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A Retrospective Evaluation of the Effects of Temporary Partial Expensing

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Abstract

This paper examines how business investment responded to temporary partial expensing, first enacted in 2002 and expanded in 2003. In principle, partial expensing boosted the incentive to invest which should have had a discernable impact on spending. However, the tax changes did not occur in a vacuum, so it is challenging to isolate their impact. Our empirical approach exploits a feature of the tax change which, under certain assumptions, allows us to cleanly estimate its impact. Specifically, partial expensing provided relatively generous tax treatment for long-lived assets. We use this insight in order to construct a difference-in-difference estimator of the tax effects. In addition, the standard model of investment with capital adjustment costs predicts a run up in investment spending prior to expiration and a pothole just after. Our examination of the details of expenditure patterns before, during, and after partial expensing using both monthly and quarterly data suggests considerable ambiguity as to whether the model's predictions were borne out. In addition, anecdotal evidence provides only limited support for the effectiveness of temporary partial expensing.

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I. Introduction

This paper studies the impact of tax incentives on business investment using a unique natural experiment provided by counter-cyclical fiscal policy in the U.S. To help stimulate short-run economic activity, a tax bill was enacted in March 2002 and subsequently expanded in May 2003 that included a temporarily enhanced incentive to invest in business equipment and software. This incentive, a form of accelerated depreciation described below, is commonly referred to as temporary partial expensing or bonus depreciation. As we quantify below, temporary partial expensing is more advantageous for long-lived than short-lived capital goods. Intuitively, a short-lived asset should not benefit much from the partial expensing provision because it already gets most of its depreciation allowances relatively quickly. As a result, partial expensing not only should have increased the growth of expenditures on eligible capital goods but increased it more for relatively long-lived assets before the law expired. Similarly, shortly after expiration, growth should have declined, creating a "pothole," and the decline should have been more pronounced for long-lived assets. The differential theoretical response across capital goods with different asset lives serves as the basis for our main empirical approach which adopts a difference-in-difference methodology.

At least at a superficial level, investment expenditures through early 2005 in broad terms appeared to confirm the theoretical model's predictions. For example, on a NIPA basis, aggregate real expenditures on equipment and software, excluding spending on high-tech and transportation capital goods, accelerated from a 2 percent growth rate over the four quarters of 2002 to 6 percent over 2003 to 11 percent over 2004 and then dipped to an annual rate of only 2 percent in the first quarter of 2005 following expiration of partial expensing at the end of 2004. Expenditures on transportation capital goods (mainly motor vehicles and aircraft) also followed this same pattern.

However, our forensic examination of the details of expenditure patterns below suggests far more ambiguity as to whether the model's predictions were borne out. A quick look at the aggregate data on real high-tech expenditures (computers, software, and communications equipment) offers a glimpse at the problem (see figure 1 at end of paper). Although the high-tech growth rate over 2003 exceeded that recorded in 2002, it fell back in 2004 before spiking up in the first quarter of 2005.

The rest of the paper is organized as follows. Section II presents the impact of partial expensing on the present value of depreciation allowances, the channel through which the incentive to invest is affected directly. Section III briefly discusses the expected theoretical impact on investment expenditures before and after the expiration of the provision under different assumptions about adjustment costs. Section IV presents empirical results using our basic difference-in-difference methodology. Section V discusses other evidence derived from IRS corporate return data for 2002 and 2003 and from national surveys of businesses. Section VI concludes.

II. Effect of Partial Expensing on the Present Value of Depreciation Allowances

Under the tax bill enacted in 2002, businesses were allowed to deduct or expense 30 percent of the cost of new capital goods in the first year the asset was placed in service, with the remaining 70 percent recovered under pre-existing law; to qualify, the asset could not have a tax life greater than 20 years (thus ruling out nonresidential structures). Of course, the more that depreciation could be taken up front, the less that would be available later in the asset's life. Nonetheless, with a positive discount rate, the present value of depreciation allowances was boosted by the new law. Further, the new 30 percent partial expensing was only temporary in that it could be taken on capital purchases that took place before September 11, 2004. The original bill was extended at the end of May 2003 with two major modifications: the 30 percent bonus was upped to 50 percent, and purchased capital goods had to be placed in service by the end of 2004.[1]

Under the standard Hall-Jorgenson (1967) formulation of the tax-adjusted user cost of capital, an increase in the present value of depreciation allowances, Z, boosts the incentive to invest. Ceteris paribus, the partial expensing provision provides such a boost. The table below compares depreciation allowances, per dollar invested, for assets with different tax service lives; this table updates a similar one in Cohen, Hansen, and Hassett (2002). In addition, the table shows the percent change in T [$=(1-\tau Z)/(1-\tau)$], which is equivalent to the percent change in the user cost in this partial equilibrium exercise that holds all components of the Hall-Jorgenson user cost fixed except for Z.

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[1] In fact, this central provision expired as scheduled at the end of 2004. Under certain restrictive conditions, however, the placed-in-service date is the end of 2005, applying for example to capital goods with a production period of at least one year and a cost exceeding $1 million.

Table 1: Depreciation Allowances: Old Law vs. Partial Expensing (Per dollar invested)

	7-year tax life assets		5-year tax life assets		3-year tax life assets	
Year	Old law	New law	Old law	New law	Old law	New law
1	.1429	.571	.20	.60	.3333	.6666
2	.2448	.1224	.32	.16	.4445	.2222
3	.1749	.0875	.192	.096	.1481	.0741
4	.1249	.0625	.1152	.0576	.0741	.0371
5	.0893	.0447	.1152	.0576		
6	.0893	.0447	.0576	.0288		
7	.0893	.0447				
8	.0446	.0223				
Z	.8843	.9430	.9183	.9592	.9550	.9775
% ΔT		-2.93		-2.11		-1.18
		(-4.04)		(-2.96)		(-1.70)

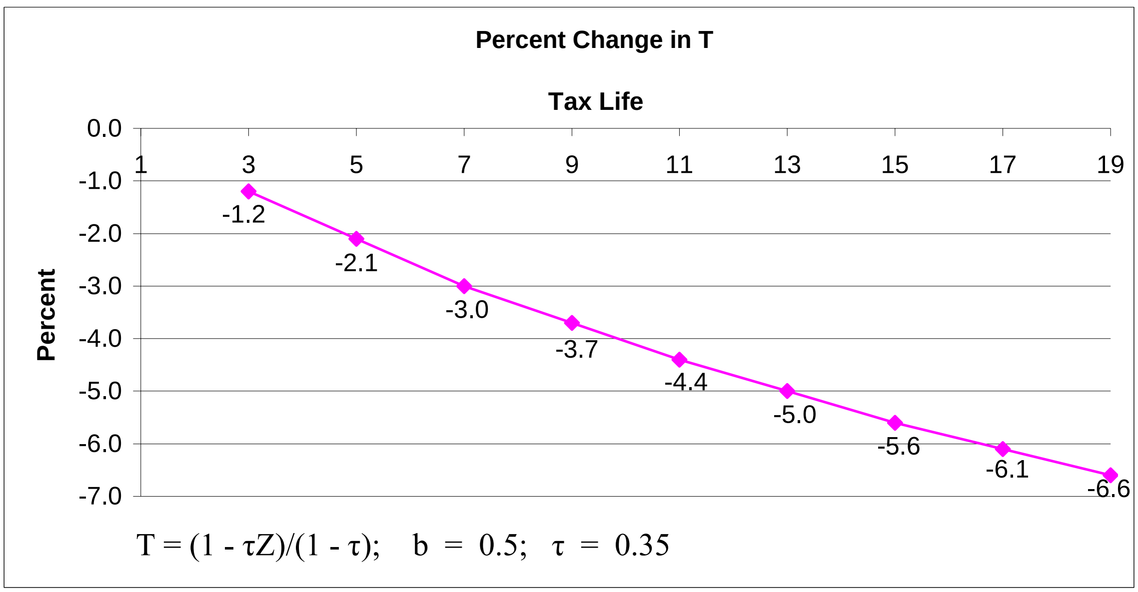
Notes:
1. Z denotes present discounted value of depreciation allowances per dollar invested, using an annual discount rate of 5.0 percent (with no discounting in the first year). Figures in parentheses at the bottom of the table use an annual discount rate of 7.5 percent.
2. T = $(1 - \tau Z)/(1 - \tau)$, where the corporate tax rate, τ, is 0.35. %ΔT is the percent change in T.
3. Calculations assume that firms use the double-declining balance method of depreciation, with half-year convention in the first year. For example, the fraction of the cost of the asset allowable for depreciation in the first year is (2/L)(1/2), where L is the tax service life; with a bonus depreciation rate, b, of 50 percent the first-year allowance changes to .50 + (.5)(2/L)(1/2).

The table illustrates several points. First, the increase in Z is larger, the longer-lived the asset. Correspondingly, the decline in the user cost of capital is larger, the longer-lived the asset.

Second, enhancement to the incentive to invest generally is not huge. For example, with a bonus depreciation of 50 percent in the first year, as shown on the bottom row of table 1, the user cost for assets with 7-year tax lives declines only about 3 percent and falls only about 2 percent for assets with 5-year lives; in deriving these figures, a 5 percent discount rate is used in calculating the present value of depreciation allowances. Although most investment is in assets with tax service lives of 7 years or less, it is useful to consider the impact of partial expensing on longer lived assets. The chart below plots the percent change in T, and hence the user cost, for assets with tax lives up to 19 years; for example, the user cost declines about 5-1/2 percent for an asset with a 15-year tax life. To put these results into perspective, an investment tax credit of about 2 percent would lead to a similar-sized reduction in the user cost.[2]

The chart is helpful because it provides the intuition for how we econometrically identify the impact of the tax reform. Although the tax effects are not huge in magnitude, there is appreciable variation in the user cost of capital across assets—for example, the change in the user cost is 50% greater for assets with a 7-year tax life compared with assets with a 5-year tax life. This heterogeneity enables us to estimate the impact of the tax change using a simple approach like differences-in-differences.

Figure 2



An important feature of a temporary partial expensing is that the user cost declines by a larger amount just prior to the expiration of the provision. Using a formula from Auerbach and Hassett (1992), discussed in detail below (see equation 2), we compute that the user cost declines roughly 18 percent for assets with 7-year tax lives just prior to expiration. This surge in the incentive to invest is another source of identification

[2] We thank Andy Abel for pointing out the effect on the user cost of assets with lives more than 7 years and the equivalence to an investment tax credit. The latter follows from the relationship between the present value of depreciation allowances under bonus depreciation, Z_b, and under prior law, Z_o: $Z_b = b + (1-b)Z_o$ where b is the bonus depreciation rate. The equivalent investment tax credit rate, k, is determined from $1 - k - \tau Z_o = 1 - \tau Z_b$, which implies that $k = \tau(1 - Z_o)b$. If $\tau = 0.35$, $Z_o = 0.9$, and $b = 0.5$, then $k \approx .02$. For sake of comparison, the investment tax credit was 10 percent prior to its expiration in 1986.

in our empirical approach—investment should have boomed prior to the expiration of the law as firms pulled forward investment.

Third, the lower is the interest rate used for discounting depreciation allowances, the smaller is the increase in Z and hence in the increase in the incentive to invest. Indeed, at the limit, there would be no added investment incentive if interest rates were zero, because firms would be indifferent to the time pattern of depreciation allowances. We would note that the appropriate discount rate is not unambiguous. Summers (1987) argues that the tax value of depreciation deductions is essentially a riskless asset and hence that an after-tax nominal interest rate on safe assets (such as Treasury securities) should be used as the discount rate; Auerbach and Hassett (1992) make a similar argument. However, in a survey of large corporations, Summers found that the median rate used for discounting depreciation allowances was 15 percent, far in excess of the after-tax nominal Treasury rate at that time. Of course, using a discount rate of 15 percent (not shown in table) would increase the magnitude of the base-case effects on the user cost that are shown.

Fourth, although not shown explicitly, the boost to the incentive to invest was only 60 percent as large under the first tax bill with 30 percent bonus depreciation. However, even with smaller magnitudes, the relative changes in the user cost of capital still provided a ready source of variation for the econometric exercise.

III. Theoretical Impact of Temporary Changes in Business Taxation on Investment

The theoretical investment literature includes several papers analyzing the effects of temporary changes in business taxes on the path of investment. Papers utilizing a partial equilibrium framework include Abel (1982), Auerbach (1989), Auerbach and Hassett (1992), Cohen, Hansen, and Hassett (2002), and Romer (2001, 2nd ed., chapter 8), while papers using a general equilibrium approach include Edge and Rudd (2005) and House and Shapiro (2005). Instead of re-deriving results, we will highlight the key findings of the literature that are relevant to our study.

In standard models of firm investment behavior, changes in interest rates or taxes do not lead to an instantaneous adjustment to the new desired capital stock because it is assumed that such adjustments are costly. Typically the cost of adjustment is assumed to rise at an increasing rate with the level of capital expenditures, implying that it is desirable for the firm to spread the expenditures over time. Further, expectations of future changes in investment incentives lead to immediate changes in investment in order to reduce the adjustment costs that would occur if investment were delayed until the new incentives became effective.

Auerbach and Hassett (1992) show that in the presence of such capital adjustment costs the optimal level of investment at date t varies inversely with the relevant measure of the user cost of capital, C_t^*. As shown in equation 1, this measure is a weighted average of the current and expected future user costs of capital where, as described below, the weights, ω_i, indicate the relative contributions of these various components. (The weights sum to unity, and the summation runs from s = t to infinity):

(1) $C_t^* = E_t \Sigma \omega_{s-t} C_s$

The user cost, C_s, in this expression is given by (assuming static expectations about the pre-tax price of new capital goods):

(2) $C_s = p_s \; [(1 - \Gamma_s)/(1 - \tau)] \; [(\rho + \delta) + (\Gamma_{s+1} - \Gamma_s)/(1 - \Gamma_s)]$

(3) $\Gamma_s = \tau Z_s$

where p denotes the cost of new capital goods, ρ the nominal after-tax cost of funds, δ the rate of physical depreciation, τ the corporate income tax rate, Z the present value of depreciation allowances per dollar invested, and Γ the present value of the tax saving associated with depreciation allowances (for simplicity, Γ assumes no investment tax credit); p(1 – Γ) is the effective (i.e., net-of-tax subsidy) price of new capital goods. Loosely speaking, equation 2 states that the user cost of capital depends on the cost of funds, depreciation, and taxes.

Also, the weights, ω_i , vary with the marginal cost of adjustment. Intuitively, with low adjustment costs the weight applied to near-term values of the user cost is relatively high, so that current investment is not much affected by expected future values of the cost of capital. By contrast, with high adjustment costs the weight applied to near-term levels of the user cost is relatively low, implying a greater sensitivity of current investment to future user costs.

An immediate and unanticipated unit change in the user-cost path expected to last indefinitely, for example due to a new tax law, would cause an identical unit change in the weighted average expression (C_t^*) because the weights sum to unity. However, if changes to tax law are expected to be temporary, the user cost must reflect this anticipation; and, the final term in expression 2 captures this effect. For example, in the period prior to the expected expiration of partial expensing, presumably in late 2004, firms would have recognized that the present value of depreciation allowances was about to fall back to its original value, and hence the user cost in that period was temporarily reduced by the anticipated rise in the effective (i.e,. tax-adjusted) price of new capital goods at the beginning of 2005. As noted above, the user cost declined 18 percent for 7-year assets just prior to expiration. This should have induced intertemporal substitution in which future investment was pulled forward into 2004 assuming that firms were convinced at that time that partial expensing would not again be extended. Correspondingly, in early 2005 investment should have been reduced (relative to baseline).[3]

The dynamic response of investment to partial expensing is sensitive to the modeling of adjustment costs. This is best established in the work of Edge and Rudd (2005) who consider several types of adjustment costs including the standard case discussed above in which adjustment costs depend on the change in the capital stock as well as the case in which they depend on the change in investment. The latter is intended to capture time to plan and build.

[3] An alternative way to examine the dynamic effects of a temporary change in partial expensing is through models that derive investment as an increasing function of "q," the ratio of the shadow price of installed capital to the net-of-tax marginal cost of uninstalled capital. Such an approach is taken in Abel (1982) and in Romer (2001), for example, who then utilize phase diagrams to determine the effects of changes in tax law. The dynamic effects are qualitatively identical to those discussed in the text. In particular, starting from equilibrium, investment rises following the introduction of temporary partial expensing; this is because q jumps up initially, reflecting the enhanced incentives from the new tax law. Further, just prior to expiration investment spending is accelerating; so is q because future reductions in the stock of capital boost the discounted marginal product stream and hence the value of existing capital at that time. After expiration, investment falls with the removal of the new tax incentive, and q rises until equilibrium is reached. Correspondingly, the capital stock peaks at the time of expiration and then falls back to its original equilibrium value. If partial expensing is introduced when the economy is out of equilibrium (but on the stable arm), for example when the capital stock is below equilibrium as in Abel (1982, figure 3), following an initial jump, q falls over time while partial expensing is in effect (it falls because the capital stock remains below equilibrium, and the marginal product of capital above it, along the adjustment path); however this decline is not as steep as would otherwise have taken place along the stable arm. In this sense, q is above baseline and investment is stimulated until expiration. At that instant, investment plunges along with q (in order to return to the stable arm). Moreover, at that moment q is less than its value on the baseline path (because K is greater owing to the boost to investment while partial expensing was in effect), and hence investment is then less than its baseline value in order that the same steady state K is achieved.

In a partial equilibrium setup with capital adjustment costs, the Edge and Rudd simulations show that there is an immediate jump up in investment spending as partial expensing is introduced, an acceleration in investment right before expiration, and a plunge in investment at the time of expiration. At that point, the capital stock, which has risen monotonically above its steady state value, begins to gradually adjust back to its original value in a manner that reflects the fact that capital adjustment is costly. The temporary nature of the partial expensing policy thus encourages firms to pull forward investment spending before the incentive expires. Essentially, firms realize that capital had gone on sale before the provision's expiry and pull forward their spending accordingly. This is all quite similar to the textbook model in Romer (2001), for example.

In the general equilibrium extension of the model, the investment effects discussed above are attenuated because of higher interest rates. The higher rates are necessary to induce households to forego some consumption and to supply more labor (thus yielding a greater supply of capital goods); in addition, higher rates boost the cost of capital both directly and through a reduction in the present discounted value of nominal depreciation allowances.

The results are somewhat different when adjustment costs are modeled to depend on the change in investment. Intuitively, since it is more costly to adjust investment spending than in the prior case, spending should not adjust as abruptly as before; moreover, firms should begin to reduce the level of investment further in advance of the expiration date in order to better spread out the investment adjustment costs. In fact, this is the case in the model simulations: the investment response to temporary partial expensing is smoother and more hump-shaped than before, with the peak of spending occurring about a year prior to the expiration date; moreover, the decline in spending growth from its peak is gradual and not as deep as before (nor does spending drop below baseline, although growth does turn negative). We would note that all the results in Edge and Rudd assume that agents remain certain throughout the process that the details of the temporary partial expensing provision will be implemented as initially enacted into law.

There are several reasons why actual investment behavior might deviate substantially from the implications of the standard model in the case of bonus depreciation. First, the model implicitly assumes that firms have positive profits against which they can claim bonus depreciation. However, for firms making losses during the period between 2002 and 2004, bonus depreciation would have been of little value (apart from carryback and carryforward possibilities, discussed more below). While no doubt true for some firms, this explanation seems inappropriate in the aggregate because corporate profits were robust during the period.

Second, it also is possible that the additional administrative costs of applying for bonus depreciation outweigh the tax savings. This does not appear to be the case, because the partial expensing part of IRS tax form 4562 (depreciation and amortization), only requires that the property's basis be multiplied by 50 percent (or 30 percent when applicable) with the resulting figure placed on line 14 of the form (and that the amount on which the taxpayer figures the regular depreciation deduction be reduced by the amount of bonus depreciation).

Third, the three years during which partial expensing was in effect may have been too short to matter for firms with longer product/investment cycles. For example, if a firm in early 2002 was planning on buying and installing new capital goods in 2007 necessary for the manufacture of a new product at that time, the partial expensing provision would have been irrelevant. This is not a completely convincing argument because firms that had planned several years ago to install new capital in early 2005 may have been able to advance the installation by a few weeks, perhaps at some incremental cost, and taken advantage of the partial expensing provision. Of course, it is possible that speeding up the process, even by just a few weeks, could involve incremental costs that would outweigh the tax advantages. Indeed, the incremental costs might arise because the new capital goods themselves were firm-specific and required much time to build.

IV. Empirical Results

A. Methodology and Data Description

As noted above, basic models of firm investment behavior imply an increase (relative to baseline) in real expenditures on all qualifying new capital goods while the temporary partial expensing provision is in effect. In addition, these models also imply a larger response of real expenditures on relatively long-lived assets than on relatively short-lived assets. The latter observation serves as the basis of our difference-in-difference approach in which we compare the change in growth rates of expenditures on long-lived and on short-lived capital goods. We utilize two comparison periods: "before" vs. "during" and "after" vs. "during." In the case of the first comparison period, for example, we consider the null hypothesis that the increase in the growth rate of real expenditures on assets with 7-year tax lives across the two periods exceeded the corresponding increase in the growth rate of expenditures on assets with 5-year tax lives.

In addition to comparing differences in outcomes over adjacent periods, we also calculate the difference-in-difference estimator using OLS regressions. In particular, we run the following generic regression:

$$\Delta Y_i = a + bX_i + \varepsilon_i ,$$

where Y_i denotes the growth rate of investment in capital good i, ΔY denotes the change in the growth rate over adjacent periods (for example, the growth rate for the "during" period minus the growth rate for the "before" period), and X_i denotes a dummy variable that equals 1 for "treated" capital goods and 0 otherwise. For the bulk of the regressions, we consider the assets with 7-year or more tax lives to be the "treated" group and assets with 5-year and less tax lives to be the "control" group. We are most interested in the OLS estimate of b which, according to the theory, should be positive for the "during" period (relative to the "before" period) and negative for the "after" period (relative to the "during" period). Finally, we also consider regressions where the growth rate of investment of a particular type of capital good is weighted by its nominal share in total investment to control for the possibility that a small dollar change in investment over adjacent periods might translate into a huge percent change and hence distort the meaning of the OLS estimates.

Our basic comparison of differences in outcomes over two adjacent periods not only is straightforward and intuitive but has the additional advantage that the estimated standard errors of the coefficient on the treatment dummy in the regression analysis are meaningful even in small samples, as shown in Bertrand, Duflo, and Mullainathan (2003, updated).

However, implicit in the use of the difference-in-difference methodology is the maintained hypothesis that the change in the growth rate of expenditures on 7-year and on 5-year assets (e.g., between the "before" and "during" periods) would have been equal, up to a stochastic error-term, in the absence of partial expensing. If not, one might erroneously attribute a role for partial expensing when in fact the observed outcomes resulted from some other set of independent factors that differentially affected the 5-year and 7-year classes. During the decade-long "before" period that we employ using monthly shipments data, the average (nominal) growth rate in the two classes of assets was quite similar, suggesting that this might have continued in the absence of partial expensing, and thus lending some support for using our approach. Also lending support is the fact that growth in the two asset classes, although not equal, generally moved in lockstep between 2000 and 2003. By contrast, prior to 2000, this was not the case; further using quarterly NIPA data on real expenditure growth, the average growth rates of the 5-year and 7-year classes were not very similar during the "before" period. Ideally, one could use a structural model of investment spending with good time-series forecasting properties to help assess whether the growth in the different asset classes would have been similar in the absence of partial expensing but we are unfamiliar with such models; indeed it even has been hard to estimate models on time-series data in which the user cost of capital is statistically significant.

The empirical work below makes use of two data sets. First, we employ Census' monthly data on nominal shipments of capital goods. Because imports of foreign-made capital goods are eligible for partial expensing but exports are not, we adjust the basic data on shipments for net foreign flows. Next, we weight the resulting net shipments data by the estimated fraction going to equipment investment rather than to other components of aggregate demand or to intermediate use; these estimated fractions are derived from the 1997 benchmark U.S. input-output tables (the most recent published data detailed enough to generate weights).[4] These monthly data underlie the NIPA quarterly estimates of real expenditures on equipment and software, which we also utilize.

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[4] Details regarding construction of the weights, as well as our programs, are available from the authors upon request. The choice of weights affects our basic difference-in-difference calculations which add together the value of the weighted net shipments data for all capital goods of a given tax-life grouping before computing percent changes. However, the choice of weights does not affect the monthly regression results because the weights, which are constant over time, cancel out in computing growth rates of individual capital assets: that is, for capital good i, the growth rate of unweighted shipments equals the growth rate of weighted shipments. This issue does not arise in the quarterly NIPA regressions, because

Before turning to the results, we briefly discuss key similarities and differences between our empirical approach and that of recent work by House and Shapiro (2005) on the same topic. Among similarities, both approaches identify the impacts of partial expensing by variation across capital goods with different tax service lives. In particular, both studies recognize that the higher the tax service life of eligible capital goods, the greater is the theoretical investment response.

However, the studies differ in several ways. Using "reduced form" forecasting equations, House and Shapiro focus on the relationship between forecast errors for real investment in different types of capital and tax service lives; they report evidence that partial expensing worked as predicted by theory. However, they use quarterly NIPA data through 2004:Q1 and thus do not examine the effects through the date of expiration of partial expensing and in the subsequent months (and moreover are not based on data from the annual revision in July 2005). By contrast, we use a difference-in-difference method that compares growth rates of eligible capital assets with two different service lives (5 years or less and 7 years or more) over various periods. In addition, our study compares investment growth before partial expensing, during the entire period it was in effect, and during the six months following expiration. Moreover, we utilize monthly shipments data as well as quarterly NIPA data. The monthly data incorporate the benchmark revisions to the M3 data published in August 2005. The NIPA data through 2005:Q1 are based on the annual revision, published in July 2005, and data for 2005:Q2 are based on the "final" estimates published in September 2005.

B. Results for investment component of monthly nominal adjusted shipments

As a brief introduction to the empirical work, we plot monthly net shipments of capital goods since 1992 (see figure 3 at end of paper); we separately show the time profiles for the 5-year and 7-year classes. Although both asset classes trended up strongly during the 2002 to 2004 period, the level of shipments of 5-year assets declined early in the period and shipments in both classes actually *increased* in January 2005,

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the NIPA data are constructed by applying unpublished time-varying weights to the monthly shipments data.

immediately following expiration of partial expensing. This suggests that finding formal empirical support for the standard theoretical model may by difficult.

The formal results are mixed using monthly Census data. In the table, the "during" period begins in June 2003, just after enactment of the second partial expensing law (we discuss below the similarity of results when the "during" period begins in April 2002). While partial expensing was in effect, spending growth in both the 5-year and 7-year asset categories picked up substantially, in line with predictions of the standard theoretical model. However, the increment to growth in the 5-year class exceeded that in the 7-year class, counter to the model prediction. During the "after" period shown in the table (January through March), spending growth declined (relative to growth over the "during" period) for the 5-year class and turned negative for the 7-year class, supporting the standard theory.

The appropriate length of the "after" period, with its predicted pothole in investment spending, is not obvious on a priori grounds, and indeed the results for the "after" period are sensitive to its length. For example, if the relevant after period is January only (not shown), spending growth in the 5-year category *rises* relative to the "during" period, although growth in the 7-year category turns negative in the after period. If the "after" period includes January and February (not shown), the theory receives its greatest support because growth in both the 5-year and 7-year classes turns negative and by a larger amount in the 7-year grouping. The results are qualitatively very similar when unweighted shipments data are used. Also, when the starting date for the "during" period is April 2002, just after enactment of the first partial expensing law, the results are qualitatively very similar.

The regression analysis of the monthly data can be summarized as follows. Generally the expected positive sign is found in the "before" versus "during" comparison with a 2002 starting date but the wrong sign is found with a 2003 starting date (we tried several starting dates for months surrounding the dates of enactment); the estimated slope coefficient generally is not statistically significantly different from zero. Further, the expected negative sign is found in the "after" versus "during" comparison (we tried several end dates in 2005), but the slope coefficient generally is not significantly different from zero.[5]

Table 2
Weighted Nominal Net Shipments of Nondefense Capital Goods Excluding Transportation Equipment*
(Percent change, annual rate)

"Before vs. During"	**Tax Service life**	
	5 years or less	**7 years or more**
1. Jan 1992 – June 2003	4.51	4.08
2. June 2003 – Dec 2004	22.54	14.04
3. Difference (2-1)	18.03	9.96
4. Diff – in – diff	**-8.07**	

"During vs. After"	**Tax Service life**	
	5 years or less	**7 years or more**
5. June 2003 – Dec 2004	22.54	14.04
6. Jan 2005 – Mar 2005	7.76	-23.48
7. Difference (6-5)	-14.78	-37.52
8. Diff – in – diff	**-22.74**	

* Net shipments of capital goods are defined as Census M3 shipments minus exports plus imports. To extract the amount of net shipments going to equipment investment, weights derived from the 1997 benchmark input-output tables are applied to the disaggregated components. The "5 years or less" class is computed as the sum of the dollar value of weighted shipments of all capital goods with tax service lives of 5 years or less; a similar procedure is used to construct the "7 years or more" class.

[5] We also examine different partitions of capital goods. For example, we consider the case in which construction equipment is excluded from the analysis; this is a plausible exclusion given the boom in residential investment during this period. The results are similar to those discussed above, although we have found for certain ending dates in the "after" period that the slope coefficient is (barely) significant.

C. Results for quarterly NIPA real equipment expenditures

The results again are mixed using quarterly real NIPA data. While partial expensing was in effect, spending growth in both the 5-year and 7-year asset categories picked up substantially and by more than it picked up in the non-residential spending category, in line with predictions of the standard theoretical model (see table 3). However, the increase in growth in the 5-year class exceeded that in the 7-year class, counter to the model prediction. These results do not appear to be explained by changing patterns of relative prices of new capital goods over the period. In particular, the rate of price deflation of computers slowed dramatically in the "during" period whereas the price change of most other capital goods was largely unchanged; if the rate of computer price deflation had not slowed it is likely that the pick up in growth of real investment spending in the 5-year class would have been even larger than in the table (assuming that most of the variation in computer price inflation owes to supply side influences), making the discrepancy from the model prediction even greater.

During the "after" period (taken to be 2005:Q1 in the table), spending growth declined (relative to growth over the "during" period) for the 7-year class, but it increased for the 5-year class and turned negative for non-residential structures. (Using nominal NIPA data yield similar mixed results.) During the "after" period that includes both 2005:Q1 and 2005:Q2 (not shown), spending growth turned slightly negative for the 7-year class, but increased for the 5-year class. The "during" versus "after" comparisons thus offer only mixed support for the basic model. Moreover, there was a sizable spike in price inflation of capital goods in the 7-year class in early 2005 that arguably contributed to the slowdown in growth of real investment spending in the 7-year class, thus diminishing the importance of partial expensing as a contributing factor.

The outcome of the regression analysis of the quarterly NIPA data is similar to that using the monthly shipments data. Generally the expected positive sign is found in the "before" versus "during" comparison with a 2002 starting date but the wrong sign is found with a 2003 starting date; the estimated slope coefficient generally is not statistically significantly different from zero. By contrast, the expected negative sign is found in the "after" versus "during" comparison, but again the slope coefficient generally is not significantly different from zero. Qualitatively, the same results hold in the regressions that weight the growth rates of spending on each capital good by its nominal

Table 3
Real Investment in Equipment & Software
Excluding Transportation and Software**
(Percent change, annual rate)

"Before vs. During"	**Tax Service life**		
	Eligible		**Not eligible**
	5 years or less	**7 years or more**	**Non-residential Structures**
1. 1992 Q1 – 2003 Q3	14.16	3.38	0.51
2. 2003 Q3 – 2004 Q4	21.55	8.71	2.02
3. Difference (2-1)	7.39	5.33	1.51
4. Diff – in – diff	**-2.06**		**-4.33***

* Relative to total of 5-year and 7-year assets

"During vs. After"	**Tax Service life**		
	Eligible		**Not eligible**
	5 years or less	**7 years or more**	**Non-residential Structures**
5. 2003 Q3 – 2004 Q4	21.55	8.71	2.02
6. 2005 Q1	23.12	5.6	-2.02
7. Difference (6-5)	1.58	-3.11	-4.04
8. Diff – in – diff	**-4.68**		**-2.76***

* Relative to total of 5-year and 7-year assets
****** The "5 years or less" class is computed as the real chain aggregated value of all capital goods with tax service lives of 5 years or less; a similar procedure is used to construct the "7 years or more" class.

share of total investment. The regression results also are not supportive of the basic theoretical model when spending on non-residential structures is compared to that on equipment investment.

V. Other Evidence

Other evidence provides only limited support for the effectiveness of temporary partial expensing.

A. IRS data

Based on examination of a sample of corporate tax returns for 2003, the Treasury Department finds that the take-up rate (i.e., the fraction of eligible investment dollars that was claimed for purposes of receiving bonus depreciation) was only about 55 percent, up slightly from the 53 percent rate in 2002 (see table 4 at end of paper).[6] Among firms with positive taxable income, the take-up rate was 65 percent in 2003, down slightly from the 68 percent rate in 2002. (Similar figures apply to firms with zero or negative income). Investment in eligible capital goods differs depending on whether the corporation claimed bonus depreciation and whether it had positive or no taxable income. For example, in 2003 about 36 percent of total eligible investment was by companies that claimed bonus depreciation but had zero or negative income; about 47 percent of eligible investment was by companies that claimed bonus depreciation and had positive income; only about 17 percent was by companies that did not claim bonus depreciation.

Several lessons and potential puzzles are suggested by the Treasury data. First, firms that did not claim bonus depreciation (roughly two-thirds of all firms) had very little eligible investment during the period, as should have been expected.

Second, firms that took advantage of bonus depreciation claimed it only on two-thirds of the eligible investment undertaken (and this held whether or not the firms had positive taxable income); this raises the question of why they did not claim it on all

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[6] Knittel (2005) is the source of much of these data and follows up on some of the issues raised in this paper. To compute take-up rates in 2003, an assumption is necessary about the effective bonus depreciation rate because data are available only on the amount of bonus depreciation claimed and the amount of eligible investment. Treasury figures assume an effective bonus depreciation rate of 45 percent in 2003; this is less than 50 percent because the new higher statutory rate in 2003 did not apply for the entire year. For example, with an effective rate of 33 percent, the implied take-up rates would be about 90 percent in 2003.

eligible investment.[7] Firms with no before-tax income had an incentive to fully claim bonus depreciation, thereby creating a net operating loss, so as not to forego the option to use it in the future (recall that a company was not allowed by law to claim bonus depreciation on a capital good for the first time in years *after* it was placed in service) or possibly to carry it back to prior tax years if feasible. Firms with no taxable current income (defined to be net of total depreciation allowances) but positive before-tax income also had an incentive to fully claim bonus depreciation on all eligible investment and carry forward any unused depreciation to future years (or carry it back to prior tax years). Moreover, the low take-up rates for corporations with positive taxable income also are puzzling, suggesting that firms either were not minimizing current taxes or were not leaving open the option to claim bonus depreciation in the future. This behavior raises the possibility that "money was left on the table" not only on marginal investments but on inframarginal investments (i.e., investments that would have happened even in the absence of partial expensing) as well. It will be interesting to see if such results continue to hold on 2004 tax returns.

Third, the fraction of firms claiming bonus depreciation declined from nearly 40 percent in 2002 to 30 percent in 2003; a decline is consistent with expansion of the section 179 expensing provision in 2003 which likely induced firms to switch from taking bonus depreciation to full expensing.

B. Survey data

The Institute for Supply Management (ISM) posted a survey on its web site early in 2005, asking the following question: "What effect did the bonus depreciation tax provision have on your capital spending?" Nearly two-thirds of the 115 respondents indicated that there was no effect on the timing of capital spending; about one-quarter indicated that it accelerated the timing of spending marginally; and less than 10 percent indicated that it accelerated the timing of spending significantly.

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[7] This does not mean necessarily that a typical firm claimed bonus depreciation on only two out of three eligible investment dollars. Rather it could reflect that some firms claimed bonus depreciation on all eligible investment and that others did not claim any, implying an aggregate take-up rate of two-thirds. However, an initial look at the data suggests that many firms were, in fact, partial claimants.

The Empire State Manufacturing Survey for September 2004 indicated that only three of the thirty respondents cited partial expensing as a reason to increase capital spending.

In a NABE survey late in 2004, only about 10 percent of respondents indicated that partial expensing was significant and receiving management attention; about half indicated that it was marginal and not a management focus; the remainder indicated that it had no impact.

In a Philadelphia Fed survey late in 2004, only 12 percent of manufacturers and 2 percent of non-manufacturers indicated that partial expensing was a factor in their decision to increase capital spending.

Together the survey results indicate that partial expensing affected investment decisions of very few respondents. However, the surveys contain no information on the size of the projects that were affected: there may have been a more sizable impact recognizing that investment is lumpy and the provision may have led the marginal investor towards implementing large-scale investment.

VI. Conclusion

This paper examines the effect on investment expenditures of the temporary partial expensing or bonus depreciation laws enacted in 2002 and 2003. In principle, partial expensing boosted the incentive to invest, and more so for long-lived equipment than for short-lived equipment, although our calculations suggest that the ceteris paribus reduction in the user cost of capital was not very large (except in the period immediately preceding expiration). Further, the standard theoretical model of investment spending with capital adjustment costs predicts a run up in investment spending prior to expiration of partial expensing and a pothole just after. Our empirical examination of the details of expenditure patterns before, during, and after partial expensing using both monthly and quarterly data and a difference-in-difference framework suggests only a very limited impact of partial expensing on investment spending, if any. In addition, other evidence, including examination of a sample of corporate tax returns and of survey data, provides only limited support for the effectiveness of partial expensing. The decidedly mixed nature of the empirical results may reflect the inherent difficulty in uncovering a tight relationship when changes in the incentives to invest are not very big and high-frequency investment data are volatile and noisy.

Nonetheless, future research seemingly would benefit from attempts to reconcile theoretical models of the effects of temporary business tax incentives with empirical evidence from the period of temporary partial expensing. We have offered a few possible explanations for why the predictions of the standard model with capital adjustment costs have received only limited support in the data. Perhaps future work should be directed at examining models with investment and other types of adjustment costs and models of investment in the context of lengthy product cycles. Also, in light of the fact that partial expensing did not boost the incentives to invest by all that much, development of models with threshold effects may be useful.

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Table 4: Partial Expensing Statistics

Tax Year 2002: 30 Percent Bonus	Number Of Firms	Net Income	Positive Income	Negative Income	Taxable Income	Eligible Invest (4)	Claimed Bonus	Tax After Credits	Take-Up Rate (5)
All Firms	677,362	264	641	-377	573	505	81	146	53.3%
1 Firms with No Taxable Income	396,541	-335	37	-372	0	258	37	0	47.2%
a claim bonus	141,741	-139	15	-154	0	195	37	0	62.3%
b do not claim any bonus	254,800	-197	21	-218	0	63	0	0	0.0%
2 Firms with Taxable Income	280,821	600	604	-5	573	247	44	146	59.6%
a claim bonus	116,220	465	468	-3	446	217	44	120	67.8%
b do not claim any bonus	164,601	134	136	-2	127	30	0	26	0.0%
Tax Year 2003: 50 Percent Bonus (see footnote 3)									
All Firms	646,651	450	740	-290	668	455	113	169	55.0%
1 Firms with No Taxable Income	380,857	-251	37	-287	0	222	50	1	50.2%
a claim bonus	117,521	-90	20	-110	0	164	50	1	67.7%
b do not claim any bonus	263,336	-161	17	-178	0	57	0	0	0.0%
2 Firms with Taxable Income	265,793	701	703	-2	668	234	63	168	59.6%
a claim bonus	81,291	537	539	-2	515	215	63	140	64.8%
b do not claim any bonus	184,502	164	164	0	153	19	0	28	0.0%

Notes

1 C Corporations only, excludes S Corps, RICs and REITs. Billions of dollars.

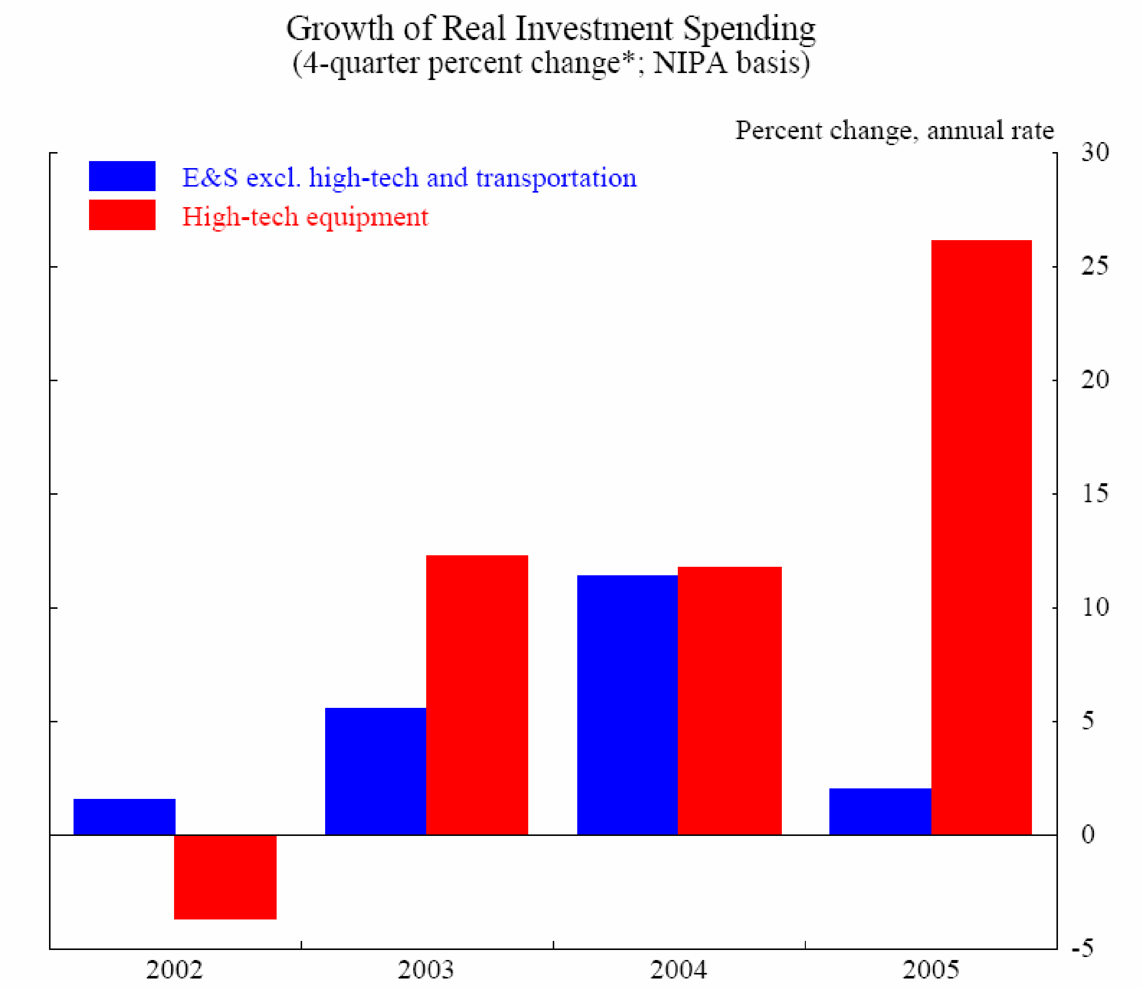
2 Data based on SOI sample of corporations claiming depreciation greater than $10,000.

3 Taxable Income is equal to Positive Income less loss carryforwards less dividends received deduction (minor).

4 Eligible investment likely does not include software; these amounts were not reported separately on tax forms.
Due to exclusion of software, take-up rates may be overstated if bonus was claimed for software; understated if it was not.

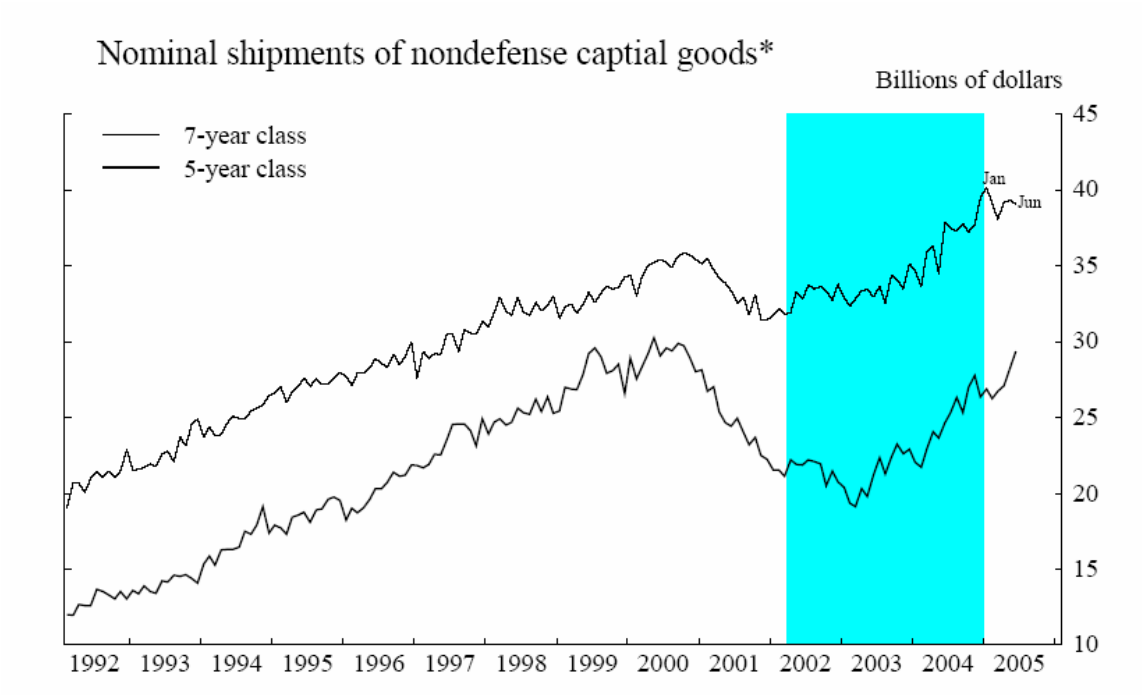
5 Assumes that all eligible investment in 2002 that claims bonus claims at 30 percent.
For 2003, assumes average applicable bonus percentage is 45 percent.
In 2003, for example, the take-up rate is inferred as bonus amount claimed divided by the product of 0.45 and the amount of eligible investment.

Figure 1



* 2005 value is the growth rate in 2005Q1 at an annual rate.

Figure 3



* Excludes aircraft and parts.

Note. Shaded region depicts period of partial expensing.