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Investment, Overhang, and Tax Policy

The past decade has seen an unusual pattern of investment. The boom of the 1990s generated unusually high investment rates, particularly in equipment, and the bust of the 2000s witnessed an unusually large decline in investment. A drop in equipment investment normally accounts for about 10 to 20 percent of the decline in GDP during a recession; in the 2001 recession, however, it accounted for 120 percent.[1]

In the public mind, the recent boom and bust in investment are directly linked due to "capital overhang." Although the term is not very precisely defined, this view generally holds that excess investment in the 1990s, fueled by an asset price bubble, left corporations with excess capital stocks, and therefore no demand for investment, during the 2000s. The popular view also holds that these conditions will continue until normal economic growth eliminates the overhang and, consequently, that there is little policymakers can do to remedy the situation, by subsidizing investment with tax policy, for example. Variants on this view have been espoused by private sector analysts and economists,[2] and the notion of a

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1. McCarthy (2003) documents the decline in equipment investment as a share of GDP for all business cycles since 1953 and shows the 2001 recession to be an outlier.

2. See, for example, Berner (2001); Graeme Leach, "The Worries of the World," *GCIEye* no. 1, 2002, accessed August 2004 (www.gcieurope.com/eye/GCIEye_Issue01.pdf), and Stephen Roach, "The Costs of Bursting Bubbles," *New York Times,* September 22, 2002, section 4, p. 13.

capital overhang has certainly been on the minds of leading Federal Reserve officials and researchers.[3]

Whether or not a capital overhang is the true explanation of the investment bust, it is clear that the drop in investment has motivated policymakers to try to stimulate investment through ambitious fiscal policy changes.[4] Under President George W. Bush, depreciation allowances for equipment investment have been increased twice, in 2002 and 2003, and in 2003 the tax rate on dividend income was cut sharply and that on capital gains income more modestly. These measures were mainly intended to increase after-tax returns and stimulate investment. The typical analysis of the investment collapse and policy response is summarized by the Republican chairman of the Joint Economic Committee:

> Excessive and bad business investments made during the stock market bubble have taken years to liquidate. In nine of the 10 quarters beginning with the fourth quarter of 2000, real business investment has declined. Fortunately, recent tax legislation signed into law in 2003 should promote business investment by increasing the after-tax returns from investing in capital assets and alleviating financing constraints among small and medium-size firms.[5]

Yet, after several years of tax cuts, investment has still not risen impressively compared with previous recoveries. This contrast has reignited claims that tax policy is ineffective at stimulating investment, although some make the more specific charge that tax policy is impotent when it follows a period of excessive investment.

This paper examines the evidence on the two related issues of capital overhang and taxes using data at the industry, the asset, and especially the firm level. Specifically, we address two questions: first, did "over"-investment in the 1990s *cause* the low investment of the 2000s, and, second, did investment in the 2000s become less sensitive to prices, and does this explain why tax policies, specifically the equipment expensing and the dividend tax cuts of 2002 and 2003, seem to have been ineffective in restoring investment to normal levels?

3. See, for example, Greenspan (2002), Ferguson (2001), Bernanke (2003), French, Klier, and Oppedahl (2002), Pelgrin, Schich, and de Serres (2002), Kliesen (2003), Doms (2004), and McCarthy (2004).

4. Unlike the behavior of investment, the behavior of tax policy in the 2000s is completely consistent with earlier time periods. Cummins, Hassett, and Hubbard (1994) have documented that a primary determinant of investment tax subsidies is a drop in investment.

5. Saxton (2003).

We begin by examining the degree to which growth in investment during the boom was correlated with a decline in investment during the bust across different assets and industries. There are, of course, many possible definitions of overhang or excess investment. We will *not* try to show that there was no overoptimism in product or capital markets. Clearly equity prices rose substantially and then fell, as did investment rates. Instead we investigate whether investment grew the most in those assets and industries in which it subsequently declined the most. We want to know if any aftereffects of the investment boom of the 1990s persisted into the 2000s—whether firms behaved differently because too much capital remained from the investment decisions of the 1990s.

The evidence across assets, industries, and firms suggests that, contrary to the popular view, there is little correlation between the investment boom of the 1990s and the investment bust of the 2000s. We also present some more specific evidence, using firm-level data, that investment behavior has remained just as responsive to the fundamentals (as measured by Tobin's *q*) regardless of how much a firm's investment grew or how much its market value rose in the 1990s. Essentially, we find that the explanatory power of the standard empirical model of investment has not deteriorated in the 2000s, despite the common perception that it has.

We then use that standard model to consider the impact of tax cuts. To estimate the impact of the dividend tax reduction, we revisit an enduring debate in public finance between the "new" view of dividend taxation, which says that dividend tax cuts do not reduce the cost of capital for marginal investments, and the "traditional" view, which says that such cuts do reduce the marginal cost of capital and thus stimulate investment. The evidence at the firm level strongly supports the new view and suggests that the dividend tax reductions enacted in 2003 had little or no effect on investment.

Finally, to estimate the impact of the changes in depreciation allowances, we estimate a tax-adjusted *q* model similar to that of Lawrence Summers,[6] but with greater emphasis on the importance of error in the measurement of *q,* as emphasized by Jason Cummins, Kevin Hassett, and

6. Summers (1981).

Glenn Hubbard.[7] The method introduced for handling these measurement error issues yields results that suggest that both tax policy and q are likely to have much larger effects on investment than found in the traditional literature, where coefficients are very small and imply implausibly large costs of adjustment. Even with the more reasonable adjustment costs, however, we show that the depreciation allowance changes of 2002 and 2003 changed the tax term by a relatively small amount: the estimated overall impact in these two years was an increase in investment of only 1 to 2 percent, far too small to offset the double-digit declines of the early 2000s.

Capital Overhang and Investment

Real investment was considerably higher than normal during the late 1990s. When recession years are excluded, investment from 1947:1 to 1995:2 averaged about 12 percent of GDP; the highest quarterly level was 15 percent in 1984:3. From 1996:1 to 2000:4, in contrast, this ratio *averaged* more than 16 percent, and it reached 18 percent at its peak. The distinctiveness of these investment rates holds even relative to the business cycle. Figure 1 shows that investment in the quarters leading up to the 2001 peak was higher than it had been during comparable periods in previous cycles. The popular view holds that this extra investment resulted from the excesses of the 1990s bubble.[8]

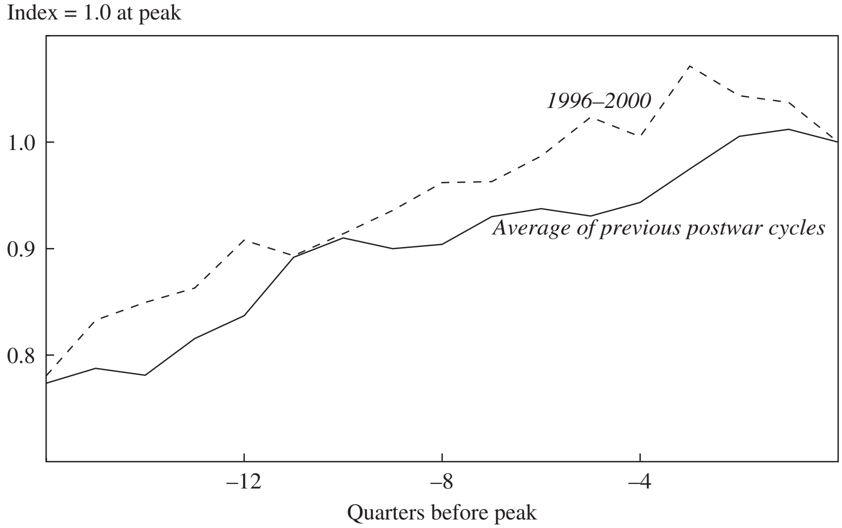
With this view in mind, figure 2 provides a counterpart to figure 1, showing the path of investment in the period after the trough quarter for the recovery that began in late 2001 and for the average of previous recoveries. The increase in investment in the current recovery, at least through the beginning of 2004, is notably smaller than in the average recovery. Taken together, these trends make it plausible to many observers that investment after the most recent trough was lower than in previous cycles precisely because investment in previous years had been higher.

Of course, these aggregate patterns do not establish any underlying connection between the rise and the fall. To test for a causal relationship, we believe, it is critical to disaggregate the investment data. Most aca-

7. Cummins, Hassett, and Hubbard (1994).

8. Tevlin and Whelan (2003) argue that much of the increase in gross investment can be explained empirically by falling prices of computers and their higher depreciation rates.

Figure 1. Real Investment Relative to Business Cycle Peak, Postwar Average and 1996–2000[a]



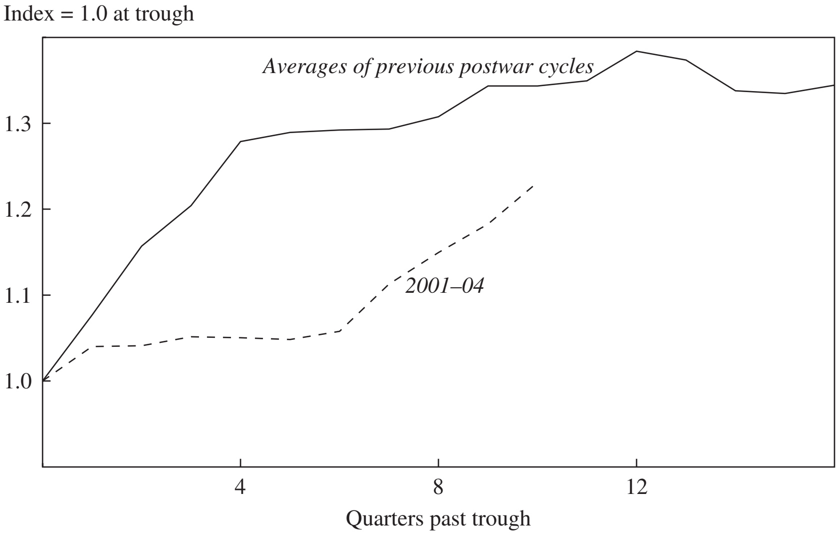
Source: Authors' calculations using National Income and Product Accounts data.
a. Investment is measured as a fraction of GDP.

demic work looking at the capital overhang has not done so, or has done so at a very broad level, emphasizing that the reversal in investment has been concentrated in information technology investment.[9] It is clear that the exuberance of the 1990s was not shared equally in all sectors. Industries such as telecommunications experienced huge increases in the 1990s in a way that railroads or mining, say, did not. We believe that any overhang, in the sense of excess capital remaining at the end of the boom, is inherently an industry- or firm-level phenomenon, which requires that we look at data at that level.

An additional reason to look at the industry- and firm-level data is that investment theory typically begins with the premise that there is a perfectly functioning secondary market for capital goods and a flat supply curve for capital. In such a world, firms with an overhang of unused capital equipment can simply sell it without incurring any loss. For the

9. Two papers by McCarthy (2001, 2004) are exceptions.

Figure 2. Real Investment Relative to Business Cycle Trough, Postwar Average and 2001–04[a]



Source: Authors' calculations using National Income and Product Accounts data.
a. Investment is measured as a fraction of GDP.

popular view to make sense, then, either investment must be in some way irreversible (which leads to a rather different model),[10] or there must be some other type of adjustment cost associated with disinvestment.[11] Matthew Shapiro and Valerie Ramey have documented that, in some industries, a sizable wedge can develop between the purchase price of capital goods and the sale price.[12] These types of irreversibilities are likely to be firm or asset specific rather than applying to all types of investment in all sectors homogeneously. Fortunately, data on investment are available at the industry, asset type, and firm level, and, as we will show, the evidence at all three levels of disaggregation is generally the same.

10. As in, for example, Abel and Eberly (2002).

11. The adjustment costs could be at the firm level, or they might be external in the sense that the supply of capital goods in a particular industry is upward sloping as in Goolsbee (1998, 2001).

12. Ramey and Shapiro (2001). Evidence presented by Goolsbee and Gross (2000) is also consistent with that view.

Evidence at the Industry Level

We begin with the evidence on changes in investment at the industry level. Rather than rely on the more aggregated fixed asset data available from the Bureau of Economic Analysis (BEA), we turn to the Annual Capital Expenditure Survey (ACES) of the U.S. Census Bureau, which provides a finer industry disaggregation than is available elsewhere. The survey samples approximately 46,000 companies in more than 100 industries, categorized according to the 1997 North American Industry Classification System (NAICS). We narrow this categorization down to eighty-one nonoverlapping industries at approximately the three-digit NAICS level.[13]

The ACES provides measures of gross investment only and does not estimate industries' capital stock. Consequently, we cannot scale investment by lagged capital as is done in traditional empirical work on investment. Instead we simply investigate the change in total investment both for equipment alone and for equipment and structures combined. Empirical models of investment have struggled to explain the behavior of investment in structures, and it is not known whether this problem is due to mismeasurement in the tax term, unobservable factors in structures markets (such as liquidity and financing issues relating to the supply side of the market), or some other factor.[14] Since we cannot readily isolate equipment investment from structures investment in the firm-level data employed below, we have to assume that equipment investment and overall investment behave in the same way. Given that, by the 2000s, equipment accounted for something like 80 percent of nonresidential investment, this may not be too heroic an assumption, but the results in these areas will allow us to check the results in a circumstance where we have both sets of data.

Our goal with these data is to look for general evidence supporting the view that a capital overhang from the 1990s is a key factor determining investment in the 2000s. If overhang is quantitatively important, one might expect to find that those industries in which investment has fallen in the 2000s are the same as those in which investment grew substantially in

13. Before 1997, Standard Industrial Classification (SIC) codes were employed.

14. See, for example, Auerbach and Hassett (1992), who discuss the problems with estimating structures investment.

the 1990s. To test this relationship formally, we performed a cross-sectional regression of the change in log investment by industry from 2000 to 2002 (the period widely viewed as the “collapse”) on the change in log investment from 1994 to 1999 in the same industry, estimating the following equation:

$$\ln(I_{i,\ 2002}) - \ln(I_{i,\ 2000}) = \alpha + \beta[\ln(I_{i,\ 1999}) - \ln(I_{i,\ 1994})] + \epsilon_i. \qquad (1)$$

This test would show no evidence of reversion, of course, if all industries boomed and then busted together equally, since any such effect would simply appear in the constant term. Given that the investment growth of the 1990s was not likely to have been identical across industries, this equation provides a useful estimation strategy.

Table 1 presents, in the top panel, the results of estimating equation 1 by ordinary least squares (OLS) and, in the bottom panel, results for the same specifications employing median regressions, to ensure that the

Table 1. Regressions of Changes in Investment during 2000–02 on Changes in Investment during the 1990s, Equipment Only, Using Data by Industry[a]

Sample period	*All industries* 1-1	*Manufacturing only* 1-2	*All industries* 1-3	*Manufacturing only* 1-4
Ordinary least squares regressions				
1994–99	−0.084	−0.5315		
	(0.0693)	(0.1894)		
1997–99			−0.0582	−0.4204
			(0.0853)	(0.2047)
1994–97			−0.1435	−0.7878
			(0.1331)	(0.2704)
No. of observations	81	23	81	23
Adjusted R^2	.018	.273	.022	.330
Median regressions				
1994–99	−0.0205	−0.5836		
	(0.0994)	(0.2210)		
1997–99			0.0239	−0.5712
			(0.1392)	(0.2753)
1994–97			−0.1164	−0.8117
			(0.2206)	(0.4492)
No. of observations	81	23	81	23

Source: Authors’ regressions using data from the Annual Capital Expenditure Survey of the U.S. Census Bureau.

a. The dependent variable in all regressions is the change in log capital expenditure on equipment from 2000 to 2002; the independent variable is the same change in log values in the same industry for the indicated sample period. Numbers in parentheses are standard errors.

results in the top panel do not purely reflect the role of large outliers. Column 1-1 reports the results from the basic overhang specification. The OLS and median regressions produce coefficients that are negative but very small and not significantly different from zero. To give a sense of the magnitude of this effect, a 1-standard-deviation change in the investment rate from 1994 to 1999 (0.53, or from the median of 0.38 to about the 85th percentile) is associated with only a 2.9 percent lower level of investment (less than one-twelfth of a standard deviation) from 2000 to 2002. This is modest evidence of an overhang, at best.

Given the serious decline of manufacturing in the most recent recession, and given that old-line manufacturing was not typically involved in the Internet boom, we further investigate the manufacturing sector separately. In column 1-2, which restricts the sample to the twenty-three manufacturing industries, the evidence for an overhang seems more pronounced. In both the OLS and the median regressions, there is a large and significant negative coefficient on the change in investment from 1994 to 1999. In the median regression, a 1-standard-deviation increase in the investment rate among manufacturing industries (a log value of 0.32) in 1994–99 corresponds to an almost 22 percent lower investment rate in 2000–02, which is equal to about two-thirds of the standard deviation of those changes. If one takes this larger effect as evidence of overhang (as opposed to a cyclical phenomenon), however, it should be noted that manufacturing industries accounted for only about 22 percent of total equipment investment and 18 percent of total investment in 2002, according to the ACES.[15] Consequently, on the present evidence, mean reversion for manufacturing can explain only a limited part of the aggregate collapse of investment.

The common explanation for capital overhang is that an abundance of funds raised in the capital market during the bubble encouraged the excess investment, particularly during the 1997–99 period. Indeed, the broadly disaggregated, cost of capital–type analysis done by Jonathan McCarthy suggests that there was no capital overhang at all until 1998, even in the high-technology investment goods sector (computers and communications equipment).[16] In columns 1-3 and 1-4, therefore, we con-

15. This is also consistent with the evidence cited by Bernanke (2003).
16. McCarthy (2003).

sider separately the periods from 1994 to 1997 and from 1997 to 1999 in order to isolate the effects of the bubble period and to take account of underlying growth trends in different industries that might mask investment reversion. Again there is little evidence of reversion across all industries, and there are larger negative coefficients in manufacturing. The later period, in which the overhang is alleged to have occurred, has a smaller coefficient than the earlier period, although the standard errors are not small enough to reject the hypothesis that they are equal. Rather than supporting the intuition of a bubble-induced capital overhang, this consideration of the two subperiods suggests some underlying, more secular mechanism associated with the continuing decline in U.S. manufacturing.

Table 2 considers the behavior of both equipment and structures investment. The results are qualitatively similar to those in table 1 in that they show little evidence of reversion, either generally or in manufacturing, featuring the dynamics discussed earlier.

Table 2. Regressions of Changes in Investment during 2000–02 on Changes in Investment during the 1990s, Equipment and Structures, Using Data by Industry[a]

Sample period	*All industries* 2-1	*Manufacturing only* 2-2	*All industries* 2-3	*Manufacturing only* 2-4
Ordinary least squares regressions				
1994–99	–0.0516	–0.5426		
	(0.0645)	(0.169)		
1997–99			–0.0677	–0.4786
			(–0.0871)	(0.1916)
1994–97			–0.0304	–0.6663
			(0.1001)	(0.2395)
No. of observations	81	23	81	23
Adjusted R^2	0.008	0.329	0.009	0.247
Median regressions				
1994–99	0.0533	–0.6793		
	(0.1066)	(0.2030)		
1997–99			0.0285	–0.5450
			(0.1182)	(0.3532)
1994–97			–0.1186	–0.6564
			(0.1184)	(0.3665)
No. of observations	81	23	81	23

Source: Authors' regressions using data from the Annual Capital Expenditure Survey of the U.S. Census Bureau.

a. The dependent variable in all regressions is the change in log capital expenditure on equipment and structures from 2000 to 2002; the independent variable is the change in log values in the same industry for the indicated sample period. Numbers in parentheses are standard errors.

Table 3. Regressions of Changes in Investment during 2000–02 on Changes in Investment during the 1990s, Using Data by Asset Type[a]

Sample period	*3-1*	*3-2*
Ordinary least squares regressions		
1994–99	–0.0945	
	(0.0970)	
1997–99		0.0388
		(0.1576)
1994–97		–0.2326
		(0.1611)
No. of observations[b]	34	34
Adjusted R^2	.029	.063
Median regressions		
1994–99	–0.1490	
	(0.1105)	
1997–99		0.0545
		(0.1270)
1994–97		–0.2407
		(0.1113)
No. of observations[b]	34	34

Source: Authors' regressions using National Income and Product Accounts data from the Bureau of Economic Analysis.

a. The dependent variable in all regressions is the change in log capital expenditure from 2000 to 2002; the independent variable is the same change in log values for the same asset type for the indicated sample period. Numbers in parentheses are standard errors.

b. Sample includes twenty-five categories of capital equipment and nine categories of structures.

Evidence at the Asset Level

Next we consider the general evidence on investment by type of investment good rather than by industry. We did this by testing our basic regression model (equation 1) using data by asset category instead of by industry. Using only the BEA data available for the whole period 1994–2002, we have twenty-five different categories of equipment and an additional nine categories of structures.[17] As in tables 1 and 2, the two panels of table 3 report both OLS and median regressions. (Weighting by the initial capital stock in these regressions provides very similar results, which we do not report here.) Those asset types that had the largest increases in investment from 1994 to 1999 are not systematically those that had the largest drop in investment from 2000 to 2002: the regressions

17. The categories of structures employed by the BEA change slightly over the period.

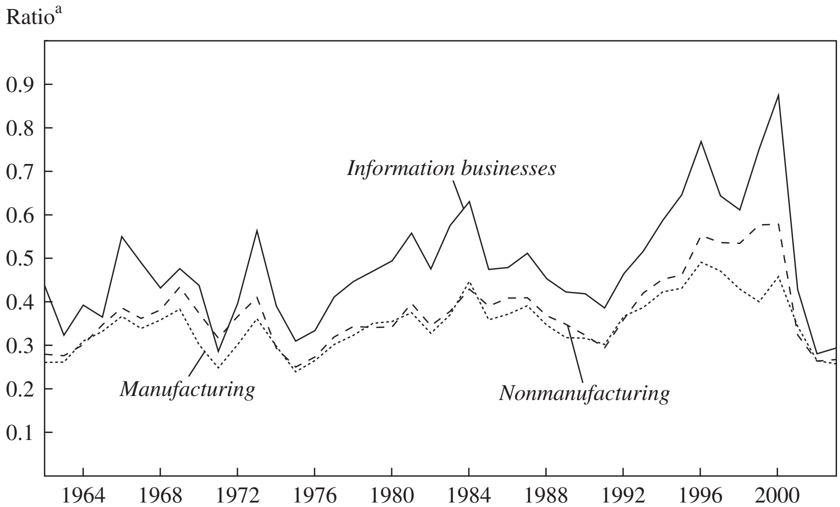
show a small and insignificant negative coefficient. This is equally true in the OLS and the median regression, and the coefficients have similar magnitudes. In the top panel, the estimate in column 3-1 indicates that an asset type whose log investment grew by 1 standard deviation (a log value of 0.36) more than the median asset from 1994 to 1999 would be expected to have a drop in log investment from 2000 to 2002 about one-sixth of a standard deviation larger than that of the median firm.

Column 3-2 repeats this analysis but splits the data into the early and late periods of the boom, 1994–97 and 1997–99, respectively. Here, although the coefficient estimates are imprecise, they are not consistent with the typical overhang story. If anything, the coefficients are again larger in absolute value in the earlier period than in the later period. Indeed, both of the point estimates in the later period are greater than zero, suggesting that those assets whose real investment grew most in the 1990s saw even greater investment growth in the 2000s. The irrational exuberance hypothesis would say just the opposite. Of course, in both cases the regressions do not control for anything but merely indicate the absence of a strong negative correlation. Using the firm-level data, we can further investigate these phenomena at the firm level, with better controls for observables related to investment opportunities.

Evidence at the Firm Level

Our firm-level sample includes all companies that appear in the Compustat research file from 1962 to 2003. Figure 3 plots the average investment rate (defined as capital expenditure divided by the beginning-of-period net capital stock) for manufacturing firms, for nonmanufacturing firms, and for firms involved in information businesses. Information businesses are defined as those in NAICS categories 334 (computer manufacturing) and 51 (information); this grouping is one we return to later, because the irrational exuberance of the late 1990s is commonly viewed as having been most extreme there. These data reveal the same pattern as the aggregate data: investment rates rose dramatically in the 1990s and then fell dramatically in the 2000s. We cannot say how representative the universe of publicly traded firms is of the rest of the economy, but in some ways the sheer magnitude of the firm-level sample makes it an overwhelmingly important component of aggregate investment on its own. Our calculations suggest that aggregate capital expendi-

Figure 3. Firm-Level Investment Rates by Sector, 1962–2003



Source: Authors' calculations using Compustat data.
a. Ratio of current capital expenditure to the capital stock in the previous period, calculated as described in appendix A.

ture in the firms in the Compustat data constituted 85 to 90 percent of private, nonresidential investment in the United States for most of the last twenty-five years.[18] Our sample in 2003 does not include all firms, since some share of firms had yet to have their reports coded by Compustat at the time of our analysis. Nonetheless, the sample is large (more than 80 percent of the 2002 sample) and provides a perspective not afforded by the industry-or asset-level data, given their earlier cutoffs.

We begin with the general evidence that parallels the previous results in examining the changes in investment rates during the bust and the subsequent boom, but with the advantage that, in the firm-level data, we can compute the change in the investment rate because we have capital stock data for each firm. Our modified regression equation, then, is

18. One important shortcoming of the Compustat data (and common to virtually all empirical work that uses these data to study investment) is the inability to isolate domestic from international expenditure or the degree to which q measures worldwide rather than domestic investment opportunities.

Table 4. Regressions of Changes in Investment Rates during 2000–02 on Changes in Investment Rates during the 1990s, Using Data by Firm[a]

Independent variable	*4-1*	*4-2*	*4-3*
Ordinary least squares regressions			
Investment rate change, 1994–99	–0.0325		–0.0237
	(0.0234)		(0.0216)
Investment rate change, 1997–99		–0.0739	
		(0.0376)	
Investment rate change, 1994–97		–0.0174	
		(0.0252)	
Change in sales, 2000–02[b]			0.0364
			(0.0304)
No. of observations	3,249	3,225	3,172
Adjusted R^2	.002	.005	.004
Median regressions			
Investment rate change, 1994–99	–0.0170		–0.0120
	(0.0051)		(0.0051)
Investment rate change, 1997–99		–0.0351	
		(0.0063)	
Investment rate change, 1994–97		–0.0071	
		(0.0051)	
Change in sales, 2000–02[b]			0.0545
			(0.0040)
No. of observations	3,249	3,225	1,798

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the change in the firm's investment rate, as defined in the text, from 2000 to 2002. Numbers in parentheses are standard errors.

b. In percent.

$$(2) \qquad \left(\frac{I}{K}\right)^i_{2002} - \left(\frac{I}{K}\right)^i_{2000} = \alpha + \beta\left[\left(\frac{I}{K}\right)^i_{1999} - \left(\frac{I}{K}\right)^i_{1994}\right] + e,$$

where I is capital expenditure at the firm level and is scaled by the lagged capital stock K.[19]

As before, the top panel of table 4 presents the OLS results and the bottom panel the median regression results. Column 4-1 reports results for a specification that emphasizes the relationship between the change in investment rates over the 1994–99 boom and that over the 2000–02 bust. Given that a firm must have existed in 1994, 1999, 2000, and 2002 to appear in the sample for this regression, the sample size is somewhat

19. Appendix A describes how we compute the capital stock for each firm, following Salinger and Summers (1984) and Cummins, Hassett, and Hubbard (1994).

smaller than the full universe of firms. These results again show a very small and insignificant negative correlation in the changes in investment rates. The median percentage change in the capital stock from 2000 to 2002 was –0.3 percent. The estimated coefficients are indeed tiny compared with the median firm. The coefficient on the lagged investment change variable indicates that a firm whose increase in investment rate during the boom was 1 standard deviation (about 0.65) above that of the median firm would have seen its investment fall by about 0.02, or only about one-thirty-fifth of a standard deviation, during the bust. The bottom panel of table 4 repeats this specification but controls for outliers by using a median regression (particularly important when firm data are used), and here the coefficient is even smaller but statistically significant. A firm whose investment grew by 1 standard deviation more than the median during the boom would have seen its investment fall during the bust by only about one-seventieth of a standard deviation more than the median firm.

The regressions reported in column 4-2 of both panels in table 4 split the 1994–99 period into two parts as an additional control, to account for firms whose size is trending upward. Inclusion of this split, however, produced little change in the general result of a very small negative impact relative to trend. Finally, the regressions in column 4-3 include the percentage change in the firm's real sales as an additional control, to further take into account the fact that firms might be growing or shrinking over the period in a way that drives the investment results. (Recall the large coefficients on manufacturing investment in the industry-level data.) In this regression, sales growth is positively correlated with growth in investment, but the evidence on reversion is even a bit more modest than in the first two columns.

The evidence thus far, then, provides very limited support for the view that firms, asset types, and industries that had major increases in their investment in the 1990s experienced major drops in investment in the 2000s. This seems to suggest that overhang was not the dominant factor influencing investment in the later period. A more precise test is available, however, by relating overhang to the sensitivity of investment to fundamentals at the firm level.

Evidence on Overhang and the Sensitivity of Investment

The firm-level data allow us to further examine whether firms have been less responsive to changes in tax-adjusted q in the 2000s if they had significant valuation increases in the 1990s. If, in fact, firms experiencing large changes in market value exhibit a different response than other firms to tax-adjusted q in the 2000s, this could help explain why taxes have not seemed to have a major impact on investment. The next section and appendix B discuss in more detail our tax-adjusted measure of q and the model underlying it. There we provide a fuller discussion of the measurement issues and the predictions of that model, but we include this analysis here in order to fully address the overhang phenomenon. Our basic estimating equation will add an interaction term to the standard equation relating investment to q.

We investigate the relevance of two different measures of overhang in the 1990s: one based on equity values and one based on capital expansion. Table 5 reports results of regressions using the lagged change in q as a measure of the degree to which overhang is operative.[20] We create the variable $\Delta_{t-3}^{t-7} q_{it}^{2000+}$, which is the change in q observed in the period three to seven years before the current year and only for the time period 2000–03.[21] So, in 2002 for example, this variable would be the change in the firm's q from 1995 to 1999. Before the 2000s this variable is always zero. One view of the overhang hypothesis is that investment for firms with large capital overhangs from the 1990s should be less sensitive to fundamentals or tax rates.[22]

This yields the following investment equation:

$$(3) \qquad (I/K)_{it} = \alpha_i + \gamma_t + \beta_1 Q_{it} + \delta Q_{it}(\Delta_{t-3}^{t-7} q_{it}^{2000+}) + \beta_2(\text{cash}/K)_{it} + \epsilon_{it}.$$

Here α_i and γ_t are firm and year dummies, respectively, and Q is tax-adjusted q, as defined below. Column 5-1 of table 5 presents the results

20. We considered using the lagged change in the price-earnings ratio as the measure of firms with overhang, but this had the obvious problem that many firms had negative earnings.

21. Other lags, such as the change in q from five years ago to two years ago, yield similar results.

22. In a previous draft we also examined whether having had a large increase in K or in q during the 1990s led the *level* of investment at the firm to be lower, controlling for current q (as opposed to the increase changing the slope of the investment-q relationship). We found virtually no evidence that it did.

Table 5. Regressions Testing Sensitivity of the Firm-Level Investment-Q Relationship to Past Changes in q[a]

Independent variable	*All industries* 5-1	*All industries* 5-2	*Information businesses only* 5-3	*Manufacturing only* 5-4	*All industries* 5-5
Q	0.0124	0.0221	0.0143	0.0137	0.0123
	(0.0014)	(0.0013)	(0.0032)	(0.0018)	(0.0014)
$Q \times \%\Delta q(t-3 \text{ to } t-7)$,	0.0006	0.0002	−0.0005	0.0010	0.0006
2000 or after[b]	(0.0004)	(0.0005)	(0.0011)	(0.0007)	(0.0004)
$Q \times \%\Delta q(t-3 \text{ to } t-7)$,					0.0003
1999 or before[c]					(0.0003)
Ratio of cash flow to	0.0198	0.0157	0.0069	0.0236	0.0198
capital stock	(0.0031)	(0.0024)	(0.0057)	(0.0042)	(0.0031)
Year dummies included	Yes	Yes	Yes	Yes	Yes
Firm dummies included	Yes	No	Yes	Yes	Yes
No. of observations	69,540	69,540	11,758	36,313	69,540
Adjusted R^2	.403	.039	.399	.377	.403

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the firm's investment rate in a given year, as defined in the text. Q is tax-adjusted q, defined as $[q/(1-\tau)] - [(1-\Gamma)/(1-\tau)]$, where Γ is the standard measure of the tax treatment of investment and τ is the corporate tax rate. Numbers in parentheses are standard errors clustered at the firm level.

b. Q times the change in q observed over the period three to seven years before the current year, where the current year is 2000, 2001, 2002, or 2003.

c. As above, where the current year is 1999 or before.

from estimating this equation over all firms. It shows that there is no significant difference in the investment-q relationship in the 2000s for firms that had larger run-ups in their stock prices in the 1990s. Indeed, the point estimate is actually positive, although small. Column 5-2 excludes the firm dummies, so that we are explicitly comparing results across firms rather than within a given firm. The result on the interaction term is very similar to that in column 5-1: positive and not significant.

Column 5-3 returns to the specification with firm dummies but restricts the sample to firms in information businesses; these are the firms most closely associated with the technology bubble. There is again no evidence that large increases in equity values in the 1990s have reduced the sensitivity of investment to the fundamentals in the 2000s. The point estimate on the interaction term is insignificant, although this time slightly less than zero. Column 5-4 repeats the analysis, this time for manufacturing firms only, and again there is nothing notable. Finally, column 5-5 investigates whether the relationship changed any differently in the 2000s than it did in earlier periods that followed asset price increases. The evidence suggests that it did not.

Table 6 repeats the exercise reported in table 5 but uses the lagged percentage change in capital for the firm during the 1990s as the measure of overhang. The advantage of the lagged change in q as the overhang measure in table 5 is that it picks up more directly the influence of asset price bubbles, which typically underlie the popular explanation of overhang. The lagged percentage change in the capital stock as used in table 6, in contrast, is a more direct measure of capital accumulation.

Table 6 reports estimates of the following equation:

$$(4) \qquad (I/K)_{it} = \alpha_i + \gamma_t + \beta_1 Q_{it} + \delta Q_{it}(\%\Delta_{t-3}^{t-7} K_{it}^{2000+}) + \beta_2(\text{cash}/K)_{it} + \epsilon_{it},$$

where $\%\Delta_{t-3}^{t-7} K_{it}^{2000+}$ is the percentage change in the net capital stock of the firm between time $t-3$ and time $t-7$ for 2000–03 (in other words, the change in the capital stock during the mid-1990s).

Estimating this equation for the entire sample of firms, as reported in column 6-1, does show a significant negative coefficient on the interacted Q term, indicating that firms that had larger accumulations of capital in the 1990s did, indeed, show less sensitivity to the fundamentals in their investment behavior in the 2000s. Although the direction is consistent with the overhang view, the magnitude is extremely small. To see this, consider that the highest mean value of lagged capital growth was 1.37 in

Table 6. Regressions Testing Sensitivity of the Firm-Level Investment-*Q* Relationship to Past Changes in Investment[a]

Independent variable	*All industries* 6-1	*All industries* 6-2	*Information businesses only* 6-3	*Manufacturing only* 6-4	*All industries* 6-5
q	0.0124	0.0214	0.0155	0.0117	0.0137
	(0.0014)	(0.0012)	(0.0011)	(0.0017)	(–0.0015)
$Q \times \%\Delta K(t-3 \text{ to } t-7)$,	–0.0027	0.0008	–0.0021	–0.0023	–0.0030
2000 or after[b]	(0.0007)	(0.0004)	(0.0011)	(0.0009)	(0.0007)
$Q \times \%\Delta K(t-3 \text{ to } t-7)$,					–0.0013
1999 or before[c]					(0.0004)
Ratio of cash flow to	0.0168	0.0114	0.0058	0.0143	0.0168
capital stock	(0.0024)	(0.0017)	(0.0045)	(0.0033)	(0.0024)
Year dummies included	Yes	Yes	Yes	Yes	Yes
Firm dummies included	Yes	No	Yes	Yes	Yes
No. of observations	83,147	83,147	14,735	44,326	83,147
Adjusted R^2	.371	.035	.357	.337	.371

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the firm's investment rate, as defined in the text, in a given year. Q is tax-adjusted q as defined in table 5; K is the capital stock. Numbers in parentheses are standard errors clustered at the firm level.

b. Q times the change in the capital stock observed over the period three to seven years before the current year, where the current year is 2000, 2001, 2002, or 2003.

c. As above, where the current year is 1999 or before.

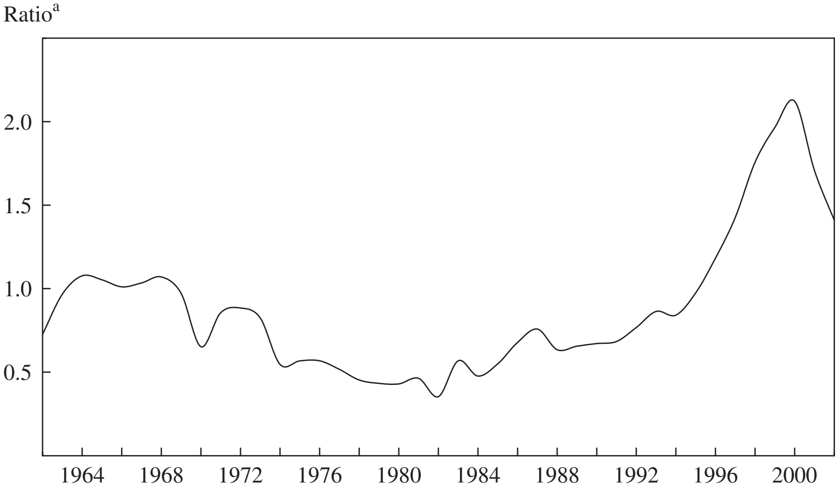
2002 (with a median value of past growth of 0.41). This value predicts that the coefficient on Q would fall by only 0.0037 (and only 0.0011 for the median). When we explicitly compare across firms by dropping the firm dummies (column 6-2), the point estimate becomes positive. Column 6-3 restricts the sample to information businesses as before; the coefficient on lagged capital growth, although slightly negative, is similarly modest. Column 6-4 repeats the analysis for manufacturing firms only and again finds similar results. Column 6-5 demonstrates that, with this measure of overhang, there is normally a small negative impact of lagged capital growth on current investment rates, even in the period before the 2000s. The difference in the coefficient between the 2000s and the pre-2000s period is only about 0.0017.

Taken together, the results in this section provide little evidence that capital overhang has played a key role in investment behavior in the 2000s. Low investment during the bust is not correlated strongly with excessive investment in the boom. Similarly, the sensitivity of investment in the 2000s to the fundamentals is not markedly different for firms overall or for those firms usually at the heart of the overhang view. In other words, the standard firm-level model using tax-adjusted q has not become noticeably worse at explaining investment. Accordingly, in the following section we use this model to analyze the impact of taxes.

q Theory, Investment Incentives, and Dividend Taxes: Theory and Empirics

As a prelude to using the tax-adjusted q model to study the impact of the Bush tax cuts, it is useful to consider the aggregate movements in q over the whole of the period that our firm sample covers, 1962–2003, in thinking about the root determinants of the behavior of aggregate investment in the 1990s and 2000s. Figure 4 plots average q for the corporate sector as a whole, measured as the total market value of all publicly traded firms as computed by CRSP (Center for Research in Security Prices) divided by the total stock of corporate capital as computed by the BEA in its fixed reproducible tangible wealth series. The series shows a historic rise in q in the mid-1990s and an unprecedentedly steep fall in the

Figure 4. Aggregate *q*, 1962–2002



Source: Authors' calculations using BEA and Compustat data.
a. Ratio of the aggregate market value of all firms in the Compustat sample to the stock of corporate capital as computed by the BEA in its Fixed Reproducible Tangible Wealth series.

2000s.[23] Previous studies have found only very small coefficients on tax-adjusted *q,* and so this rise and fall in *q* might not imply much in the way of aggregate investment changes. We estimate the investment relationship, however, within a slightly different framework than is typical, to overcome possibly conflating measurement issues. It should be clear that, if the true coefficient on *q* for investment is not 0.02 but closer to 1, as argued below, the investment collapse is eminently comprehensible within the conventional framework. Clearly, within a standard *q* model of investment, an equity price bubble can still drive investment up and then down through movements in *q.* Such an account of the investment experience of the 1990s and 2000s is distinct from the intuition of a lingering overhang from the 1990s.

Of course, as critics have frequently pointed out, the fundamental question is why the coefficients on *q* in investment regressions are typically so low, implying extremely large adjustment costs. One of the key

23. A plot using the average of firm *q*s in our sample (not shown) yields a similar picture.

potential problems discussed in the literature has been the importance of measurement error in q. Marginal q is the variable of interest, but the data can provide only average q. At least some of the existing literature has argued that measurement error is at the root of the relatively weak empirical performance of traditional investment models.[24] This issue of measurement error is particularly important for thinking about the impact of taxation, as we demonstrate below.

If, in fact, an empirical implementation of the q model provides more reasonable coefficients through an alternative strategy of dealing with these measurement issues, then these estimates can serve as the foundation for analyses of the true marginal costs of adjustment and the impact of the various tax policy changes enacted during the Bush administration (the changes in depreciation allowances as well as the changes in dividend and capital gains taxes). The rest of this section undertakes such an analysis.

Tax-Adjusted q Theory, Dividend Taxes, and the Marginal Source of Funds

To use the q model to analyze the impact of taxes, particularly dividend taxes, we revisit the techniques for incorporating taxes into such models developed by Summers and by James Poterba.[25] A crucial issue in determining the impact of dividend taxes in this framework is what the marginal source of funds for firms' investments is. Briefly, if the marginal source of funds is retained earnings, then dividend taxes will have no impact on marginal investment incentives. But if the marginal source of funds is new equity, then dividend taxes will influence investment. This distinction is the subject of an enduring debate in public finance between the "new" and the "traditional" view of dividend taxation.

Appendix B works through the implications of the two views in some detail and provides alternative estimating equations. The investment model typically estimated in the literature follows the traditional view. In this view dividend taxes influence investment by, essentially, double-taxing corporate income. Assuming quadratic adjustment costs, this view generates the following investment-q relationship:

24. See, for example, Cummins, Hassett, and Hubbard (1994), Bond and Cummins (2000), and Goolsbee (2001).

25. Summers (1981); Poterba and Summers (1983, 1985).

$$\frac{I_t}{K_{t-1}} = \mu + \left(\frac{1}{\varphi}\right)\left(\frac{q_t}{1-\tau} - \frac{1-\Gamma}{1-\tau}\right), \tag{5}$$

where I is investment, K is the firm's capital stock, φ is the adjustment cost parameter, and μ represents an average investment rate. Under this assumption, net new equity finances investment, so that investment is determined by the point at which shareholders are indifferent between holding a dollar inside or holding it outside the firm. In a world without other taxes, the firm stops investing once $q = 1$. Of course, if investment is heavily subsidized (that is, if $\Gamma > \tau$), firms may even continue investing with $q < 1$, but the general idea is the same. Changes in dividend taxes will influence equity values and investment incentives by influencing the relative preference of investors to hold their money inside rather than outside the firm.

If, however, retained earnings are the marginal source of finance, the traditional investment-q relationship of equation 5 will not hold. In this case (again assuming quadratic adjustment costs), the relationship will follow

$$\frac{I_t}{K_{t-1}} = \mu + \left(\frac{1}{\varphi}\right)\left\{\left[\frac{q_t\left(\frac{1-c}{1-\theta}\right)}{1-\tau}\right] - \left(\frac{1-\Gamma}{1-\tau}\right)\right\}, \tag{6}$$

where θ is the tax rate on dividends is and c is the accrual-equivalent tax rate on capital gains.

Equation 6 corresponds to the "new" (or "trapped equity" or "tax capitalization") view of the role of dividend taxation. In this view dividend taxes do *not* influence the tax term for marginal investments.[26] Instead they are fully capitalized into existing share prices. In other words, changes in dividend taxes serve solely as a penalty or windfall on existing firm values. To see the intuition behind this, consider a firm that uses retained earnings at the margin to finance investment, with dividends determined as a residual. In this model dividends are the only means of distributing earnings to shareholders. In this setting, given that retained

26. This view originates in the work of King (1977), Auerbach (1979), and Bradford (1981).

earnings are the marginal source of financing, investment is determined by the point at which shareholders are indifferent between receiving a dollar today as a dividend, with value $1 - \theta$, and having the dollar reinvested, yielding $(1 - c)q$. Accordingly, the firm will stop investing at the point $q = \frac{1-\theta}{1-c} < 1$ in a world of no other taxes, rather than at $q = 1$ as in the traditional case.

What is counterintuitive about the new view, as expressed in equation 6, is that although it argues that dividend taxes do not influence investment, the dividend tax rate appears in the investment equation. In contrast, equation 5, which exemplifies the traditional view, does not include a dividend tax term but corresponds to the view that dividend taxes do influence investment. The intuition for this is simply that, when dividend taxes get capitalized into share values, they influence q. This effect needs to be removed from the investment equation under the new view, because this part of q has no impact on investment. Alternatively, under the traditional view embodied in equation 5, a permanent dividend tax cut raises the value of q above 1, and this encourages further investment, just as any other increase in q does.

There is an old and contentious debate within public finance over which of these views is the more accurate. Proponents of the traditional view cite evidence on the effects of dividend tax rates on corporate dividend payout policy.[27] Furthermore, dividends seem more stable than the new view implies, and other means of distributing profits to shareholders, such as share repurchases, have become increasingly important. Proponents of the new view note that new equity issuances are still quite rare for most companies and that firms pay dividends even though dividends are tax disadvantaged. The arguments in this debate are considerably more involved than we can describe here.[28] Fundamentally, however, which view is more accurate is primarily an empirical matter. Surprisingly, except for the work on aggregate investment in the United King-

27. See the work of Poterba and Summers (1985), Chetty and Saez (2004), and Poterba (2004) and the papers they cite. Auerbach (2002) points out, however, that interpretation of the empirical evidence on this point is complicated by the fact that temporary cuts in dividend taxes should encourage dividend payouts, even under the new view.

28. Fuller assessments of both views can be found in Auerbach and Hassett (2003), Carroll, Hassett, and Mackie (2003), and Poterba and Summers (1985).

dom by Poterba and Summers,[29] there have been no direct attempts to test between the two views using investment data.

Poterba and Summers use thirty years of annual data from the United Kingdom to test between equations 5 and 6; their results support the traditional view. Although Alan Auerbach and Hassett have been critical of these findings for, among other things, failing to account for other macroeconomic and tax changes occurring at the same time,[30] these estimates are still the only direct empirical tests of how dividend taxes affect investment. Oddly, no one has extended the methods of Poterba and Summers to firm-level data, where it is possible to control for many aggregate factors. Nor has anyone ever applied their method to the United States, perhaps because, until the 2003 tax cut, U.S. dividend taxes did not change in isolation from other changes, but rather varied only through changes in personal income tax rates. Instead the empirical work testing the new versus the traditional view has adopted the indirect method of examining the relationship between dividend taxes and dividend payments (or the valuation of dividend payments by investors).[31]

The recent large changes in dividend taxes, however, make such an analysis possible. Indeed, testing between these two views (and making the required detour into the public finance debate) is critical for evaluating the impact of the Bush tax cuts on investment. If the marginal source of funds turns out to be retained earnings, the dividend tax cut will have little or no impact on marginal incentives to invest. Before explicitly testing between the two views, however, we lay out the basic tax-adjusted q model and illustrate why we believe measurement error is a primary reason that such models have implied high adjustment costs and have performed so poorly in the past.

Empirical Implementation of the *Q* Model

In computing q empirically, we use the historical and current Compustat database, which provides data on a panel of firms from 1962 through

29. Poterba and Summers (1983, 1985).

30. Auerbach (2002); Auerbach and Hassett (2003).

31. See, for example, Bernheim and Wantz (1995), Poterba (2004), Chetty and Saez (2004), and Poterba and Summers (1985), as well as the opposing evidence in Bolster and Janjigian (1991), Blouin, Raedy, and Shackelford (2004), and Ikenberry and Julio (2004).

2003.[32] For some firms we also match this sample to the earnings estimates provided by I/B/E/S (Institutional Brokers' Estimate System). Estimates of the tax term at the asset level are derived from data provided generously by Dale Jorgenson.[33] As described in more detail in appendix A, we follow Cummins, Hassett, and Hubbard and Robert Chirinko, Steven Fazzari, and Andrew Meyer in using the BEA's capital flows table for 1997 to calculate the share of investment in each industry for each asset type.[34] With that weighting, we calculate the weighted-average tax term in each year for each four-digit industry in the Compustat data. Average marginal tax rates on dividend and capital gains income (on an accrual basis) are taken from Poterba.[35] Further discussion of the variable construction and the sources of data is provided in appendix A.

The measurement of q and, in turn, Q, hinges on constructing a measure of the ratio of a firm's market value to its book value. The corporate finance literature and the public finance literature have diverged somewhat in their measurement of this ratio, and we consider both alternatives in the results that follow. The corporate finance literature, as exemplified in the 1997 paper by Steven Kaplan and Luigi Zingales,[36] employs data from Compustat to derive a measure of q as $\frac{BV\ Assets + (MV\ Equity - BV\ Equity)}{BV\ Assets}$, where BV stands for book value and MV for market value, and all values are taken from public financial records.[37] In contrast, the public finance literature has emphasized the derivation by Salinger and Summers,[38] which constructs q as $\frac{MV\ Equity + MV\ Debt}{MV\ Assets}$, where debt and equity values are taken from financial reports, but the market value of assets is imputed using perpetual inventory methods and valuations of inventory as discussed in the data appendix to Cummins, Hassett, and Hubbard.[39]

32. Because of reporting conventions, the 2003 sample is somewhat smaller than the sample in earlier years.

33. The data are described in more detail in Jorgenson and Yun (2001). Importantly, the Jorgenson calculations do not take any future expectations of tax changes into account. They use only the statutory tax rules for the year in question.

34. Cummins, Hassett, and Hubbard (1994); Chirinko, Fazzari, and Meyer (1999).

35. Poterba (2004).

36. Kaplan and Zingales (1997).

37. This numerator is also sometimes adjusted for deferred taxes.

38. Salinger and Summers (1984); see also Cummins, Hassett, and Hubbard (1994).

39. Cummins, Hassett, and Hubbard (1994).

Implicitly, this formulation takes the market value of debt to be its book value.

As with any firm-level analysis employing Compustat data to study investment, rules for considering extreme observations must be employed. Following studies such as that by Simon Gilchrist and Charles Himmelberg, we truncate our measures of q (and of investment and cash flow as a share of the capital stock) at the 1st and the 99th percentile.[40] Investment rates and cash flow rates are taken as the ratio of capital expenditure and operating cash flow before depreciation, respectively, to the capital stock.

Table 7 reports the results of estimating q models in our firm sample, under both of the two alternative definitions of q, as well as Q, that is, q adjusted for taxes, $\left(\frac{q_t}{1-\tau} - \frac{1-\Gamma}{1-\tau}\right)$. We postpone discussion of the relevance of dividend taxes, and so our estimating equation is equation 5 above, with and without consideration of taxes. Columns 7-1 and 7-4 of table 7 contrast the performance of the corporate finance and public finance measures of q without consideration of tax factors. Both coefficients are significant and positive, but the coefficient on the corporate finance q is much larger. Inspection of the public finance qs indicates that extreme values make up a large fraction of the sample and may contribute to this pattern. Comparison of columns 7-2 and 7-5 provides a similar result, with significantly larger coefficients on the corporate finance–based measure of Q. Nonetheless, the coefficients reflect the common difficulty in this literature, which is that these small coefficients translate into extremely high adjustment cost parameters (the inverse of the measured coefficient). Inclusion of both q and Q, in the specifications reported in columns 7-3 and 7-6, results in a similar pattern, but does indicate that tax-adjusted q outperforms q in explaining investment. This finding parallels the finding by Summers of the relevance of tax adjustments in improving the estimation of the q model.[41]

Given the relative performance of q and Q in the results reported in table 7, it is useful to consider separately the terms that make up Q to better understand the sources of the relatively small coefficients on Q. As discussed above, $Q = \frac{q_t}{1-\tau} - \frac{1-\Gamma}{1-\tau}$, and so the specifications in table 7 can

40. Gilchrist and Himmelberg (1998).
41. Summers (1981).

Table 7. Regressions Testing Sensitivity of the Firm-Level Investment-Q Relationship to q and Tax-Adjusted q Using Alternative Definitions[a]

	Regressions using corporate finance definition of q			*Regressions using public finance definition of q*		
Independent variable	*7-1*	*7-2*	*7-3*	*7-4*	*7-5*	*7-6*
q	0.0379		–0.1111	0.0007		–0.0030
	(0.0019)		(0.0174)	(0.0002)		(0.0018)
Q		0.0231	0.0863		0.0005	0.0023
		(0.0011)	(0.0102)		(0.0001)	(0.0010)
Ratio of cash flow to capital stock	0.0020	0.0006	0.0015	0.0003	–0.0013	–0.0013
	(0.0015)	(0.0015)	(0.0016)	(0.0015)	(0.0015)	(0.0016)
No. of observations	160,051	142,043	142,043	161,416	142,882	142,882
Adjusted R^2	.377	.376	.377	.368	.367	.367

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the firm's investment rate, as defined in the text, in a given year. Q is tax-adjusted q as defined in table 5. All regressions include year and firm dummies. Numbers in parentheses are standard errors clustered at the firm level.

naturally be recast to consider the separate effects for these two terms. Splitting Q in this manner has the advantage of allowing us to consider the role of measurement error in biasing the estimates previously obtained. More specifically, Cummins, Hassett, and Hubbard argue that mismeasurement of q means that using the estimated coefficients from standard investment regressions can dramatically understate the impact of investment taxes.[42] They emphasize large tax reforms as being times when the tax part of Q is not mismeasured, and they use these periods as the basis for comparing actual with projected investment. The specifications provided in table 7 take a simpler approach but in the same spirit. If measurement error in q is a problem, splitting Q into two parts has the advantage that the coefficient (or, more accurately, its absolute value) on the $\frac{1-\Gamma}{1-\tau}$ term should provide a better estimate of the true coefficient on q.[43]

Table 8 presents the results from splitting Q into its component parts. Specifically, the specification in the first column replaces Q with q scaled by 1 minus the corporate tax rate and terms for the equipment tax term and the structures tax term. It is difficult to measure a firm's relative investment in equipment and structures, and so we simply include both tax terms as separate regressors. Given the traditional difficulties in understanding the dynamics of incentives for investment in structures,[44] and given that equipment accounts for approximately 80 percent of corporate investment, we expect the equipment tax term to be much more precisely estimated. Controls for internal cash flow are included as well.

The key result from this table is that, although the q term remains small, the coefficient on the equipment tax term is considerably larger than typically estimated when just using Q and is close to 1 in absolute value.[45] The second column includes q without a tax adjustment and indicates, as with the results in table 7, that a tax-adjusted q term performs

42. Cummins, Hassett, and Hubbard (1994).

43. This assumes that the measurement errors are not correlated in the two series. We tried the same regressions in the exercise below, but excluding the q term and including only the tax terms, and found the coefficient on the tax term to be even slightly larger in absolute value, and so we are not as concerned about this issue.

44. See Auerbach and Hassett (1992).

45. We also tried including lagged q and tax term terms, but this had no impact on the results.

Table 8. Regressions Testing Sensitivity of the Firm-Level Investment-Q Relationship to Components of Tax-Adjusted q[a]

Independent variable	*Baseline regression*	*Including ordinary q in regression*	*Include controls for past depreciation allowances*[b]	*Include controls for debt shares*[c]	*Instrumental variables regression*[d]
$q/(1-t)$	0.0231	0.0858	0.0166	0.0245	0.2120
	(0.0011)	(0.0102)	(0.0011)	(0.0011)	(0.0054)
q		–0.1103			
		(0.0174)			
Tax term, equipment	–0.8895	–0.7865	–0.7078	–0.8949	–2.5351
	(0.3173)	(0.3162)	(0.2870)	(0.3163)	(1.0101)
Tax term, structures	–0.0169	–0.0064	–0.0333	–0.0127	–0.7902
	(0.0452)	(0.0453)	(0.0408)	(0.0450)	(0.2716)
Ratio of cash flow to capital stock	0.0005	0.0004	0.0090	0.0002	0.0170
	(0.0015)	(0.0015)	(0.0018)	(0.0015)	(0.0022)
No. of observations	141,629	141,629	111,059	141,245	46,154
Adjusted R^2	0.376	.377	.381	.378	—

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the firm's investment rate, as defined in the text, in a given year. All regressions include year and firm dummies. Numbers in parentheses are standard errors clustered at the firm level.

b. Controls for the present value of tax depreciation allowances on previously purchased investment, as described in appendix B.

c. Controls for the share of debt in firm financing.

d. Financial analysts' reported estimates of the firm's earnings are used as an instrument for firm q.

better than ordinary *q*. In this specification the coefficient on the equipment tax term remains significant and large. The third and fourth columns report two alternative robustness checks for these results that are modifications to the basic tax-adjusted *q* model. First, the theory does imply that the present value of tax depreciation allowances on previously purchased investment should be included in the value of the firm. This is frequently left out of empirical work on *Q,* since it is difficult to compute. In the third column we approximate the size of these tax shields as described in appendix A, and we add the value of these shields to the value of the firm in *Q*. This does not change the estimated results dramatically. We found this to be true for all of the major results in the paper, and, since computing the allowances requires reducing the sample by more than 30,000, we exclude them from the results that follow. Similarly, the model presented above follows most of the literature in assuming away any issues regarding debt financing. In the fourth column we incorporate the share of the firm's financing that comes from debt,[46] and the results are again similar.

The large coefficients on the tax term terms are worth dwelling on. First, the model predicts that these coefficients should be of the same magnitude as those on tax-adjusted *q,* but of opposite sign. Here, instead, the coefficients on the equipment tax term are considerably larger. With measurement error in *q,* the coefficient on the tax term may provide a more realistic estimate of the true coefficient. Such a coefficient is considerably closer to 1 and, consequently, corresponds to more realistic estimates of adjustment costs. Restricting attention to years with major tax reforms yielded similar estimates.[47]

To obtain some further evidence on the role of *q* mismeasurement as the reason for the small coefficient on the *q* term, we also modify the empirical strategy of Stephen Bond and Cummins,[48] within the framework of table 8. Their intuition is that earnings estimates by equity analysts as provided in the I/B/E/S database are a part of *q* that is based only on fundamentals.[49] Rather than use these estimates to create an alternative

46. Following Summers (1981).

47. These results are similar to findings by Cummins, Hassett, and Hubbard (1994).

48. Bond and Cummins (2000).

49. Cummins, Hassett, and Oliner (forthcoming) also look at investment equations that include analysts' earnings estimates.

q measure, however, we use them as instruments for *q*.[50] Employing the earnings estimates comes at considerable cost, given the shorter time frame covered by the I/B/E/S database (1983–2003) and the severely restricted number of firms covered by I/B/E/S. Nonetheless, we report in the fifth column of table 8 the results of this estimation. Several points are worth noting. First, as indicated by the tenfold increase in the coefficient on tax-adjusted *q,* mismeasurement of *q* seems important. Second, the coefficient on the equipment tax term rises considerably as well. Given the considerably smaller panel for these instrumental variables results, we rely on the coefficients on the equipment tax term term in the first column of table 8 as the best estimate of the true coefficient from a tax-adjusted *q* model. This analysis suggests that the true adjustment costs for investment are of plausible size, and so we use the model to estimate the impact of the Bush tax cuts. Finally, it is useful to consider whether the relevance of the *q* model is different in manufacturing industries, since many previous studies have restricted their sample to manufacturing. We prefer not to do this, since manufacturing accounts for only a small fraction of total investment. Table 9 replicates the analysis from the first column of table 8 and divides the sample. Although the reduced sample sizes reduce the power of these tests, the coefficients on the relevant tax term terms are quite similar in the two subsamples, suggesting that the model performs similarly well in both settings.

The Impact of Tax Cuts in the 2000s

During the George W. Bush administration two major changes have been made to the tax code to reduce taxes on capital. First, in 2003 the top capital gains tax rate was reduced from 20 percent to 15 percent, and the tax rate on most dividends was reduced from the ordinary personal income tax rate (which then had a maximum of 38.6 percent) to the capital gains tax rate. The second change substantially accelerated depreciation. In 2002 depreciation allowances for virtually all types of equipment investment were increased, as firms gained the right to immediately expense 30 percent of their purchases. In 2003 depreciation allowances

50. To be precise, we use the earnings estimates divided by $(1 - \tau)$ as an instrument for $q/(1 - \tau)$.

Table 9. Regressions Testing Sensitivity of the Firm-Level Investment-*Q* Relationship to Components of *Q* in Manufacturing and Nonmanufacturing Industries[a]

Independent variable	*All industries*	*Manufacturing industries only*	*Nonmanufacturing industries only*
$q/(1-t)$	0.0231	0.0210	0.0169
	(0.0011)	(0.0015)	(0.0011)
Tax term, equipment	–0.8895	–1.1545	–0.7034
	(0.3173)	(0.6943)	(0.2853)
Tax term, structures	–0.0169	–0.0035	–0.0307
	(0.0452)	(0.1762)	(0.0405)
Ratio of cash flow to capital stock	0.0005	0.0001	0.0090
	(0.0015)	(0.0022)	(0.0018)
No. of observations	141,629	68,680	111,059
Adjusted R^2	.376	.336	.381

Source: Authors' regressions using data from Compustat.
a. The dependent variable in all regressions is the firm's investment rate, as defined in the text, in a given year. All regressions are as specified in the first column of table 8. Numbers in parentheses are standard errors clustered at the firm level.

were increased again, as the fraction that could be immediately expensed increased to 50 percent. Each of these tax changes needs to be treated differently under the *Q* model.

Dividend Taxes

Although implementation of the dividend tax reduction was somewhat complex, essentially the maximum rate on dividends for individuals was reduced from the top rate on ordinary income (38.6 percent) to the capital gains tax rate (maximum of 15 percent). Advocates argued that this tax cut would reduce the tax term and stimulate business investment.[51] The Joint Committee on Taxation estimated that the dividend tax cut would reduce revenue by more than $100 billion from 2003 to 2008.[52] Given this high cost, it is worth assessing the impact of the cut. If the "new" view is correct, changes in dividend taxes have little or no impact on the cost of capital.

Table 10 reports results of our testing between the two views. In the first column we consider the relevance of dividend taxes by contrasting the predictions of equations 5 and 6 in one specification. The difference is

51. See Hederman (2004) and Larry Kudlow, "A Capital Idea from Microsoft," National Review Online, posted on July 23, 2004 (www.nationalreview.com/kudlow/kudlow200407230854.asp).

52. Joint Committee on Taxation (2003a).

Table 10. Regressions Testing Sensitivity of the Firm-Level Investment-*Q* Relationship to Capital Gains and Dividend Tax Rates[a]

	Sample period		
Independent variable	*1961–2003*	*1961–1996*	*1997–2003*
$q/(1-t)$	–0.0158	–0.0067	–0.0652
	(0.0130)	(0.0154)	(0.0345)
$(1-tcg)/(1-tdiv) \times q/(1-t)$[b]	0.0312	0.0241	0.0673
	(0.0105)	(0.0122)	(0.0291)
Tax term, equipment	–0.7795	–0.6258	0.748
	(0.3154)	(0.3219)	(2.6180)
Tax term, structures	–0.0081	–0.0237	9.464
	(0.0454)	(0.0459)	(2.7730)
Ratio of cash flow to capital stock	0.0004	0.0134	–0.0184
	(0.0015)	(0.0025)	(0.0023)
No. of observations	141,643	100,525	41,118
Adjusted R^2	.376	.426	.486

Source: Authors' regressions using data from Compustat.

a. The dependent variable in all regressions is the firm's investment rate, as defined in the text, in a given year. All regressions include year and firm dummies. Numbers in parentheses are standard errors clustered at the firm level.

b. *tcg* is the accrual-equivalent tax rate on capital gains and *tdiv* the tax rate on dividends.

simply whether the q term is adjusted by the dividend tax preference parameter or not. In the empirical specification of the first column, we use all years for which we have firm data. The measure of q that is interacted with the $\left(\frac{1-c}{1-\theta}\right)$ term has a positive coefficient and is highly significant. The measure that is *not* interacted with the $\left(\frac{1-c}{1-\theta}\right)$ term is insignificant and actually has a negative coefficient. The two coefficients are significantly different from one another as well. In other words, although the marginal source of funds for these firms cannot be observed directly, their investment behavior is consistent with their treating retained earnings as the marginal source, and this implies that the new view is the correct one.

One major criticism of most previous analyses of the impact of dividend tax rates on investment and other economic behavior has been that changes in the rates themselves do not occur in isolation, but instead accompany changes in the top marginal rate on ordinary income.[53] In the later part of our sample, however (1997–2003), the tax changes that

53. See, for example, Auerbach (2002).

occurred are fairly specific in isolating the impact of dividend and capital gains taxes. In 1997 capital gains rates fell without any change in the top marginal income tax rate, and in 2003 both the capital gains rate and the dividend tax rate did so. This period, then, should be particularly instructive. For this reason (and because firm financing decisions may have changed over time with the rise of new equity issuances), we break the sample into the period before and the period including and after 1997. Results for these two subsamples are reported in the second and third columns of table 10. Both regressions show that the new view outperforms the traditional view, but the evidence is particularly strong for the later period.[54] Again, the evidence in all cases supports the new view and implies a small or negligible impact of dividend taxes on investment.

At the other extreme, in keeping with the discussion in Auerbach and Hassett, among others,[55] who have argued that the new view may apply for some firms and the traditional view for others, we calculate approximately how the dividend tax change would change the cost of capital if our findings were wrong and the traditional view held.[56]

Under the traditional view, the required after-tax rate of return r^* will be $r/[1 - p\theta - (1 - p)c]$, where r is the before-tax rate of return, p is the dividend payout rate, and c and θ correspond to the capital gains and dividend tax rates, respectively. The full cost of capital, assuming no inflation in the price of investment goods and a permanent change in tax policy, will then be $COC = (r^* + \delta)\left(\frac{1-\Gamma}{1-t}\right)$.

With a real interest rate of 5 percent, annual depreciation of 15 percent, a payout rate of 50 percent, and an accrual tax rate on capital gains equal to one quarter the statutory rate (as is commonly assumed in the literature), reducing the dividend tax from 38.6 percent to the level of the capital gains rate in 2003 for a fully taxable investor would be the

54. We also tried using only the personal tax rates from Poterba (2004) to take out any potential bias that the trends in corporate and nontaxable investor shares of dividends received might have on average marginal tax rates. This made no difference to our results and consistently showed evidence in favor of the new view. Note that our results are not identified by the level of the dividend tax term (which gets absorbed in the year dummies) but instead by the interaction with q.

55. Auerbach and Hassett (2002).

56. Carroll, Hassett, and Mackie (2003) simulate the impact in more detail under various assumptions.

equivalent of dividing the cost of capital by 1.035. The equipment tax term in 2003 was about 1.031, so this would have an effect on investment of approximately the same magnitude as converting the tax code to complete and immediate expensing of all equipment investment in 2003 (since dividing the tax term by 1.035 would yield a value of approximately 1, the same as immediate expensing). We will show in the next subsection, however, that changes to the tax term of that magnitude may not increase investment by much in the short run during this sample period.

The Impact of Partial Expensing

Although we find no impact of the dividend tax cuts on investment, the other tax incentives enacted during the early 2000s, specifically the depreciation allowance and partial expensing changes, directly reduced the tax term under either view of the dividend tax and should have stimulated investment. Their apparent failure to do so has led some to argue that tax policy is not effective.

MAGNITUDE OF THE CUTS. In 2002 President Bush signed a change in the tax code to allow for partial expensing of equipment; this change was made retroactive to cover all investment in 2002. In essence this rule change broke an investment into two parts. Thirty percent of the investment is immediately expensed. The remaining 70 percent is depreciated according to the normal schedule (which allows the firm to write off some portion in the first year, some portion in the second, and so on, for the tax life of the asset). Given that a fairly large share of the investment not being expensed already gets depreciated in the first year, this new law heavily weighted the depreciation allowances toward the first year.[57] In 2003 the law was changed again (and again made retroactive to cover investments made at any time during the year) to allow for first-year expensing of 50 percent of the investment. Although this provision was scheduled to expire at the end of 2003, it was extended to 2004 and may be extended further in the future—as of this writing, many legislators and commentators are arguing that it should be made permanent.

57. Cohen, Hassett, and Hansen (2002) provide a comprehensive analysis of the 2002 change.

These incentives were costly to provide, of course. The Joint Committee on Taxation estimated the cost of the changes in 2002 at about $35 billion and the cost of the higher expensing in 2003 and 2004 at about $32 billion and $53 billion, respectively.[58] Extending it indefinitely would presumably entail similar annual costs.

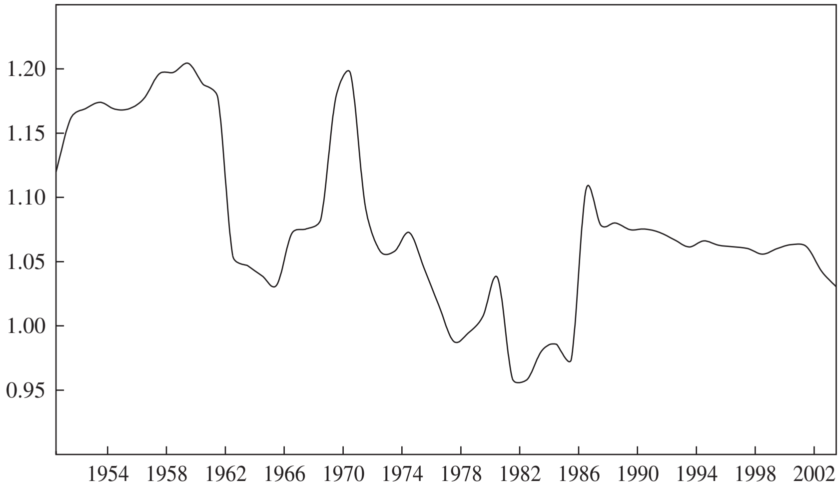
To estimate the effect of the changed investment incentives, we compute the increase in investment implied by the changes to depreciation allowances. The last two columns of appendix table A-1 report the change in the tax term from 2001 to 2003, averaged across industries at the three-digit NAICS level. The first column considers the overall change in the tax cost, and the second the change in the tax term for equipment only. Not surprisingly, the amounts differ across industries depending on the nature of the investment goods they purchase. Airlines, for example, invest mostly in equipment and mostly in long-lived assets such as aircraft. Long-lived assets that qualify for bonus depreciation receive the largest boost from allowing 50 percent immediate expensing (since they were depreciated over a longer period before) and thus provide the largest changes in the tax term. Firms in industries such as real estate and hotels invest little in equipment, and what equipment they buy tends to consist of computers and other short-lived assets for which immediate expensing is not as large an improvement.

The table shows that even these rather dramatic changes to the depreciation and expensing rules did not have a very large impact on the tax term. The average change in the equipment tax term across all firms is about 0.03 (0.02 after incorporation of the equipment share). Such a change is modest compared with changes such as the investment tax credit of 1962, its restoration in the early 1970s, or the increases in the depreciation allowance in 1981, all of which changed the overall tax term by around 0.10. Figure 5 depicts the industry-average equipment tax term over roughly the last half century and shows that the most recent changes in investment incentives have been modest by historical standards.

This relatively small effect stems from several factors. First, the value of an acceleration in depreciation allowances is a function of the corporate tax rate: with corporate tax rates already lower than they were in previous decades, altering depreciation schedules has a more muted effect. Second, the well-documented shift of investment toward computers and other

58. Joint Committee on Taxation (2002, 2003a, 2003b).

Figure 5. Aggregate Tax Term for Equipment,[a] 1950–2003



Source: Authors' calculations based on Jorgenson and Yun (2001).
a. Unweighted average of $q/(1-\tau)-(1-\Gamma)/(1-\tau)$ for 300 three-digit NAICS industries.

equipment with shorter lives has meant that accelerated depreciation provides less relief. The average net present value of depreciation allowances for equipment investment in 2001 was already approximately 90 percent of the investment value even before the tax cuts, suggesting that even complete expensing (raising the net present value to 1) would provide limited additional benefit. Given the smaller magnitude of the 2002 and 2003 cuts, it is unsurprising that such incentives could not overcome the dramatic drop in investment induced by the remarkable drop in q over the period. Our estimates suggest that these incentives do work as they are designed, but that their magnitude is simply too small to counteract the aggregate trend.

HOW MUCH DID THESE INCENTIVES INCREASE INVESTMENT? To estimate the precise impact of the tax changes on investment, we return to the tax-adjusted q model. To use that model to simulate the impact of the tax cuts in 2002 and 2003, we need to compute the transition path for investment in the standard q model.[59] Auerbach outlines a linearization that

59. See Abel (1981) and Summers (1981) for discussion.

makes this particularly easy,[60] and we adopt his notation to derive the predicted effects. Assuming a Cobb-Douglas production function with a capital share of $1 - a$, a real before-tax interest rate of r, quadratic adjustment costs of φ (the reciprocal of the true coefficient on Q in our regressions), and an adjustment cost-modified depreciation rate for capital in the firm of $\hat{\delta}$ (the specific formula for which is given below), Auerbach shows that, for an unanticipated permanent change in tax policy, the capital stock follows a simple partial adjustment model with $\dot{K}_t = \lambda_1(K^* - K_t)$, where K^* is the desired capital stock. The rate of adjustment $-\lambda_1$ follows the formula

$$\lambda_1 = \frac{r - \sqrt{r^2 + \frac{4a\left(r + \hat{\delta}\right)}{\varphi}}}{2}. \tag{7}$$

To compute this adjustment rate empirically, we assume a real interest rate of 5 percent. We compute a, the complement of the capital share, as 1 minus the gross output share of value added for each industry as reported in the disaggregated National Income and Product Accounts data for 1998. We take the true coefficient on Q to be 1, following the results above. We compute $\hat{\delta} = \delta[1 - (\varphi\,\delta)/2]$, using our value for φ and the industry-average depreciation rate on equipment or total investment, as computed from the weighted average by asset in the Jorgenson data using the industry weights in the capital flow table. This gives an annual adjustment rate for each firm. The average annual adjustment rate for all firms is about 33 percent, and the average value for each three-digit industry is given in appendix table A-1 (for structures and equipment as well as for equipment only). We then use the Cobb-Douglas production function to derive the optimal capital stock.[61]

60. Auerbach (1989).

61. Following the traditional literature, we make these calculations assuming that the elasticity of K^* with respect to the cost of capital is equal to -1, for a Cobb-Douglas production function for a given level of output. Such a figure is consistent with the empirical findings surveyed in Hassett and Hubbard (2002) but larger than the findings discussed in Chirinko (1993) or in Chirinko, Fazzari, and Meyer (1999). If labor were held fixed rather than output, our calculations would be scaled by $1/\alpha$, where α is the complement of the industry capital share (averaging about .66 to .70 in our data). To compute the total effect with varying output would require a full general equilibrium model for all sectors with industry-specific demand information. More details on the assumptions behind such calculations can be found in Coen (1969) and Hall and Jorgenson (1969).

To compute the effect of these policies over the past two years, we assume that the depreciation changes were unanticipated and thought to be permanent.[62] We first derive the optimal capital stock and amount of adjustment in the first year (2002). We then calculate the new optimal capital stock for 2003 (after the second tax cut) and the amount of adjustment based on the new gap between K^* and actual K (where actual K is higher than it was in 2001 because of the investment undertaken in 2002). Averaging for each three-digit industry and summing over the two years, we estimate the impact of the tax cuts on the capital stock for each industry (table 11). The average increase for the period is only about 1.0 to 1.5 percent, and so it is immediately clear why these tax cuts have seemed to have little success in stemming the investment declines: their short-run stimulus effect is too small. This is not a refutation of the view that taxes matter. The tax cuts were effective in changing incentives—they simply were not large enough to counteract the double-digit declines in investment rates observed in the 2000s. Changes to depreciation allowances simply do not have much impact when the system is already so close to full expensing and when aggregate declines in market value (and therefore in q) are so large. Since firms are moving asymptotically to the optimal capital stock, the effects of the policy change will be smaller in later years than in the first two years. After 2004 the average total increase will still be less than 2 percent.

Conclusion

This paper has addressed two major questions arising from the puzzling investment experience of the 2000s thus far: First, to what extent was the equity bubble of the 1990s correlated with the decline in investment in the 2000s? And second, why didn't the major tax cuts of 2002–03 do more to restore investment to normal levels?

62. That the changes were unanticipated is probably fairly accurate. An assumption of permanence seems reasonable, because although the changes were announced as temporary, from the moment they were passed many have been advocating that they be made permanent (and indeed the changes have already been extended to 2004). We assume permanence here because it considerably simplifies the computation of the investment path.

Table 11. Estimates of Change in Capital Stock Attributable to Tax Cuts of 2002 and 2003, by Industry

		Change in capital stock, 2002–03[a] (percent)	
NAICS code	*Industry*	*Using tax term for equipment and structures*	*Using tax term for equipment only*
481	Air Transp.	1.58	1.68
514	Information Servs. & Data Processing Servs.	1.47	1.79
492	Couriers & Messengers	1.44	1.52
561	Administrative & Support Servs.	1.43	1.63
213	Support Activities for Mining	1.42	1.61
487	Scenic & Sightseeing Transp.	1.42	1.63
488	Support Activities for Transp.	1.42	1.63
485	Transit & Ground Passenger Transp.	1.39	1.52
541	Professional, Scientific, & Technical Services	1.32	1.58
233	Building, Developing, & General Contracting	1.32	1.38
234	Heavy Construction	1.32	1.38
235	Special Trade Contractors	1.32	1.38
313	Textile Mills	1.31	1.58
314	Textile Product Mills	1.30	1.60
316	Leather & Allied Product Mfg.	1.30	1.54
323	Printing & Related Support Activities	1.30	1.57
322	Paper Mfg.	1.28	1.46
421	Wholesale Trade, Durable Goods	1.27	1.58
422	Wholesale Trade, Nondurable Goods	1.27	1.58
493	Warehousing & Storage	1.26	1.63
513	Broadcasting & Telecommunications	1.25	1.68
511	Publishing	1.25	1.55
114	Fishing, Hunting, & Trapping	1.25	1.68
621	Ambulatory Health Care Servs.	1.24	1.61
331	Primary Metal Mfg.	1.22	1.43
523	Securities, Commodity Contracts, & Other Fin.	1.20	1.59
334	Computer & Electronic Product Mfg.	1.19	1.58
321	Wood Product Mfg.	1.18	1.53
336	Transp. Equip. Mfg.	1.18	1.46
315	Apparel Mfg.	1.18	1.56
484	Truck Transp.	1.16	1.36
312	Beverage & Tobacco Product Mfg.	1.15	1.39
337	Furniture & Related Product Mfg.	1.14	1.50
332	Fabricated Metal Product Mfg.	1.12	1.35
524	Insurance Carriers & Related Activities	1.12	1.41
333	Machinery Mfg.	1.12	1.43
327	Nonmetallic Mineral Product Mfg.	1.11	1.35
339	Miscellaneous Mfg.	1.11	1.41
811	Repair & Maintenance	1.11	1.45
311	Food Mfg.	1.10	1.42
335	Electrical Equip., Appliance, & Component Mfg.	1.09	1.37

(*continued*)

Table 11. Estimates of Change in Capital Stock Attributable to Tax Cuts of 2002 and 2003, by Industry (*continued*)

		Change in capital stock, 2002–03[a] (percent)	
NAICS code	*Industry*	*Using tax term for equipment and structures*	*Using tax term for equipment only*
326	Plastics & Rubber Products Mfg.	1.07	1.29
622	Hospitals	1.03	1.82
324	Petroleum & Coal Products Mfg.	1.02	1.18
212	Mining (except Oil & Gas)	0.97	1.37
812	Personal & Laundry Servs.	0.95	1.43
113	Forestry & Logging	0.94	1.20
512	Motion Picture & Sound Recording	0.93	1.66
722	Food Servs. & Drinking Places	0.88	1.48
532	Rental & Leasing Servs.	0.86	1.00
325	Chemical Mfg.	0.86	1.28
522	Credit Intermediation & Related Activities	0.80	1.28
624	Social Assistance	0.77	1.59
482	Rail Transp.	0.73	1.39
562	Waste Management & Remediation Servs.	0.71	1.44
486	Pipeline Transp.	0.66	1.75
813	Religious, Grantmaking, Civic, Prof. & Similar	0.65	1.60
533	Lessors of Nonfin. Intangible Assets	0.63	1.10
111	Crop Production	0.61	0.70
444	Building Mtrl & Garden Equip. & Supplies	0.58	1.56
448	Clothing & Clothing Accessories Stores	0.58	1.56
443	Electronics & Appliance Stores	0.58	1.56
445	Food & Beverage Stores	0.58	1.56
442	Furniture & Home Furnishings Stores	0.58	1.56
447	Gasoline Stations	0.58	1.56
452	General Merchandise Stores	0.58	1.56
446	Health & Personal Care Stores	0.58	1.56
453	Miscellaneous Store Retailers	0.58	1.56
441	Motor Vehicle & Parts Dealers	0.58	1.56
454	Nonstore Retailers	0.58	1.56
451	Sporting Goods, Hobby, Book, & Music Stores	0.58	1.56
221	Utilities	0.56	1.36
623	Nursing & Residential Care Facilities	0.56	1.74
112	Animal Production	0.54	0.66
611	Educational Servs.	0.49	1.72
713	Amusement, Gambling, & Recreation	0.41	1.31
711	Performing Arts, Spectator Sports, & Related	0.38	1.54
211	Oil & Gas Extraction	0.26	1.48
525	Funds, Trusts, & Other Fin. Vehicles	0.18	1.46
721	Accommodation	0.18	1.46
531	Real Estate	0.03	0.72

Source: Authors' calculations using data from Compustat as described in appendix A.

a. Change in capital stock associated with changes in the expensing provisions by industry as described in the text.

The data at the firm, asset, and industry level do not support the popular explanation of how capital overhang affected the investment market in the 2000s. The general evidence shows that rapid growth of investment in the 1990s had very little correlation with the investment declines in the 2000s. The evidence further indicates that the firm-level relationship between investment and q has not changed noticeably in the recent period for firms that saw large increases in their market value or that invested heavily in the 1990s. Instead the rise and fall of equity prices, in the context of a conventional tax-adjusted q model that better accounts for measurement error in measuring marginal q, is the best explanation for the investment experience of the recent past.

This conventional tax-adjusted q model then serves as the basis for our analysis of the impact of the recent tax cuts and their seeming impotence. Our results show that the dividend tax cut, despite its high revenue cost, had minimal, if any, impact on marginal investment incentives. The results strongly favor the "new" view of dividend taxation, in which such taxes are capitalized into share prices and do not affect marginal incentives. Similarly, the partial expensing provisions passed in 2002 and 2003 were not large enough to provide much counterweight to the declines in aggregate investment. Our estimates suggest that tax policies contributed to an increase in the capital stock of only 1 to 2 percent.

APPENDIX A

Data Sources and Definitions

Firm-Level Financial Data

Annual data for all companies in the Compustat database, from 1950 on, are accessed through Wharton Research Data Services (WRDS).

Market Valuation of the Capital Stock

The Compustat series "Property, Plant, and Equipment—Total (Net)" is used as a measure of capital equipment; "Capital Expenditures (Statement of Cash Flows)" is used as a measure of capital expenditure. Each of these measures is converted to constant dollars by dividing by the current value of the producer price index (PPI) for capital goods, taken from the website of the Bureau of Labor Statistics.

Three factors enter into the current valuation of the capital stock. The first is changes in the prices of capital goods held over from previous years. Our conversion to constant dollars sidesteps this component. The second is additions to capital through investment expenditure. The third is depletion of capital on hand through depreciation.

The firm's current real capital stock can be thought of as the sum of the nondepreciated stocks of all previous years plus investment in the current year. Following Cummins, Hassett, and Hubbard (1994), and assuming a constant rate of depreciation δ, we calculate the current capital stock as

$$K_T = K_0(1-\delta)^T + I_1(1-\delta)^{T-1} + \ldots + I_{T-1}(1-\delta) + I_T.$$

For example, the firm starts in period 0 with capital stock K_0, but only the nondepreciated part of this stock, $(1-\delta)K_0$, remains to be carried over to the next period. Some of this carried-over capital is used up in producing output in the second period, leaving $(1-\delta)^2K_0$ to be carried over to the third period, and so forth. By period T, then, only $(1-\delta)^TK_0$ is carried over from period 0. Similar reasoning explains the coefficients on the levels of investment carried over to period T from all previous years. I_T represents investment expenditure in period T.

Given the ending levels of the capital stock for all years, including the final year, and the final year's investment spending (all deflated by the PPI for capital goods), we can solve for the average rate of depreciation for each firm. This average rate of depreciation is then applied sequentially, from the first observed year for each firm to the last, to derive an estimated capital stock for each firm-year observation.

Conversion of Inventory from Book to Market Valuation

The Compustat series "Inventories—Total" is used as a measure of the current value of inventory holdings. As in Cummins, Hassett, and Hubbard (1994), we convert inventory levels from their book value to market value (on a last-in, first-out, or LIFO, basis) by adjusting the lagged book value of carried-over inventories for year-to-year changes in the prices of finished goods. How the adjustment mechanism is implemented depends on whether final inventories increase or decrease from one year to the next. If inventories increase, those goods carried over from the previous year are revalued at current prices, as is the net addition to total inventories:

$$\text{Inv}_t^m = \text{Inv}_{t-1}^m(P_t/P_{t-1}) + \Delta\text{Inv}_t, \text{ if } \Delta\text{Inv}_t \geq 0.$$

Essentially, under LIFO valuation rules, the ending levels of inventories include all goods that are carried over from the previous year plus unsold current production. All inventories carried into the current year remain at the end of the year and are revalued at current prices. The net addition to inventories is already measured at current prices and so needs no further adjustment.

On the other hand, if inventories decrease during the current year, it is assumed that all current production has been sold as well as some part of inventories carried over from the previous year. All goods remaining at the end of the year are then valued at current prices:

$$\begin{aligned}\text{Inv}_t^m &= (\text{Inv}_{t-1}^m + \text{Inv}_t - \text{Inv}_{t-1})(P_t/P_{t-1}) \\ &= (\text{Inv}_{t-1}^m + \Delta\text{Inv}_t)(P_t/P_{t-1}), \text{ if } \Delta\text{Inv}_t < 0.\end{aligned}$$

Operating Income

The Compustat series "Operating Income before Depreciation" and "Operating Income after Depreciation" are used as measures of net income. Each was converted from nominal to real terms by dividing by the PPI for finished goods, taken from the website of the Bureau of Labor Statistics.

Analysts' Earnings Estimates

Consensus analysts' estimates of firms' earnings per share in future years were taken from the I/B/E/S summary statistics data maintained on WRDS. The variables in this file include the number of estimates and the mean, median, and standard deviation of estimates for a number of fiscal periods (quarters or years) into the future. We merged the Compustat firm-level financial data with the I/B/E/S firm-level analysts' estimates. We used the summary estimate made during the latest month before the end of the firm's fiscal year.

Asset-Level Tax Term

Data for the asset-level tax term come from Dale Jorgenson of Harvard University; his methodology is described in Jorgenson and Yun (2001). These data provide, for each asset type, an estimate of the net present value of depreciation allowances z, the investment tax credit rate, and the depreciation rate, as well as the capital stock and the average corporate tax rate. We compute Γ as ITC + tz and the full tax term as $(1 - \text{ITC} - tz)/(1 - t)$. The calculations are myopic in that they do not include the impact of expected future tax changes; current tax rates are assumed to be permanent. We modify the net present values of depreciation allowances in 2002 and 2003, to account for the changes in the partial expensing rules. We recomputed z, for 2002, using a 70-30 weighted average of the old z and 1; we do the same, but with 50-50 weights, for 2003.

Industry- and Firm-Level Tax Terms

To derive industry-level values of the tax term for equipment and structures as well as to derive industry-level depreciation rates, we use the 1997 capital flow tables of the BEA and compute the share of equipment and structures investment by asset type for each industry at approximately the three-digit NAICS level. We match these weights to the Jorgenson tax term figures by year for each asset type to compute a weighted-average tax term in each year for each industry. We then merge that series to each firm-year based on its first listed NAICS code in Compustat (table A-1).

Present Value of Depreciation Allowances on Past Investment

To estimate the value of *A*, the net present value (NPV) of depreciation allowances on past investments, we sort firms according to the weighted average of depreciation rates on the types of equipment in which firms in their industry invest. Using the inverse of this average depreciation rate as an estimate of the lifetime of the firm's capital, we assume that all firms in the industry have a discount rate of 10 percent and use double-declining-balance depreciation until straight-line depreciation exceeds it, and then switch to straight-line. We then multiply the NPV of the remaining depreciation allowances on investment from a given year in the asset's life by the investment-to-capital ratio lagged that many periods. For example, if the actual depreciation allowances for a three-year-lived good costing \$1 were one-third each year (pure straight-line depreciation), then the NPV of the allowances in the year of the investment would be $z_{age=0} = \left(.333 + \frac{.333}{1.1} + \frac{.333}{1.1^2}\right)$, the NPV of the allowances remaining one year later would be $z_{age=1} = \left(.333 + \frac{.333}{1.1}\right)$, and the NPV of allowances after two years would be $z_{age=2} = (.333)$. We would then compute the value of depreciation on previous investments as $A = t\left[z_{age=1}\left(\frac{I}{K}\right)_{t-1} + z_{age=2}\left(\frac{I}{K}\right)_{t-2}\right]$. Note that the NPV of depreciation allowances for current (time *t*) investment is not included in this measure (although it is in *z*); hence the computation of *A* for an industry whose asset life is three years has only two terms.

We compute the NPV assuming an asset life of three years for any firm for which the inverse of its average depreciation rate is between 3 and 4, four years for any firm for which the inverse is between 4 and 5, and so on, but with a cap at nine years (a few firms had average equipment lives of slightly over ten years).

Table A-1. Estimates of Adjustments to Tax Changes by Industry

NAICS code	Industry	Adjustment rate ($-\lambda_1$): Equipment and structures	Adjustment rate ($-\lambda_1$): Equipment only	Equipment share of total investment (percent)	Depreciation rate (δ): Equipment and structures	Depreciation rate (δ): Equipment only	Change in tax term, 2001–03: Equipment and structures	Change in tax term, 2001–03: Equipment only
111	Crop Production	0.148	0.143	91	0.154	0.143	0.028	0.031
112	Animal Production	0.154	0.147	87	0.172	0.153	0.024	0.029
113	Forestry & Logging	0.318	0.304	85	0.164	0.145	0.022	0.027
114	Fishing, Hunting, & Trapping	0.272	0.262	81	0.106	0.094	0.033	0.043
211	Oil & Gas Extraction	0.315	0.252	21	0.172	0.091	0.007	0.033
212	Mining (except Oil & Gas)	0.300	0.286	82	0.135	0.118	0.023	0.030
213	Support for Mining	0.379	0.371	90	0.171	0.161	0.028	0.031
221	Utilities	0.240	0.207	58	0.140	0.092	0.019	0.038
233	Building, Developing, & Gen. Contracting	0.365	0.362	97	0.187	0.182	0.026	0.027
234	Heavy Construction	0.365	0.362	97	0.187	0.182	0.026	0.027
235	Special Trade Contractors	0.365	0.362	97	0.187	0.182	0.026	0.027
311	Food Mfg.	0.311	0.296	84	0.155	0.135	0.026	0.032
312	Beverage & Tobacco Product Mfg.	0.316	0.303	87	0.161	0.144	0.026	0.031
313	Textile Mills	0.335	0.324	88	0.128	0.117	0.029	0.034
314	Textile Product Mills	0.363	0.348	87	0.161	0.144	0.027	0.032
315	Apparel Mfg.	0.342	0.324	83	0.153	0.132	0.026	0.033
316	Leather & Allied Product Mfg.	0.344	0.332	89	0.156	0.142	0.028	0.032
321	Wood Product Mfg.	0.334	0.319	84	0.142	0.124	0.026	0.033
322	Paper Mfg.	0.307	0.301	93	0.135	0.128	0.030	0.033
323	Printing & Related Support	0.356	0.343	88	0.163	0.147	0.027	0.032
324	Petroleum & Coal Products Mfg.	0.243	0.237	91	0.155	0.144	0.030	0.033
325	Chemical Mfg.	0.286	0.268	80	0.180	0.150	0.022	0.030
326	Plastics & Rubber Products Mfg.	0.300	0.290	88	0.133	0.121	0.026	0.030
327	Nonmetallic Mineral Product Mfg.	0.302	0.291	88	0.154	0.139	0.027	0.031
331	Primary Metal Mfg.	0.345	0.332	88	0.156	0.141	0.026	0.030

332	Fabricated Metal Product Mfg.	0.339	0.328	89	0.162	0.147	0.024	0.029
333	Machinery Mfg.	0.371	0.353	85	0.196	0.171	0.023	0.029
334	Computer & Electronic Product Mfg.	0.395	0.377	86	0.212	0.186	0.024	0.030
335	Elect. Equip., Appliance, & Component Mfg.	0.327	0.312	86	0.166	0.147	0.025	0.030
336	Transp. Equip. Mfg.	0.366	0.353	88	0.171	0.155	0.024	0.029
337	Furniture & Related Product Mfg.	0.345	0.327	83	0.152	0.131	0.025	0.031
339	Miscellaneous Mfg.	0.334	0.320	86	0.162	0.144	0.024	0.029
421	Wholesale Trade, Durable Goods	0.402	0.383	86	0.208	0.183	0.024	0.029
422	Wholesale Trade, Nondurable Goods	0.402	0.383	86	0.208	0.183	0.024	0.029
441	Motor Vehicle & Parts Dealers	0.397	0.320	48	0.198	0.108	0.013	0.029
442	Furniture & Home Furnishings Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
443	Electronics & Appliance Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
444	Building Mtrl, Garden Supplies Dealers	0.397	0.320	48	0.198	0.108	0.013	0.029
445	Food & Beverage Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
446	Health & Personal Care Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
447	Gasoline Stations	0.397	0.320	48	0.198	0.108	0.013	0.029
448	Clothing & Clothing Accessories Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
451	Sporting Goods, Book, & Music Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
452	General Merchandise Stores	0.397	0.320	48	0.198	0.108	0.013	0.029
453	Miscellaneous Store Retailers	0.397	0.320	48	0.198	0.108	0.013	0.029
454	Nonstore Retailers	0.397	0.320	48	0.198	0.108	0.013	0.029
481	Air Transp.	0.313	0.309	96	0.124	0.121	0.036	0.038
482	Rail Transp.	0.288	0.253	59	0.097	0.064	0.020	0.034
484	Truck Transp.	0.350	0.339	90	0.184	0.169	0.025	0.028
485	Transit & Ground Passenger Transp.	0.367	0.360	94	0.192	0.182	0.028	0.030
486	Pipeline Transp.	0.336	0.273	48	0.177	0.098	0.017	0.037
487	Scenic & Sightseeing Transp.	0.391	0.377	90	0.193	0.176	0.027	0.031
488	Support for Transp.	0.391	0.377	90	0.193	0.176	0.027	0.031
492	Couriers & Messengers	0.402	0.397	96	0.209	0.202	0.027	0.028
493	Warehousing & Storage	0.383	0.364	84	0.180	0.156	0.025	0.031
511	Publishing Indus.	0.400	0.381	86	0.272	0.238	0.024	0.029
512	Motion Picture & Sound Recording	0.386	0.342	67	0.196	0.140	0.019	0.031

(*continued*)

Table A-1. Estimates of Adjustments to Tax Changes by Industry (*continued*)

		Adjustment rate($-\lambda_1$)			*Depreciation rate (δ)*		*Change in tax term, 2001–03*	
NAICS code	*Industry*	*Equipment and structures*	*Equipment only*	*Equipment share of total investment (percent)*	*Equipment and structures*	*Equipment only*	*Equipment and structures*	*Equipment only*
513	Broadcasting & Telecommunications	0.278	0.246	65	0.146	0.103	0.032	0.041
514	Info Servs. & Data Processing Servs.	0.448	0.428	87	0.258	0.228	0.026	0.030
522	Credit Intermediation & Related	0.347	0.311	72	0.276	0.206	0.018	0.026
523	Securities, Commodity Contracts, & Other	0.439	0.411	82	0.272	0.227	0.022	0.027
524	Insurance Carriers & Related	0.389	0.368	85	0.270	0.233	0.022	0.027
525	Funds, Trusts, & Other Financial Vehicles	0.419	0.260	19	0.296	0.077	0.005	0.026
531	Real Estate	0.182	0.097	5	0.193	0.026	0.002	0.027
532	Rental & Leasing Servs.	0.227	0.218	88	0.194	0.173	0.026	0.030
533	Lessors of Nonfinancial Intangible Assets	0.250	0.220	68	0.249	0.178	0.020	0.030
541	Professional, Scientific, & Technical Servs.	0.404	0.385	86	0.249	0.218	0.025	0.028
561	Administrative & Support Servs.	0.412	0.400	91	0.209	0.193	0.026	0.029
562	Waste Management & Remediation Servs.	0.352	0.307	61	0.190	0.131	0.016	0.029
611	Educational Servs.	0.447	0.340	41	0.214	0.099	0.010	0.029
621	Ambulatory Health Care Servs.	0.367	0.347	83	0.181	0.154	0.026	0.032
622	Hospitals	0.409	0.363	68	0.166	0.119	0.021	0.033
623	Nursing & Residential Care Facilities	0.414	0.328	44	0.172	0.087	0.012	0.031
624	Social Assistance	0.419	0.357	59	0.206	0.132	0.016	0.028
711	Performing Arts, Spectator Sports	0.365	0.273	36	0.192	0.084	0.010	0.031
713	Amusement, Gambling, & Recreation	0.346	0.277	43	0.165	0.087	0.010	0.027
721	Accommodation	0.334	0.232	20	0.160	0.052	0.005	0.031
722	Food Servs. & Drinking Places	0.382	0.343	69	0.171	0.126	0.018	0.028
811	Repair & Maintenance	0.368	0.342	78	0.175	0.142	0.023	0.028
812	Personal & Laundry Servs.	0.386	0.353	75	0.199	0.155	0.019	0.027
813	Religious, Grantmaking, Civic, Profess.	0.402	0.329	52	0.222	0.128	0.014	0.029

Source: Authors' calculations using data from Compustat.

Note that our measure is an approximation because it assumes that tax law remains unchanged over the whole sample period. In other words, the NPV of depreciation allowances on current investment, *z,* that we get from Jorgenson varies over time, but we do not have the entire depreciation schedules on which each *z* is based, and so we cannot let the calculation vary for *A*. We tried many different ways of computing *A,* for example adopting different assumptions about depreciation methods, different discount rates, and so on, and found they had negligible impact on the regression results.

APPENDIX B

Tax-Adjusted q with Dividend Taxes

WE BEGIN BY establishing the equilibrium condition that shareholders receive their required return, *r,* from holding equity that provides taxable dividends and capital gains, so that

$$\text{(B1)} \qquad rV_t = (1 - \theta)D_t + (1 - c)\{E_t[V_{t+1}] - V_t - V_t^N\},$$

where θ is the tax rate on dividends and c is the accrual-equivalent tax rate on capital gains. D_t denotes dividends paid to shareholders in period *t, V* is equity value, and V_t^N denotes equity contributions made in period *t.* Given that dividends and capital gains are alternative forms of returns to shareholders, it is useful to summarize the relative tax penalty on dividends and capital gains with the dividend tax preference parameter γ:

$$\text{(B2)} \qquad \gamma = (1 - \theta)/(1 - c).$$

Given that capital gains taxes are paid only when the gain is realized, γ is considered to be less than 1.[63] Solving equation B1 forward, and imposing the transversality condition that firm value cannot be infinite in a finite period, provides a value equation for the firm that implies

$$\text{(B3)} \qquad V_0 = \sum_{t=0}^{\infty} \beta_t E_0\left(\gamma D_t - V_t^N\right),$$

63. Even with similar rates on dividends and realized capital gains, $\gamma < 1$ is thought to hold. Typically, the accrual-equivalent c is usually taken as one-quarter of the statutory rate applicable to capital gains.

where β is the appropriate after-tax discount factor. Equation B3 corresponds to the straightforward intuition that firm value at time 0 is the present-discounted, tax-adjusted value of all future dividends, taking into account any equity contributions required to maintain a proportional shareholding in the firm.

Firm value maximization is subject to several constraints. Dividends and equity issuance are constrained to be nonnegative.[64] The firm's capital stock K evolves according to

$$K_t = K_{t-1}(1 - \delta) + I_t, \tag{B4}$$

where δ is a constant proportional rate of decay and I is investment. The underlying cash flow identity for the firm is given by

$$\begin{aligned}(1 - \tau)[F(K_t, L_t) - w_t L_t - C(I_t, K_{t-1})p_t] \\ + V_t^N + \tau A_t = D_t + I_t p_t(1 - \Gamma_t),\end{aligned} \tag{B5}$$

where τ is the statutory corporate tax rate, $F(K, L)$ is firm output, L is labor, w is the wage rate, $C(I_t, K_{t-1})$ is an adjustment cost function for investment, and τA captures the tax value of depreciation allowances on previous investments. Variable p is the price of capital goods relative to output, and Γ is a summary measure of tax provisions that directly influence investment, such as the tax value of depreciation allowances and investment tax credits. The source and measurement of Γ are described in appendix A. In short, equation B5 states that a firm's after-tax cash flow and its new equity issuances are sources of funds, which are used for investment and for paying dividends, and the ps ensure that all terms are properly price adjusted.[65]

Given the expression for firm value in equation B3 and the constraints discussed above, firm value maximization employs the following Hamiltonian equation:

$$H_t = \gamma D_t - V_t^N - \lambda_t^1[K_t - K_{t-1}(1 - \delta) - I_t] - \lambda_t^2 D_t - \lambda_t^3 V_t^N. \tag{B6}$$

64. As Poterba and Summers (1985) note, repurchases can be allowed without loss of generality. However, negative new equity issuances must be bounded by some maximum amount, an assumption justified by the IRS's ability to characterize large, regularized repurchases as dividends.

65. We abstract from debt and the presence of tax-deductible interest without loss of generality.

In this setting, λ_t^1, λ_t^2, and λ_t^3 correspond to the shadow values of capital goods, dividends, and negative equity issuances, respectively. Substituting the value of dividends from the cash flow identity in equation B5, we can rewrite equation B6 as

$$\text{(B7)} \qquad H_t = (\gamma - \lambda_t^2)\{(1-\tau)[F(K, L) - wL - C(I_t, K_{t-1})p_t] + V_t^N + I_t p_t(1-\Gamma) + \tau A_t\} - V_t^N - \lambda_t^1[K_t - K_{t-1}(1-d) - I_t] - \lambda_t^3 V_t^N.$$

Differentiating this Hamiltonian provides the relevant first-order conditions. The first-order condition for investment is provided by

$$\text{(B8)} \qquad -(\gamma - \lambda_t^2)(1-\tau)C_I p_t - p_t(1-\Gamma) + \lambda_t^1 = 0,$$

and the conditions for dividends and net equity issuance are provided by

$$\text{(B9)} \qquad D_t \geq 0;\ \lambda_t^2 \geq 0;\ \text{and } D_t\lambda_t^2 = 0$$

and

$$\text{(B10)} \qquad V_t^N \geq 0;\ (\gamma - \lambda_t^2 - 1 - \lambda_t^3) \geq 0;\ \text{and } V_t^N(\gamma - \lambda_t^2 - 1 - \lambda_t^3) = 0, \text{ respectively.}$$

Rearranging the investment first-order condition provided in equation B8 provides an expression for q that corresponds to the shadow price for capital:

$$\text{(B11)} \qquad (\lambda_t^1/p_t) = q_t = (\gamma - \lambda_t^2)[(1-\tau)\ C_I + (1-\Gamma)],$$

where C_I is the marginal adjustment cost of new investment. In order to put this in more familiar terms, we specify a conventional, quadratic adjustment cost function:

$$\text{(B12)} \qquad C(I_t, K_{t-1}) = (\varphi/2)[(I_t/K_{t-1}) - \mu]^2 K_{t-1},$$

where φ is the adjustment cost parameter and μ represents an average investment rate. This quadratic adjustment cost function allows us to represent equation B11 in more familiar terms. Differentiating the cost function with respect to I and substituting it into equation B11 yields

$$\text{(B13)} \qquad \frac{I_t}{K_{t-1}} = \mu + \left(\frac{1}{\varphi}\right)\left(\frac{\dfrac{q_t}{\gamma - \lambda_t^2} - (1-\Gamma)}{1-\tau}\right).$$

Equation B13 is the basic estimating equation commonly used in the *q*-theory literature, with the slight peculiarity that q_t is divided by $(\gamma - \lambda_t^2)$. In the existing literature and our discussion below, $\left[\frac{q_t - (1-\Gamma)}{1-\tau}\right]$ is also referred to as *Q* rather than *q*. It will be important in our discussion of measurement error to note that *Q* is actually composed of two parts, associated with investment opportunities and taxes.

In order to consider under what conditions the additional, peculiar term disappears, it is critical to specify the marginal source of financing. To do so we return to the conditions B9 and B10 and consider the alternative cases where the marginal source of financing is either retained earnings or new equity issuance.

First, consider the case where the marginal source of finance is new equity issuances. In this case, $\lambda_t^3 = 0$ and, consequently, $\lambda_t^2 = \gamma - 1$, as indicated by equation B10. In this case equation B13 becomes its more familiar variant:

$$\text{(B14)} \qquad \frac{I_t}{K_{t-1}} = \mu + \left(\frac{1}{\varphi}\right)\left(\frac{q_t}{1-\tau} - \frac{1-\Gamma}{1-\tau}\right).$$

Now consider the alternative case where the marginal source of finance is retained earnings rather than new equity issuance. This implies that dividends are positive and that $\lambda_t^2 = 0$. In turn, this implies that equation B13 can be rewritten as

$$\text{(B15)} \qquad \frac{I_t}{K_{t-1}} = \mu + \left(\frac{1}{\varphi}\right)\left\{\left[\frac{q_t\left(\frac{1-c}{1-\theta}\right)}{1-\tau}\right] - \left(\frac{1-\Gamma}{1-\tau}\right)\right\}.$$

Equations B14 and B15 provide alternative *q*-theory specifications for investment that incorporate different assumptions about the marginal source of finance and, consequently, about the role of dividend taxation in influencing investment.

Comments and Discussion

Kevin A. Hassett: This paper by Mihir Desai and Austan Goolsbee examines the impact of recent corporate tax changes on investment behavior and investigates the impact of a possible capital overhang on investment. Since my fellow discussant will focus on the overhang issue, I will concentrate my remarks on the tax and investment side of the paper.

To summarize my conclusions: The paper is a good, state-of-the-art econometric effort that confirms many of the findings of the recent investment literature. The regression results are competently arrived at and believable. However, the authors' policy discussion and their discussion of the impact of recent tax reforms offer conclusions that do not follow from their results. In relating their results to the impact of current policies, the authors have favored some extreme assumptions that are not supported by their empirical work, all aligned in a manner to make the tax cuts seem ineffective. A more balanced assessment of the recent impact of the tax reforms would certainly be more favorable.

A LOOK AT THE LITERATURE. The first of the recent corporate tax changes reduced the user cost of capital by allowing firms to expense a fraction of their capital purchases. This expensing has been "temporary" from the outset, although there has been significant uncertainty about whether the expensing provisions would be allowed to expire. There is little dispute that this tax change will lower the user cost of capital. In a recent paper in the *National Tax Journal,* my coauthors and I found that this reduction would vary by asset class, averaging about 2 to 3 percent, if the change were viewed as permanent and if the expensing fraction were the original, lower number.[1] If instead the provision were expected

1. Cohen, Hansen, and Hassett (2002).

to expire, firms would have an incentive to shift investment forward. We found that this effect would reduce the current user cost by much more.

The second change was to lower the tax rate on dividends and capital gains. The effect of this change on the user cost depends on the marginal source of finance. In another recent paper, my coauthor and I found that approximately half of all firms behave as if they use new share issues as their marginal source of finance,[2] and approximately half behave as if they use retained earnings. Accordingly, relying on a third recent paper, in which my coauthors and I modeled the impact of dividend tax law changes,[3] I find that the reduction attributable to the recent changes would be quite large under the "old view" of dividend taxation and much smaller under the "new view." However, these conclusions depend crucially on unobservables. The most important of these are the marginal tax rates on dividends and on capital gains, which in turn depend on the nature of financial equilibrium. If, for example, a "Miller equilibrium" describes the world, the relevant rates are those at which the marginal investor is just indifferent between debt and equity, not the average observed rate. Across a range of assumptions, however, the dividend change reduces the cost of capital by about 7 percent on average, assuming that firms themselves are split 50-50 between the old and the new views.

More recent evidence consistent with the idea that there exist both old and new view firms includes work by James Poterba,[4] who has found that dividend payout responds significantly to tax changes, and by Raj Chetty and Emmanuel Saez,[5] who found that dividend payouts increased sharply after the recent change in the law. In a work in progress, Alan Auerbach and I are exploring share price responses to the dividend change and finding results that confirm the conclusions in our earlier paper. There thus appears to be a great deal of heterogeneity in the data, with some firms behaving according to the old view and some according to the new view.

Whether these changes would result in a stimulus to investment depends on the elasticity of investment with respect to the user cost. Glenn Hubbard and I, in our chapter in the *Handbook of Public Economics,* concluded that the literature is now leaning toward a relatively large elasticity.

2. Auerbach and Hassett (2002).
3. Carroll, Hassett, and Mackie (2003).
4. Poterba (2004).
5. Chetty and Saez (2004).

A number of recent papers have strengthened support for the conclusion that neoclassical fundamentals are important, by overturning past findings that cash flow is a much more important determinant of investment than the user cost or *Q*. For example, in a forthcoming paper, my coauthors and I find that cash flow does not matter in investment equations once one controls for measurement error in *Q*.[6] Thus liquidity constraints should not, the literature suggests, mute the possible effects of tax cuts.

THIS PAPER IN RELATION TO THE LITERATURE. This paper provides a very clear view of where the empirical investment literature is at the moment. The authors find that, once one controls for measurement problems, fundamentals such as taxes are hugely important in investment equations. Indeed, in most of their specifications, the estimated coefficient for the tax term is close to or exceeds 1 in absolute value. Confirming the findings of Jason Cummins, Stephen Oliner, and myself,[7] they also find that cash flow does not influence investment over and above the fundamentals.

The paper breaks from the literature in only one way. Using the same data as much of the previous literature, the authors follow an empirical strategy much like that of Poterba and Lawrence Summers in their seminal paper on the old and new views.[8] They reverse the Poterba and Summers result and find that the new view cost of capital explains investment. This departs significantly from the recent literature that has used dividend rather than investment behavior to assess the relative importance of the two views.

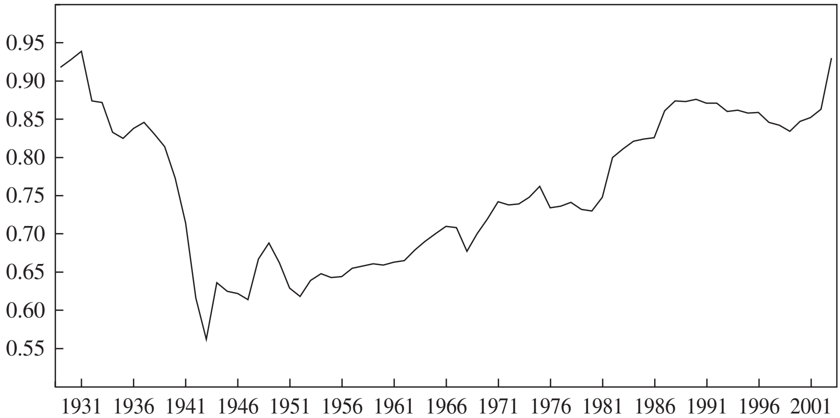
Their result favoring the new view is not very convincing, however. For one thing, they favor the new view on the basis of parameter estimates that are interacted with the *Q* variable, which the authors themselves concede is mismeasured. The new view *Q* estimate is slightly less absurd than the old view *Q* estimate, but both are an order of magnitude smaller than the coefficients on the separate tax terms. If the coefficients were the same as those on the tax terms, one might have more confidence in the results.

In addition, there is serious doubt that Desai and Goolsbee's approach has any power to distinguish between the two views. What mainly distinguishes the two models is a *marginal* tax wedge variable that is unobservable but approximated by an *average* taken from tax returns. That should

6. Cummins, Hassett, and Oliner (forthcoming).
7. Cummins, Hassett, and Oliner (forthcoming).
8. Poterba and Summers (1983).

Figure 1. Investor Tax Preference for Dividends versus Capital Gains, 1929–2003

Aggregate dividend tax preference parameter (θ)[a]



Source: Poterba (2004).

a. $\theta_t = \Sigma w_{h,t}*[(1-\tau_{div,h,t})/(1-\tau_{cg,h,t})]$, where $w_{h,t}$ is the share of corporate stock owned at time t by investor h, and τ_{div} and τ_{cg} are the marginal tax rates on dividends and long-term capital gains, respectively. Calculations assume that the effective capital gains tax rate is only one-quarter the statutory rate.

give one pause. Second, the tax wedge variable does not vary across firms. This means that the authors have *no* within variation to identify the two models, and they have very few real degrees of freedom. The correlation between the two relevant variables must be enormous—within a given year it is unity. Add year effects, and it is something of a miracle that their computer did not crash. It did not *only* because of the interaction with the noisy *Q* variable. That the two variables enter with opposite-signed coefficients suggests that the design matrix may be ill conditioned, and this raises red flags. This is exactly why other recent empirical attempts to evaluate the relative importance of the two views have not attempted to do so with investment data.

Moreover, the tax wedge variable mostly follows a steady upward trend during this period (figure 1). Indeed, over the period observed in the paper, in only two years (1982 and 2003) did the variable deviate more than 5 percent, positively or negatively, from its value in the previous year. The explanation of the results may simply be a spurious trend relationship.

Or maybe not. It is quite uncertain whether this average wedge is the appropriate measure. It might be just as reasonable to use statutory tax rates for dividends. Indeed, one of the more interesting aspects of the recent tax changes is that the marginal dividend tax rate is no longer one of any number of tax rates but instead is a known parameter. We do not know what it is until the last observation. The accrual-equivalent capital gains tax rate is also a guesstimate. Do the results change if other, equally valid measures are used? The authors are too confident that they have the correct measure of the crucial variable.

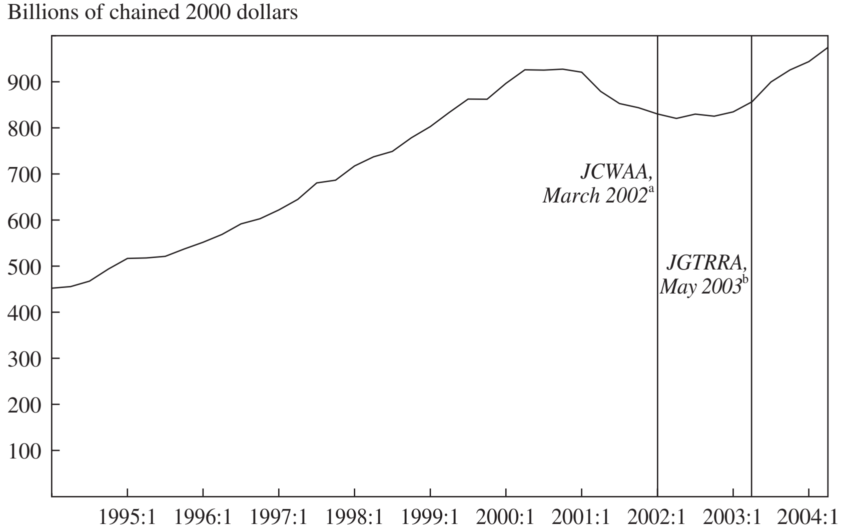
Thus, where the paper agrees with the literature, it is on firm ground. Its disagreements with the literature may just be the result of poor design.

DID THE RECENT TAX CHANGES STIMULATE INVESTMENT? Given the authors' finding that tax variables affect investment, one might expect that they would conclude that the recent tax changes had a major impact on investment. They conclude otherwise for two reasons. First, they offer a misguided view of the recent data. Second, they greatly understate the user cost effects of the recent tax changes, and hence find a small impact on investment. I will respond to each of these in turn.

The authors argue that investment has not increased after these tax changes, but the chart they present in making this case is rather misleading. Equipment investment surged after the dividend tax cut (figure 2). We do not know yet whether this happened because of the cut, but surge it did. The authors conclude that it did *not* respond to tax policy only by cyclically adjusting the chart. But the current recovery may have been slower than past recoveries for a number of reasons unrelated to investment policy. The key question is, Did investment policy stimulate investment, ceteris paribus? The regressions that the authors run are not cyclically adjusted, nor should the prima facie evidence be. The authors appear to presume that a pro-investment policy can be judged successful only if it immediately returns investment to a point beyond its previous cyclically adjusted peak. I can think of no coherent rationale for such a view.

The authors understate the user cost reductions for two main reasons. First, they accept their own estimates and assume that all firms adhere to the new view. In doing so they neutralize most of the user cost effect of the recent dividend and capital gains tax cuts. Second, they assume that investors ignore the scheduled 2004 expiration of the partial expensing provision and instead assume that it will remain in effect. Recall that, if the provision does not expire, the user cost effects of the combined policies sum to about 9 to 10 percent. Given the authors' estimates, such a decline is an impressive stimulus.

Figure 2. Gross Private Domestic Investment in Software and Equipment, 1994–2004



Source: National Income and Product Accounts.
a. Job Creation and Worker Assistance Act, which established a 30 percent depreciation bonus.
b. Jobs and Growth Tax Relief Reconciliation Act, which raised the depreciation bonus to 50 percent and cut dividend tax rates.

For partial expensing, the expiration is a big deal. For example, for seven-year-lived equipment, the percentage reduction in the Jorgensonian user cost in an expiration year (with only 30 percent partial expensing) is about 14 percent.[9] By assuming that the measure does not expire, the authors load the case in favor of their conclusion that, despite the high investment elasticity, the recent tax cuts had no effect. Using their coefficients and the more reasonable assumption that the expensing provision is expected to expire, one could just as easily generate, from their own model, a predicted 20 percent increase in equipment investment this year. And investment has been increasing sharply, supporting, casually at least, the view that policy has had the effect that the empirical evidence would predict. Their conclusions about the efficacy of current tax policy are likely the reverse of the truth.

9. Cohen, Hansen, and Hassett (2002, table 2).

CONCLUSION. The empirical evidence that the paper presents with regard to investment and the user cost supports the earlier literature in numerous ways and will likely be cited often as a competent and up-to-date estimation effort. The conclusions with regard to the new view versus old view debate differ from those of the earlier literature, but questions about the authors' specification suggest that the optimal Bayesian weight on these results is fairly low. In discussing policy, the authors' assumptions lead to an understatement of the user cost effects. Contrary to their claims, the evidence supports the view that the recent tax cuts likely had a significant impact on investment.

John V. Leahy: Mihir Desai and Austan Goolsbee have written a very interesting and provocative paper on the recent downturn in investment spending in the United States. In fact, they have written two papers. The first deals with one commonly attributed cause of the downturn, namely, "capital overhang." The second investigates the success of one of the intended solutions to this problem, namely, the Bush tax cuts. Sticking to my comparative advantage, I will address my comments to the paper on capital overhang.

Briefly stated, Desai and Goolsbee make two claims. First, they claim that there is little evidence of capital overhang in the cross section. To back this claim, they show that high investment in the 1990s is not associated with low investment in the 2000s regardless of whether one sorts the data by industry, by firm, or by type of capital. Second, they claim that there is little need for the capital overhang story, because a fundamentals story based on Tobin's q performs adequately. Variables associated with capital overhang provide no additional explanatory power in a standard q-theoretic model of investment.

My main quibble with the paper is that Desai and Goolsbee never write down an explicit model of capital overhang, without which the concept is not clearly defined. We have no way of knowing how capital overhang will manifest itself in their cross-sectional data, and we have no way of knowing whether or not their tests are efficient. Is high past investment a good measure of capital overhang at the firm level? Does the capital overhang story imply that high past investment is negatively correlated with current investment? A few examples will illustrate how different theories could lead one to different conclusions regarding these points.

In their introduction Desai and Goolsbee define capital overhang as the "view . . . that excess investment in the 1990s, fueled by an asset price bubble, left corporations with excess capital stocks, and therefore no demand for investment, during the 2000s." In this view an overhang is something that is irrational and unjustified.

But there is another, more benign view of capital overhang: that there was simply too much capital, not because of excessive investment or a stock market bubble, but rather because of a change in firms' view of the profitability of investment. Much happened between 1999 and 2001 that could have induced such a change: disillusion with the information technology revolution, the decline in stock prices, corporate scandals, Y2K, 9/11. In this view rationally optimistic firms accumulated capital during the 1990s, received new information around 2000, and found themselves with more capital than they desired. There is nothing here that is hard to reconcile with standard investment theory, and no reason that a standard q-theoretic model would have any greater difficulty dealing with this episode than it would with other cycles.

There are several ways to build such a change in perspective into a standard model of investment. One way would be to consider a neoclassical model of the business cycle and endow firms with a capital stock that is above the long-run equilibrium level because of past optimism regarding the profitability of investment. Such a model would be broadly consistent with the experience over the past five years. The real interest rate, investment, and employment would all fall below their steady-state levels, and consumption would rise above its steady-state level.

How would the Desai-Goolsbee tests look in this neoclassical model? Since firms do not differ in their response to aggregate news, the cross section would be uninformative. Moreover, since the model is completely standard, marginal q would be sufficient to explain investment. Terms associated with overhang would not provide any additional information.

This neoclassical model is a bit of a straw man, however. One would not expect that a shock would hit all firms equally, or that the degree of capital overhang would be the same across firms. One might therefore expect to see some evidence of capital overhang in the cross section. What form might this evidence take?

One way to model firm-level differences in the desire to invest would be to introduce "*Ss* dynamics" in the spirit of Giuseppe Bertola, Ricardo

Caballero, and Eduardo Engel.[1] In such a model, idiosyncratic shocks would lead to cross-sectional differences in firms' desire to invest, and frictions would prevent firms from adjusting immediately to their optimal capital stock. There would then be a gap between the marginal productivity of capital that triggers investment and that which triggers disinvestment: To induce investment, capital would need to be productive enough to cover both the cost of capital and the cost of adjustment. Similarly, for disinvestment to occur, the gains achieved by disinvesting would need to cover the adjustment costs. Capital overhang might be interpreted as a situation in which adjustment costs lead a firm to hold onto more capital than it would in the absence of these frictions.

What would be the correlation between past investment and current investment in such a model? It depends on the form of the adjustment costs and the common trend in the shocks. If fixed costs dominate, investment will tend to be lumpy. These lumpy investment episodes will tend to reduce the marginal productivity of capital and make subsequent investment less desirable. In such cases one might indeed expect to see a negative correlation between investment in the past and investment in the present. Russel Cooper, John Haltiwanger, and Laura Power have shown, however, that it may be very difficult to tease this correlation out of the data.[2] Unobserved heterogeneity in the adjustment costs and differences in trend growth in productivity both tend to bias the correlation in the opposite direction.

If instead the investment friction takes the form of irreversibility or a wedge between the purchase and the sale price of capital, the situation is entirely different. In this case past investment is a signal that a firm had a high marginal productivity of capital in the past. If the idiosyncratic shocks are uncorrelated with marginal productivity, such a firm is more likely to have a high marginal productivity of capital today as well. Absent other differences across firms, past investment would then be positively, not negatively, correlated with current investment.

How does capital overhang manifest itself in the irreversible investment model? Past investment in that case is not necessarily a good measure of capital overhang. Firms that invest are generally those with too little capital. It is therefore the other firms that are more naturally susceptible to overhang. A better measure might be an indicator of the irre-

1. Bertola and Caballero (1990); Caballero and Engel (1999).
2. Cooper, Haltiwanger, and Powell (1999).

versibility of investment, although even here the correlation between overhang and investment might not accord with intuition. During a downturn, the firms that face the greatest irreversibilities and therefore suffer from the greatest threat of overhang may be precisely the firms that cut investment the least. The irreversibility prevents them from disinvesting. The Desai-Goolsbee tests are not well targeted to this theory.

A common feature of most investment models is that investment is correlated with the marginal product of capital, or, more precisely, the present value of the marginal product of capital. For the Desai-Goolsbee version of the capital overhang story to hold, one needs a model in which the high- and low-marginal-productivity firms switch places in or about 2000. Firms that had high marginal productivity in the 1990s need to have low marginal productivity in the 2000s. This switch would generate the negative correlation between past investment and present investment that their data reject. Given that present values are dominated by expectations about the future, this switch can only happen as a result of a shock that drastically alters firms' views of the future.

The lumpy *Ss* model generates this switch through a leapfrogging effect, in which firms with too little capital accumulate capital and surpass firms that start out with greater capital stocks. The following model might also fit these requirements: In the 1990s firms differed in their expected rate of productivity growth. Firms with high expected productivity growth invested more heavily than others, hoping to cash in on the expected future growth. For some reason, however, these expectations were not fulfilled, and by 2000 those firms that had expected high productivity growth found themselves with more capital than they desired, and they cut their investment spending by a greater amount than did other firms. Note that in this model one does not need to take a stand on whether or not investment was excessive. The mistaken expectations could be the result either of irrational exuberance or of rational ignorance. One interpretation of the Desai-Goolsbee regressions is that this last story does fully not explain the data, although it may be part of the story if it is combined with some other story that generates a positive correlation in investment rates.

I enjoyed reading this paper. The questions it raises are interesting and important, and the authors' answers are provocative. The evidence presented will prove an important contribution to our understanding of investment behavior. Whether or not overhang is a good term to describe recent events remains an open question.

General discussion: Several panelists raised questions about the authors' definition and measure of the capital overhang. Olivier Blanchard and Daniel Sichel noted that the regressions using *q* as an explanatory variable cannot distinguish between two important hypotheses: first, that firms and markets are perfectly rational, and investment moves in step with promising fundamentals (that is, rational forecasts of the expected present value of marginal profits), and, second, that firms make investments on the basis of stock market valuations that include a bubble component. In both cases, ex post, the firms have accumulated too much capital and are now restraining investment: in the first case because their rational forecast was in error, and in the second because they responded to an irrational market. Since the authors do not explore whether the surge in investment or the rise in *q* in the late 1990s was justified by plausible forecasts of the fundamentals, they cannot analyze the reasons for the overinvestment.

William Nordhaus noted further that the authors' equations show only whether investment is surprisingly high or low relative to market valuations. Insofar as investment in the 1990s, for example in fiber optics, turned out to have a lower rate of return than was expected, both the market value and the need for investment will now be low. Since both the decrease in *q* and the decrease in investment are due to the same outside factor, the residuals from regressions of investment on *q* are not informative about whether earlier investment was excessive. Robert Gordon remarked that the experience of the late 1990s and early 2000s should remind us of the difficulty of attributing causation to *q*. It seems likely that both firms, in their investment decisions, and the market were overoptimistic about the profitability of the new economy. Ben Bernanke reminded the Panel that the empirical literature has found very small responses to changes in *q*, which implies that firms would have smoothed their investment through the bubble. He wondered whether there were significant positive residuals to *q* in investment equations in the late 1990s. Benjamin Friedman added that during the bubble period, for the first time since World War II, there was a significant net inflow of funds to the corporate sector from equity issuance. Kevin Hassett noted further that this was a period when there were many initial public share offerings, often by new, small firms accessing the stock market for the first time.

Nordhaus suggested that changes in the dispersion of investment across firms might provide some clues about the importance of any capital overhang from the 1990s. The firms the authors consider belong to very different industries, ranging from shopping centers to aircraft engine manufacturers. Many types of capital are nontransferable across sectors, implying upper and lower bounds on investment; the upper bounds due to capacity limits in the investment-producing sectors, and the lower bounds given by zero gross investment. Given industry-specific shocks, one would expect wide dispersion in investment rates across different industries even in normal times. If overhang were specific to particular industries in 2000, then one should observe greater dispersion of investment than usual. Nordhaus reported that the dispersion in the early 2000s does not appear to be significantly greater than during other cycles of the post–World War II period. Christopher House observed that, if overhang were firm specific, reflecting dispersion of optimism across firms, then even if that dispersion in the degree increased, there would be no reason to expect aggregate investment to have been excessive in the late 1990s. The fact that it was supported John Leahy's view that one should look for an explanation at the aggregate rather than at the firm level.

Turning to the discussion of the effects of dividend taxes on investment, House noted that the authors' analysis of tax incentives assumes that the recent tax cuts are permanent; the response would be quite different if agents expected the cuts to expire as the law mandates. Standard neoclassical analysis suggests that a temporary dividend tax cut should affect the timing of dividends, with little effect on investment. House also suggested that the Congressional Budget Office's projection of $130 billion in lost revenue from the changes to partial expensing is an overestimate. Extending the CBO's projection beyond 2005 reveals that increased revenue later on makes up for much of the short-run cost; the decline in the present discounted value of revenue would be much smaller than reported.

Peter Orszag pointed out that changes in the user cost of capital due to tax cuts depend on how the tax cut is financed. He suggested that, with reasonable values for the effects of deficit-financed tax cuts on interest rates, the user cost of capital might actually rise. In the same spirit, William Brainard remarked that, although the supply of saving may be elastic in the short run when resources are underutilized, in the long run what happens depends on the elasticity of saving with respect to after-tax rates of return. It is quite possible that increasing the after-tax rate of return actually decreases private saving, since defined-benefit pension plans are target savers, and most defined-contribution plans are designed to achieve a target replacement ratio. For such plans the income effect of rate changes dominates the substitution effect. The same is true for life-cycle savers whose intertemporal elasticity of consumption is less than 1, which is what most studies suggest. He also observed that, in an open economy, the marginal source of funds may be the saving of foreigners who are not affected by the U.S. tax rate on dividends.

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