tax laws. But judged

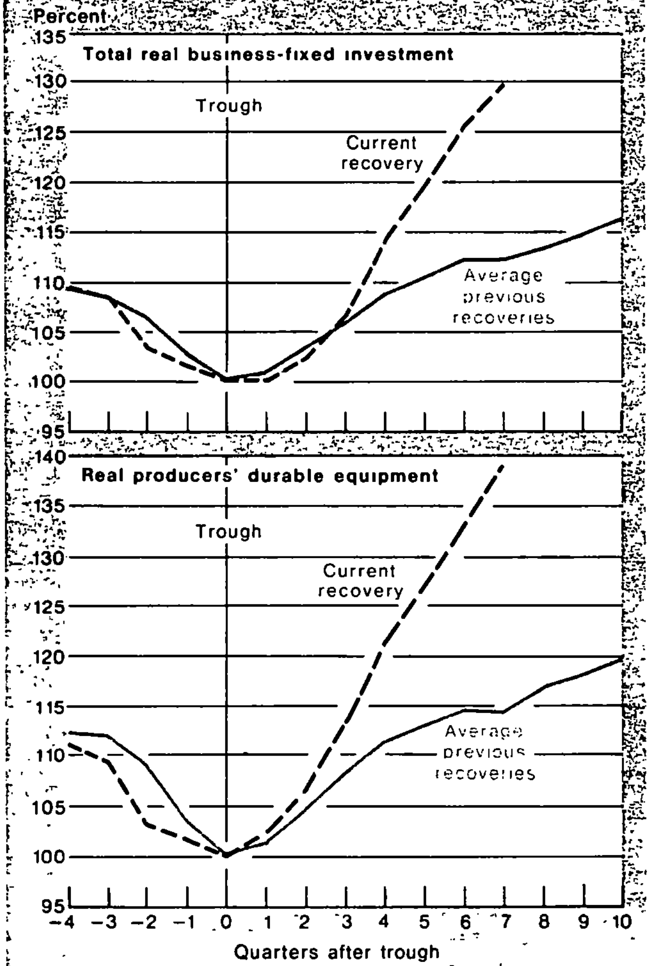
The authors would like to thank both Paul Glotzer and Sally Moran for their competent research assistance

[1]For example, Paul Craig Roberts, "Consumption Should Not Get Credit for the Expansion", *Business Week*, July 23, 1984, Maggie McConas, "Did Supply Side Incentives Work?" *Fortune*, November 26, 1984, and Chamber of Commerce of the United States, *Economic Outlook*, July 1984 and October 1984

[2]For example, Gary Hector, "Business Planning in a Tax Turmoil", *Fortune*, November 26, 1984

in terms of the FMP model, these tax changes appear to have contributed only about one-fifth of the 1983-84 growth in capital spending That impact is not insubstantial, yet it clearly cannot be considered the principal factor behind the sharp increase in investment during this recovery Further investigation suggests that a larger share of the 1983-84 investment boom is attributable to two other factors the personal income tax cuts under ERTA and the sharp drop in interest rates in 1982

Chart 1
Real Business Fixed Investment in Recoveries*



*Data are normalized relative to troughs in National Bureau of Economic Research postwar reference cycles

Sources U S Department of Commerce, Bureau of Economic Analysis

Empirical strategy and basic estimates

The FMP and the BEA econometric models have long track records and are generally well known among economists They also accord business taxes and interest rates significant roles as explanatory variables (appendix) In both models, changes in the business tax code affect BFI spending only insofar as they impinge on the marginal cost of capital goods In principle, the marginal cost of capital goods in a given period is the incremental cost of expanding output, incurred by utilizing an extra unit of capital goods for *one* period This is also equal to the cost of "hiring" that capital good for one period Naturally, the renter of the good would want to be paid enough to cover actual physical depreciation plus the opportunity cost of the tied-up funds The tax laws impinge on this cost in two ways they set a schedule for depreciation deductions, and they allow a portion of the purchase price of the capital good to be deducted immediately through the investment tax credit (ITC)

However, changes in business tax policy could influence investment spending in other ways as well by generating optimistic expectations about long-term economic prospects for the economy, they could improve the general business climate This could, in turn, lead to higher investment spending through increased effort and the application of new technology. Unfortunately, there are no explanatory variables in the standard econometric models to capture this type of effect If this effect were substantial, the forecasting performance of the conventional models ought to be significantly weaker for the recent period than for earlier periods, specifically, these models would be likely to underpredict the actual change in investment

In what follows, we first deal with the recent forecasting performance of the FMP and the BEA models and then with the impact of the 1981-82 business tax changes on investment spending in the context of those models We begin by estimating the two models over two sample periods, 1956 or 1958 to 1973 and 1956 or 1958 to 1979 Both the FMP and BEA models distinguish between equipment and structures and differ in their treatment of each Thus, in re-estimating the models, separate equations were run for producers' durable equipment (PDE) and non-residential structures (NRS) The estimates are satisfactory in terms of the usual statistical criteria (see the appendix for details of the estimates) and closely conform to those in previous studies

Based on these estimates we ran three separate experiments

- The first experiment assesses the models' forecasting accuracy over 1980-84 as a whole This tells us something about the investment tracking performance over what can fairly be described as a tumultuous period

- The second experiment examines the models' forecasting accuracy and prediction bias before and after the 1981 ERTA. This allows us to see if there is any deterioration in how well the models track after ERTA
- The third experiment compares the models' forecasting accuracy and prediction bias over the 1982-84 cyclical swing with the 1974-76 episode Here we are particularly interested in knowing whether the tracking performance of the models is worse in the current recovery than in the comparable period of the 1975-76 expansion

In addition, we re-estimated the investment equations over successively longer periods starting with 1974, generating out-of-sample forecasts for two years beyond the sample periods A comparison of out-of-sample forecasts from this experiment provides an additional basis for judging any significant changes in the forecasting performance of the standard econometric models over the recent period

In considering these various experiments, our basic objective is to see whether the prediction errors from the model forecasts are larger in recent years, especially in 1983-84 than in earlier periods. More generally, we are interested in any significant changes in the forecasting performance of the models Our presumption is that if ERTA and TEFRA wrought fundamental changes in the economy, the standard models would exhibit a long string of unusually large forecast errors implying a structural shift In judging the out-of-sample forecasts we utilize two conventional statistics—the mean or average error (ME), and the root mean squared error (RMSE) The first one is a measure of bias in forecasts and indicates the extent of underprediction or overprediction The second one is a measure of forecast accuracy, it is the square root of the average squared deviations of the predicted from the actual values. This notion of "average" forecast error differs from the more commonly used mean absolute error only in that it assigns heavier penalties to larger errors

Analysis of out-of-sample predictions

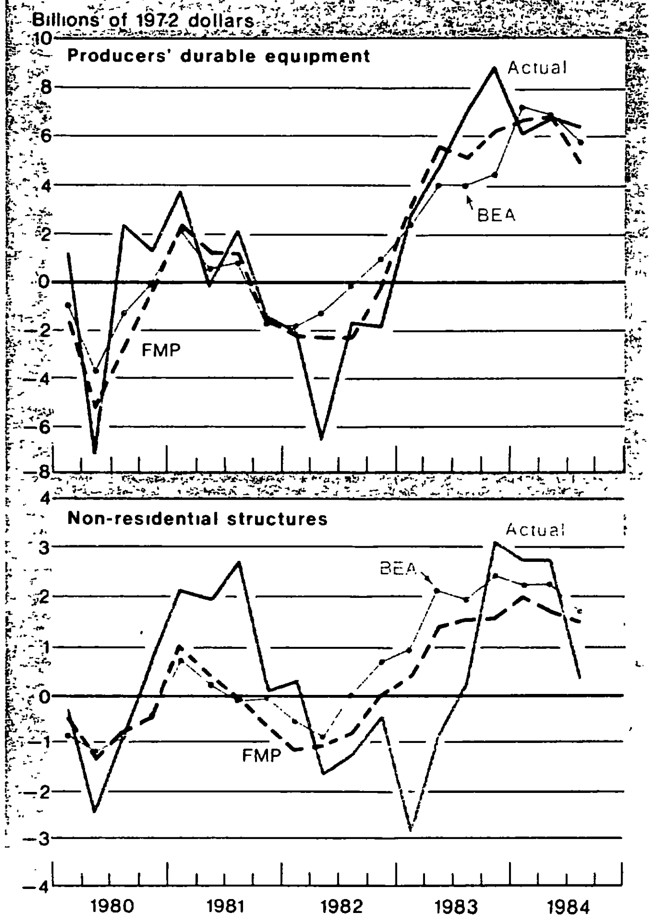
The forecasting performance over 1980-84

The out-of-sample forecasts of the quarterly changes in real producers' durable equipment (PDE) and real nonresidential structures (NRS) do not exhibit any significant bias and appear to be reasonably accurate (Chart 2) Indeed, in the case of PDE, the FMP model accurately pinpoints the 1981-III and 1982-IV turning points. (The ability to anticipate turning points is widely believed to be a key element in assessing a model's credibility.) The BEA model does almost as well in forecasting turning points, but misses the 1982-IV trough by one quarter Also, both the FMP and BEA models are able to capture the broad upsweep in PDE spending during the current recovery From 1982-IV to 1984-III the actual increase in real PDE amounted to 39 percent. The FMP's forecast called for a 35 percent increase and the BEA's for a 33 percent gain

The predicted changes in real NRS spending are less

Chart 2

Out-of-Sample Projections of Real Business Fixed Investment*



*The projections are out-of-sample forecasts based on models estimated over 1956-I to 1979-IV

Source Same as chart 1 and FMP and BEA models

Table 1

Forecasting Accuracy of the Alternative Investment Models, 1980-84

In billions of 1972 dollars

	1980-I to 1984-III		1980-I to 1981-III		1983-I to 1984-III	
	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†
Producers' Durable Equipment						
FMP Model‡	0.25	2.06	1.21	2.55	0.21	1.37
BEA Model‡	0.09	2.42	0.83	2.31	0.78	2.26
Non-residential Structures						
FMP Model‡	0.08	1.47	0.80	1.42	−0.71	1.81
BEA Model‡	−0.20	1.62	0.93	1.53	−1.16	2.02

*The mean error (actual *minus* predicted) which measures the forecast bias

†The root mean squared error which measures the forecast accuracy

‡The models are described in the appendix

Table 2

A Cyclical Comparison of Out-of-Sample Forecasts: 1974-76 versus 1981-84

In billions of 1972 dollars

	1974-76				1981-84			
	Recession 1974-I to 1975-I		Recovery 1975-II to 1976-IV		Recession 1981-IV to 1982-IV		Recovery 1983-I to 1984-III	
	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†
Producers' Durable Equipment								
FMP Model‡	0.71	1.59	−1.05	1.67	−0.19	1.87	0.57	1.98
BEA Model‡	0.22	2.40	−0.28	1.20	−1.51	2.84	1.48	2.06
Non-residential Structures								
FMP Model‡	−1.04	1.39	0.28	1.15	−0.44	0.72	−0.27	1.57
BEA Model‡	−1.04	1.66	0.13	1.14	0.02	0.55	−0.33	1.59

*The mean error (actual *minus* predicted) which measures the forecast bias

†The root mean squared error which measures the forecast accuracy

‡The models are described in the appendix The forecasts in this table are based on models that were estimated over 1956-I to 1983-IV for PDE and over 1958-I to 1973-IV for NRS

Table 3

A Comparison of Out-of-Sample Forecasts over Successive Two-Year Intervals

In billions of 1972 dollars

	1975-I to 1976-IV		1977-I to 1978-IV		1979-I to 1980-IV		1981-I to 1982-IV		1983-I to 1984-III	
	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†	ME*	RMSE†
Producers' Durable Equipment										
FMP Model‡	−0.93	1.49	1.38	2.40	1.72	3.01	−0.45	1.93	0.57	2.14
BEA Model‡	−0.18	0.96	1.31	2.33	1.30	2.79	−0.81	2.55	1.24	2.49
Non-residential Structures										
FMP Model‡	0.03	1.13	0.32	1.00	0.68	1.18	0.78	1.37	−0.68	1.82
BEA Model‡	0.11	1.11	0.44	0.97	0.67	1.12	0.58	1.40	−1.14	2.10

*The mean error (actual *minus* predicted) which measures the forecast bias

†The root mean squared error which measures the forecast accuracy

‡The models are described in the appendix The forecasts in this table are based on models that were estimated over successively longer sample periods—*e g*, 1956-I to 1974-IV, 1956-I to 1976-IV, 1956-I to 1978-IV, etc in the case of PDE

accurate than those for PDE, especially at the beginning of the recovery. Comparatively large misses were recorded in the first half of 1983 when both models predicted increases in real NRS spending whereas it actually continued falling. The pattern of NRS spending just before and just after the 1982 business-cycle trough was very unusual. Even a tightly fitting statistical model would have had a difficult time in tracking this experience, and both the FMP and BEA models leave a lot of the quarterly variation in NRS spending "unexplained" (appendix). This spending component has always eluded economists' efforts at modeling.

Still, on a more positive note, both models did anticipate the turning points in real NRS spending, although not the exact timing. And the models can be credited with foreseeing the broad contours of the recovery. Over the four quarters ended in 1984-III, the actual increase in *real* NRS amounted to \$8.8 billion, while the predicted increase was \$6.8 billion for the FMP model and \$8.5 billion for the BEA model.

A comparison of the out-of-sample predictions before and after ERTA

This experiment was designed to reveal whether the forecast errors exhibit any tendency to be larger after the passage of the 1981 ERTA. The out-of-sample forecasts for 1980-I to 1981-III were compared with those for 1983-I to 1984-III; the first period predated the major changes in the tax code while the second postdated them (Table 1)

In the case of PDE, the forecasts underpredict a bit in both periods and actually turn out to be somewhat more accurate over the later period. This outcome suggests that the changes in the tax code did not result in structural instability in the investment equations. In the case of NRS, however, the forecasts overpredict very slightly over 1983-84 but the average prediction errors turn out to be virtually identical over the two periods. There is no significant evidence of a deterioration in forecasting performance due to the liberalization in the tax code.

A cyclical comparison of out-of-sample predictions

Based on the estimates for the period through 1973, we compared the forecasting performance of the FMP and the BEA models over the 1982 downturn and the 1983-84 upturn with the corresponding cyclical episodes in 1974 and 1975-76. This is a stronger test of the forecasting performance in that the bias and accuracy are being judged for up to ten or eleven years beyond the estimation period rather than just three or four years outside the sample. The findings from this experiment are broadly similar to those from the previous one. the models do not exhibit a large systematic underprediction bias in the recent period relative to the comparable period in the mid-1970s, and the overall forecasting accuracy, at least of the FMP model, is roughly similar over the two periods (Table 2).

The FMP-model forecasts track actual real PDE spending quite well over both recession and recovery periods The forecast errors over the 1983-84 period are not significantly different from those over the 1975-76 recovery. There is no evidence of severe underprediction or overprediction bias. What little bias there is is well within the limits of statistical probability.

The BEA model for PDE, however, appears to go off track in the current recovery Its forecast errors are distinctly larger in the current recovery than in the 1975-76 upturn. It could be argued that this is symptomatic of an upward shift in the demand for capital goods. But the fact that the FMP model of PDE spending has stayed on track suggests that the problem, whatever it is, is specific to the BEA model.

The results for structures (Table 2, lower half) are more difficult to interpret They do not suggest a significant underprediction, but the forecast errors for the 1983-84 recovery are clearly larger than those recorded for the 1975-76 upturn. The deterioration in forecasting accuracy (*i.e.*, as reflected in the higher RMSE) was concentrated in the first two quarters of 1983; the forecasts in those two quarters called for increases in real NRS spending while actual outlays continued falling Note that, this pattern does not bear out the hypothesis that the 1981 business tax cuts have led to increases in BFI spending beyond what the traditional models would project.

It's hard to know whether the higher observed values of the RMSE for real NRS spending in the current recovery are an "unusual" event The error statistics are random variables, and so one expects the realized values of these statistics to vary to some extent. The question is: are observed differences between realized and predicted values "significant" in a statistical sense? In this regard, it is worth noting that both the FMP and BEA equations for structures did pass more formal statistical tests for stability over the period 1958-84 (appendix)

Further evidence

One final experiment was undertaken by re-estimating the investment equations over successively longer periods and generating out-of-sample forecasts for two years beyond the estimation period. For example, the FMP equation for structures was first estimated over the period 1958-I to 1974-IV and then used to generate forecasts for the next two years—from 1975-I to 1976-IV

Next, the sample period was extended two years, the model was re-estimated over the period from 1958-I to 1976-IV, and another two years of out-of-sample forecasts were computed—from 1977-I to 1978-IV Altogether, five different versions of each model were estimated, and five corresponding sets of forecasts were compiled

A comparison of the forecasts over successive two-year intervals indicates that the error statistics are not behaving in any systematic fashion (Table 3) For both PDE and NRS, there is no consistent underprediction (or overprediction) bias over the whole period. In the case of PDE, the realized values of RMSE for both the FMP and BEA models vary over fairly wide ranges, with the more recent values lying close to the middle of the range There is nothing in these results which suggests that the FMP or BEA models have gone haywire since the enactment of the 1981 ERTA. In the case of NRS, the realized values of RMSE remain pretty stable until 1981. But from then on, the forecast errors begin to swell, with the two biggest misses occurring (once again) in the first half of 1983. However, given that the models of NRS investment possess only limited explanatory power, the errors are not outside the normal statistical range for such models.

In sum, our analysis suggests that the FMP and the BEA models track BFI spending as well over the last few years as in earlier periods. And the out-of-sample forecasts do not appear to exhibit any significant underprediction bias in 1983-84.

Business tax policy effects on investment spending through capital costs

Given that the FMP and the BEA models have remained fairly stable, they can be used with some confidence to infer, though not precisely, the extent of recent capital spending attributable to changes in business tax policy In this section, we do this in terms of the FMP model More specifically, we assess the impact of the 1981-82 business tax changes on the marginal cost of capital, and estimate the contribution of those changes to investment spending in 1983-84 by re-estimating the FMP model

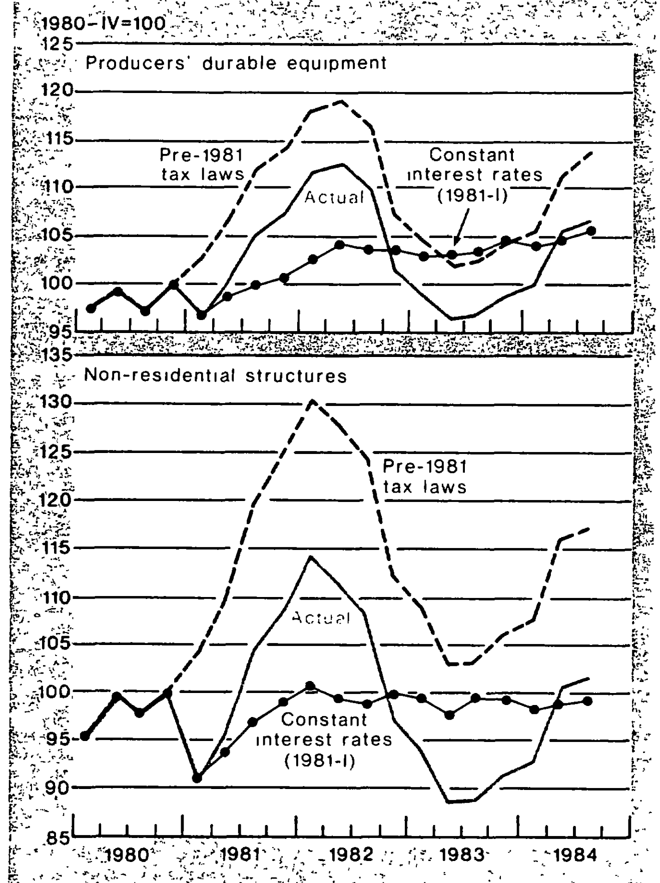
The 1981-82 business tax changes and the marginal cost of capital

For businesses, the main feature of the 1981 ERTA was its Accelerated Cost Recovery (ACR) system The new ACR system vastly changed the business tax code [3] Among the changes, three are particularly important

[3]Joseph C Wakefield and Richard C Ziemer, "Federal Fiscal Programs", *Survey of Current Business*, February 1984

Chart 3

Marginal Cost of Capital Goods



Source Federal Reserve Bank of New York staff estimates based on FMP model (see appendix)

- Tax-service lives (*i.e.*, the periods over which assets are to be depreciated for tax purposes) were lowered materially

- The investment tax credit on eligible assets was increased. (Structures remained ineligible, as they had been under the previous tax laws.)

- The tax rules governing leasing were liberalized substantially to facilitate the transfer of tax benefits from one party to another

The new ACR system was designed to reduce the cost of capital goods And it succeeded in doing so We use the FMP's specification of the tax laws—both before and after ERTA—to calculate the impact of the new ACR system on the marginal cost of capital goods.[4] For equipment the present value of the tax-allowable depreciation deductions is estimated to have been raised 13 percent under ERTA. These and the other tax changes translate into a 6.3 percent decrease in the marginal cost of equipment (Chart 3). For structures the changes were even more dramatic. Under ERTA, the present value of depreciation was increased 134 percent, and the marginal cost of these capital goods declined an estimated 15 percent.

One year later, TEFRA was enacted, and it undid some of the liberalization of ERTA. For businesses the main provisions were

- The scheduled acceleration in depreciation write-offs due in 1985 and 1986 (*i.e*, the move to 175 percent declining balance in 1985 and then to 200 percent declining balance in 1986) was repealed.

- A "basis adjustment" was adopted to offset part of the ITC. Accordingly, tax payers who claim an ITC are required to reduce the cost-base of that asset (*i.e.*, the dollar amount on which depreciation write-offs are figured) by half the ITC

- The Safe-harbor Leasing laws were repealed and replaced by a somewhat liberalized version of the pre-1981 leasing laws

These changes raised the marginal cost of equipment and structures slightly Yet that cost remained well below the levels that would have existed under the pre-1981 tax laws (Chart 3) According to the Bureau of Economic Analysis, the combined net ERTA/TEFRA tax savings to businesses will end up amounting to roughly $22½ billion over 1983-84, or $10 billion in constant 1972 dollars.[5]

Some observers have noted that the unusually high interest rates prevailing in 1981-82 blunted the impact of ERTA on the marginal cost of capital goods. The argument is that "...the effect of the tax cuts in stimulating non-residential fixed investment has been more than offset by the upward pressure on real debt and equity costs".[6]

Under this line of reasoning, the 1981-82 business tax cuts have contributed supposedly nothing at all to the recent boom This view seems to rest on the strong assumption that the reduction in the marginal cost of capital goods was fully offset by the rise in interest rates associated with ERTA. This is a questionable assumption, especially insofar as changes in the business tax code are concerned

The role assigned to high interest rates under the above argument is also somewhat misleading. High interest rates did indeed blunt the impact of the tax cuts, but rates did not remain *uniformly* high after 1981. Subsequent to the adoption of the ACR system at the beginning of 1981, the marginal cost of capital goods continued rising throughout the year and peaked in early 1982 at a level well above where it had stood at year-end 1980—just prior to ERTA. This rise was due partly to a run-up in interest rates and partly to the upward creep in capital goods prices The line in Chart 3 labeled "constant interest rates" illustrates what the marginal cost of capital goods over 1981-84 would have been under ERTA if interest rates had stayed constant at the 1981-I level. Note that, this line runs below the one for actual marginal cost until late 1982.

After peaking in early 1982, the marginal cost of capital goods then fell precipitously, primarily reflecting a sharp decline in interest rates. This drop in the marginal cost was between three and five times greater than past cyclical declines And by early 1983, the marginal cost of capital goods had fallen below what it would have been if interest rates had held steady at the 1981-I level In the absence of the unusually sharp fall in interest rates and consequently in the marginal cost of capital goods, the 1983-84 recovery in investment spending would probably have been weaker. We return to this subject in a subsequent section

Effects on business investment

The FMP model allows us to estimate the effect of changes in the marginal cost of capital associated with the 1981-82 business tax changes on investment. By assuming that tax-service lives, the ITCs, and the depreciation schedules remained unchanged at their

[4]The FMP model defines the marginal cost of capital goods in basically the same way as it appears in the appendix The tax terms in the expression for R_t were duly modified to reflect the ERTA of 1981 For equipment the tax-service life was lowered from 10 5 years to 4 6 years, the depreciation method was changed to 150 percent declining balance, with a half-year convention, and the investment tax credit was raised from 8 8 percent to 9 2 percent For non-residential structures the tax-service life was lowered from 40 years to 15 years, and the depreciation method was changed to 175 percent declining balance No attempt was made, however, to model the changes in the leasing laws (For one attempt at doing so, see Alan J Auerbach, "Corporate Taxation in the United States", *Brookings Papers on Economic Activity*, Number 2, 1983) But note that the leasing laws were tightened substantially under the TEFRA of 1982

[5]Wakefield and Ziemer, *op cit*

[6]Adrian W Throop, "A 'Supply-Side Miracle'?", *Federal Reserve Bank of San Francisco Weekly Letter*, November 2, 1984 A similar argument appears in the Congressional Budget Office, "The Economic and Budget Outlook An Update", August 1984

Table 4

The Estimated Impact of ERTA/TEFRA Business Tax Cuts on Capital Spending: 1982-IV to 1984-III

In billions of 1972 dollars

	Actual Increases	Direct Effects*	Full-Model Simulations*
Producers' Durable Equipment	$42.7	$7.9	$11 0
Nonresidential Structures	$5.2	$1.1	$1.2

*Based on the FMP model.

pre-1981 levels, we re-estimated the FMP investment forecasts. The rest of the ERTA package—specifically the personal income tax cuts—was still presumed to have occurred. The personal tax cuts stimulated aggregate economic activity to a considerable extent, and thereby buoyed capital spending. No attempt has been made to net out those indirect effects of the personal tax cuts on investment.

The results of these counterfactual reruns of history are presented in Table 4. They indicate that, even if business taxes had not been cut, capital spending would still have increased at a fast clip in the current recovery. Two alternative pairs of estimates were derived for both PDE and NRS. One pair takes into account the two direct effects: (1) the higher marginal cost of capital goods under the pre-1981 tax regime would have led to lower BFI spending; and (2) lower BFI spending would, in turn, have meant lower output (*i.e.*, on a dollar-for-dollar basis) and thereby dampened BFI spending further These two direct effects account for only about one-fifth of the cumulative increase in PDE and NRS from 1982-IV to 1984-III.

The other pair of estimates in Table 5 was derived from a full-model simulation of the FMP model in order to take account of the *indirect* feedback effects—the "reactions" in other sectors of the model to the direct effects. These full-model effects are somewhat greater than the direct effects on investment.

What else "explains" the investment boom?

If the 1981-82 business tax cuts contributed only a small part to the current investment boom, then where else has the stimulus come from? The two main candidates appear to be the personal tax cuts and the sharp fall in interest rates in late 1982

The personal tax cuts amounted to almost $50 billion over 1983-84, according to the Bureau of Economic Analysis No doubt these tax cuts contributed to the vigorous revivals in housing, car sales, and consumption spending, which initiated the overall recovery. And once the recovery was under way, BFI spending followed suit, thereby amplifying the activity in other sectors. This is the standard relationship between BFI spending, business output, and the demand for that output.

Insofar as the recovery in business output has been unusually large, the cyclical expansion in BFI spending would also have been unusually big. In fact, the 13½ percent increase in business output over the first seven quarters of this recovery has been larger than past cyclical upturns. Over comparable periods in past recoveries, the average increase amounted to 10½ percent. The faster business output growth in this recovery relative to the average of previous recoveries reflects, to a large extent, the stimulative effects of the personal tax cuts.[7] With this in mind, we used the FMP model to estimate how much smaller the expansion in real PDE spending would have been if business output had proceeded along the slower "normal" recovery path. (The cyclical upturn in real NRS has not been abnormally large, and so we limited the analysis to real PDE.) Our results indicate that real PDE spending over the first seven quarters of this recovery would then have been $7 billion, or 17½ percent, smaller.[8]

Additional stimulus came from a sharp fall in interest

[7]To the extent that the greater-than-average business output growth in this recovery is not related to the personal tax cuts, our estimates of their contribution to investment are overstated

[8]This suggests that the whole ERTA/TEFRA package—including both personal and business tax cuts—accounts for a substantial part of the 1983-84 investment boom (around 40 percent of PDE investment growth in terms of our estimates) A similar conclusion is reached by Brayton and Clark in their FMP simulations of the effects of the whole ERTA/TEFRA package, which allow for a flexible output-employment response but hold the growth rate of M1 constant See Flint Brayton and Peter B Clark, "The Macroeconomic and Sectoral Effects of ERTA Some Simulation Results", a paper presented to the Federal Reserve System Committee on Business Analysis, November 1984 The simulations from macroeconometric models indicate that over the long run the positive effect of the personal income tax cut on investment may prove to be transitory See Darrel Cohen and Peter B Clark, "The Effects of Fiscal Policy on the U S Economy", *Staff Studies No 136*, Board of Governors of the Federal Reserve System, Washington, D C , January 1984

rates in late 1982, which produced a substantial decline in the marginal cost of capital goods. Over the four quarters ended in 1983-II, the marginal cost of equipment declined almost 15 percent, while over comparable periods of past recoveries, the average drop was only 2 percent. Once again we used the FMP model to determine how differently investment spending would have turned out if the marginal cost of equipment had followed along the "normal" cyclical path. We find that real PDE spending from 1982-IV to 1984-III would have been $6 billion, or 15 percent, lower.

To sum up, the personal income tax cuts and the substantially steeper-than-average drop in interest rates appear to account for about one-third of the growth in PDE. Together these two factors seem to be more important in explaining the recent investment boom than the 1981-82 changes in business tax policy.

Concluding remarks

Our detailed examination of the out-of-sample forecasts from the FMP and BEA models indicates that there is no significant change in the investment tracking performance of those models; they perform equally well before and after the 1981-82 tax cuts, and about as well in this recovery as in the 1975-76 episode. In particular, there is no significant evidence of underprediction bias. The models are not perfect. But they are presently no more imperfect than they ever were.

The estimated models do shed some light on the question: what's behind the investment spending boom? An explanation was put together by searching for irregularly sharp movements among the determinants of investment spending included in the models. We focused on the PDE component which accounted for virtually all of the unusual strength in total BFI spending. From 1982-IV to 1984-III the total expansion in real PDE equaled almost $43 billion (1972 dollars). Over past cyclical upturns, the "normal" or average recovery in real PDE amounted to about $15 billion. Our estimates suggest that the "extra" $28 billion comes from three principal factors:

- The 1981-82 business tax cuts: $8 billion in direct effects;
- The faster-than-average recovery in business output associated with the personal tax cuts under ERTA: $7 billion; and
- The steeper-than-average fall in interest rates in late 1982: $6 billion.

These three factors seem to account for all but about $7 billion of the $28 billion discrepancy between an average investment recovery and the current recovery. Of course, these estimates embody a margin of error, but the orders of magnitude would seem to be plausible.

It is obvious from this analysis that the 1981-82 business tax cuts do not provide the principal explanation for the 1983-84 investment boom. But the estimated one-fifth of capital spending growth attributable to those cuts is not inconsequential. (Note that, this estimated contribution is equivalent to nearly 30 percent of the excess of investment growth in this recovery over the average growth in previous postwar recoveries.) It supports the argument that any significant changes in business tax policy could have substantial effects on investment and capital stock.[9] More generally, any proposals for reforming the tax code cannot afford to ignore the possible adverse consequences for business investment, and must attempt to weigh and balance those consequences against other objectives that are considered to be in the public interest.

[9] So far the current debate on tax reforms has paid very little attention to the possible effects of tax changes on investment. This is highlighted in a recent study which argues that the two major tax reform proposals—the Bradley-Gephardt tax bill and the Kemp-Kasten tax bill—incorporate substantial disincentives for investment in plant and equipment. See Joel L. Prakken, Laurence H. Meyer, and Chris P. Varvares, "Flat Taxes and Capital Formation", *Formal Publication No. 65*, Center for the Study of American Business, October 1984.

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Appendix: The Estimated Investment Models

The FMP and BEA models of BFI spending are different empirical representations of the same theory* In both versions, the optimal or cost-minimizing ratio of capital to output is determined by relative prices, *i.e*, the marginal cost of capital goods (discussed below) relative to the price of output The higher the marginal cost of capital goods relative to output prices, the lower the optimal ratio of capital to output

At a point in time, the "target-capacity" stock of capital is equal to the optimal capital-output ratio times the quantity of output firms wish to produce Should the actual stock of capital be different from the "targeted" one, businesses will close the gap by adjusting their investment spending Suppose, for example, that the actual stock exceeded the "targeted" one Businesses would then slow down their investment spending to a level below what was needed just to replace those machines and factories that had worn out Gradually, the stock of capital would shrink to the targeted level

The two models differ in two respects First, they define "desired" output differently The FMP model assumes that it may be adequately represented as a weighted average of current and past levels of actual output The BEA model defines it as "permanent" output, that is, actual output divided by capacity utilization (This definition of permanent output is used only in the BEA's equation for structures, actual output is used in the equation for equipment) Second, the two models adopt different specifications of the adjustment of the actual stock of capital to the "targeted" level Both models presume that businesses close this gap by stepping up or slowing down the pace of their BFI spending The FMP model depicts this as a gradual process but one that is invariant to economic conditions Alternatively, the BEA model also depicts this as a gradual process, but allows the speed of adjustment to vary with economic conditions

The marginal cost of capital goods

In principle, the marginal cost of capital goods in a given period is the incremental cost incurred when output is expanded in that period by adding an extra unit to the stock of real capital goods Yet capital goods are durable and yield productive services for many periods, and this makes it difficult to specify just what the incremental cost of that extra unit of capital goods is for a given period

The problem can be resolved by comparing the cost (in present-value terms) of purchasing the capital good today and then maintaining it forever versus the cost of doing so one period later Let C_t be the present value of the stream of current and future costs connected with purchasing an additional unit of capital in period t, and let the cost of capital be denoted as r (Note that the cost of capital is the interest rate or the discount rate that

Table A-1

Alternative Investment Equations

The FMP Model

Producers' Durable Equipment (putty-clay)

$$(1)\quad \Delta I_{Et} = a + \sum_{i=0}^{11} b_i \Delta\left[\left(\frac{PQB}{RE}\right)_{t-i-1} QB_{t-i}\right] + \sum_{i=0}^{11} c_i \Delta\left[\left(\frac{PQB}{RE}\right)_{t-i-1} QB_{t-i-1}\right] + u_t$$

Non-residential Structures (putty-putty)

$$(2)\quad \Delta I_{st} = a + \sum_{i=0}^{15} b_i \Delta\left[\left(\frac{PQB}{RS}\right)^{0.25}_{t-i} QB_{t-i}\right] + u_t$$

The BEA Model

Producers' Durable Equipment (putty-clay)

$$(3)\quad \Delta I_{Et} = a + \sum_{i=0}^{11} b_i \Delta\left[\left(\frac{PQB}{RE}\right)^{0.75}_{t-i} \left(QB_{t-i} - 0.87 QB_{t-i-1}\right)\right] + \sum_{j=0}^{8} c_i \Delta\left[\left(\frac{PQB}{RE}\right)^{0.75}_{t-i} \left(\frac{QB}{CU} - QB\right)_{t-i}\right] + u_t$$

Non-residential Structures (putty-putty)

$$(4)\quad \Delta I_{st} = a + \sum_{i=0}^{15} b_i \Delta\left[\left(\frac{PQB}{RS}\right)^{0.25}_{t-i} \left(\frac{QB}{CU^{0.5}}\right)_{t-i} - 0.94 \left(\frac{PQB}{RS}\right)_{t-i-1} \left(\frac{QB}{CU^{0.5}}\right)_{t-i-1}\right] + \sum_{i=0}^{15} c_i \Delta\left[\left(\frac{PQB}{RS}\right)^{0.25}_{t-i} \left(\frac{QB}{CU} - QB\right)\right]_{t-i} + u_t$$

Definitions of Symbols:

I_E = real PDE spending
I_S = real NRS spending
PQB = price deflator for gross private domestic business output
QB = gross private domestic business output
RE = marginal cost of capital goods, equipment
RS = marginal cost of capital goods, structures
CU = rate of capacity utilization

*Both the FMP and the BEA investment equations are based largely on the work done by Charles W Bischoff "The Effect of Alternative Lag Distributions", *Tax Incentives and Capital Spending*, Gary Fromm, editor Brookings Institution, 1971, and his "Business Investment in the 1970s A Comparison of Models", *Brookings Papers on Economic Activity*, Number 1, 1971 Bischoff's model was refined by Albert Ando, Franco Modigliani, Robert Rasche, and Stephen Turnovsky, "On the Role of Expectations of Price and Technological Change in an Investment Function", *International Economic Review* June 1974, the current version of the FMP model of equipment is an updated reworking of their equation

For a description of the BEA model see Robert S Chirinko and Robert Eisner, "Tax Policy and Investment in Major U S Macroeconomic Econometric Models" *Journal of Public Economics*, March 1983 investors use in evaluating the present worth of a company's earnings prospects.) Then the marginal cost of capital goods (R_t) may be defined as the difference between C_t and $C_{t+1}/(1+r)$, plus the foregone interest on this difference:†

$$(1)\quad R_t = \left(C_t - \frac{C_{t+1}}{(1+r)}\right)(1 + r)$$

This is what it costs firms, in present-value terms, to "hire" the *services* of that extra unit of capital for period t alone. In the absence of market imperfections, the "rental" cost would be the same irrespective of whether a firm leased the equipment from another firm or "rented" the equipment from itself.

An explicit expression for R_t can be obtained once C_t has been specified. One gets the following result

$$(2)\quad R_t = [1 - k - (1 - bk)\, u\, z]\, v_t\, (r_t + g)$$

where:

- k = investment tax credit,
- u = marginal corporate tax credit;
- b = proportion of investment tax credit which must be deducted from depreciation base;
- z = present value of tax-allowable depreciation deductions which may be taken over the allowable service life;
- v = purchase price of new capital goods, and
- g = (geometric) rate of economic depreciation.

†Ralph Turvey, "Marginal Cost", *Economic Journal*, June 1969.

This expression defines the price of the capital good on a net-of-tax basis, *i.e.*, net of the investment tax credit and the present-value of the depreciation deductions. The marginal cost of capital goods is equal to the sum of the opportunity cost of the funds used to purchase a unit of capital plus the value of the capital services used up in the period.

The same specification of the marginal cost of capital goods was used in estimating both the FMP and BEA models. The variables which comprise R_t (*i.e.*, k, u, and b) were defined in accordance with those in the latest version of the FMP model—with two exceptions: (1) Corcoran and Sahling's measure of the cost of capital was used in the equations for both equipment and structures.‡ (2) In computing the present value of depreciation (z), the formulas from the FMP model were used, but Moody's Baa industrial bond rate was substituted for the fictional interest rate constructed in the FMP model.

Estimation results

It has been several years since the FMP and BEA models have been updated, and so we re-estimated them with quarterly data from the mid- to late-1950s to the end of 1979.§ Separate equations were run for pro-

‡Patrick J. Corcoran and Leonard Sahling, "The Cost of Capital: How High Is It?", this *Quarterly Review*, Summer 1982.

§For two recent efforts at updating the FMP equations, see Peter K. Clark, "Investment in the 1970s: Theory, Performance, and Prediction", *Brookings Papers on Economic Activity*, Number 1, 1979, and Richard W. Kopcke, "Forecasting Investment Spending: The Performance of Statistical Models", *New England Economic Review*, November/December 1982.

Table A-2

Estimation Results*

	a	Σb_i	Σc_i	$\bar{R}^2$	SEE	DW	LaGrange-Multiplier Tests 1956(8)-I/1979-IV	LaGrange-Multiplier Tests 1956(8)-I/1984-III
FMP Equipment†	0.019 (0.96)‡	0.433 (6.55)	−0.413 (6.15)	0.603	1.33	2.25	7.42	14.92
FMP Structures§	−0.604 (2.81)	0.088 (4.39)	‖	0.303	0.89	1.88	4.50	1.53
BEA Equipment†	0.087 (0.43)	0.508 (5.09)	0.374 (2.08)	0.572	1.39	2.14	9.10	15.14
BEA Structures§	−0.834 (2.62)	5.220 (1.69)	−0.081 (3.69)	0.333	0.87	1.96	11.56	8.88

*Estimated by ordinary least squares, in terms of first differences.
†Sample period: 1956-I to 1979-IV.
‡t-statistics in parentheses.
§Sample period: 1958-I to 1979-IV.
‖Not applicable.

Appendix: The Estimated Investment Models *(continued)*

ducers' durable equipment (PDE) and non-residential structures (NRS). One notable feature of these results is that the models were estimated in terms of first differences. Other studies have generally estimated investment equations in terms of levels of time series variables, with a suitable adjustment for the autocorrelation of the errors. As a practical matter, the autocorrelation coefficients have been so high (*i.e.*, in the range of about 0.85 to 0.95) that the estimates based on levels would have been little different from those based on first differences.

In estimating these models, we wanted to keep the specifications of the models as close to the "standard" ones as possible. Nevertheless, we did experiment a bit (a) with the distinctions between "putty-putty" (where factor proportions can vary with respect to both old and new capital) and "putty-clay" (where factor proportions can vary only as far as new capital is concerned), (b) with alternative values of the nonlinear parameters, and (c) with alternative lengths of the distributed lags. The forms of the models that we finally chose are presented in Table A-1. The corresponding estimated coefficients and summary statistics are set out in Table A-2. Some of the $\bar{R}^2$s appear to be low—especially for structures. But if one allows for the distinction between levels and first differences, and its impact on the summary statistics, these results are just as good (or bad) as those in earlier studies.

A formal test of model stability is afforded by the Lagrange-multiplier statistics.‖ This test was applied to each of the four equations, and the results are reported in the last two columns of Table A-2. Essentially, the Lagrange-multiplier statistic tests whether the errors are homoscedastic over the sample period. If a model were unstable, that would show up as an unusually long string of large positive or negative errors. Thus, the finding that the errors in a model are not homoscedastic is often a symptom of instability or structural change.

Two Lagrange-multiplier statistics were computed for each model. In one case, the sample period extended from 1956-I to 1979-IV for real PDE and from 1959-I to 1979-IV for real NRS. In the other, the sample period was lengthened on the far side to 1984-III. The Lagrange-multiplier statistics are asymptotically distributed as a chi-square, χ^2. The estimated model for PDE has 8 degrees of freedom; the one for NRS, 4 degrees of freedom. At the 5 percent confidence level, the tabular values for the χ^2 distribution are 15.507 for 8 degrees of freedom and 9.488 for 4 degrees of freedom. Upon comparing the computed statistics in Table A-2 with the corresponding tabular values, it turns out that none of the Lagrange-multipliers in Table A-2 is statistically significant. Hence, all four models appear to be structurally stable.

‖For information about this test statistic, see A. Steven Englander and Cornelis A. Los, "The Stability of the Phillips Curve and Its Implications for the 1980s", Federal Reserve Bank of New York Research Paper No. 8303, January 1983.