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The Tax-adjusted Q Model with Intangible Assets: Theory and Evidence from Temporary Investment Tax Incentives

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The Tax-adjusted Q Model with Intangible Assets: Theory and Evidence from Temporary Investment Tax Incentives

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Abstract

We propose a tax-adjusted q model with physical and intangible assets and estimate the effect of bonus depreciation in the United States in the early 2000s. We find that investment responds moderately to tax incentives; however allowing for heterogeneity reveals that intangible-intensive firms are more responsive than physical-intensive firms and their differences increase with firm size. Accounting for intangible assets increases the estimated total investment response from 3.7 to 14.3 percent among the largest 500 firms. Our results imply that understanding the behavior of large and intangible-intensive firms has important implications for the design and evaluation of investment policy.

JEL Classification Numbers: H25, G31, E01

Keywords: investment tax incentives, intangible assets, q model of investment, bonus depreciation

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I. Introduction

Temporary investment tax incentives have increasingly been used as an economic stimulus policy (CBO 2008). Whether these tax incentives are an effective tool to stimulate investment remains a topic of continued interest (Cummins, Hasset, and Hubbard 1994, House and Shapiro 2008, and Edgerton 2010). The objective of this paper is to incorporate recent developments on the measurement of intangible assets and reevaluate the effect of temporary investment incentives in the US in the early 2000s.

We have reasons to believe that incorporating intangible assets in the study of investment tax incentives has empirical and policy significance. First, temporary tax investment incentives are not applicable to a large class of purchased or internally developed intangible assets.[2] But to the extent that physical and intangible investments interact in firms' production or financing decisions, the presence of intangible assets complicates the usual link between physical investment and its after-tax cost of capital. This effect likely differs between physical- and intangible-intensive firms. Second, because intangible-intensive firms tend to be larger and represent a larger fraction of aggregate investment, understanding their behavior is important for evaluating the aggregate and distributional effects of investment tax policy.[3]

We adapt a tax-adjusted q model (Hayashi 1982) and extend it to include intangible assets. Our theoretical model shows a familiar relation between average q and investment once we adjust the q term for intangible assets; however the empirical implementation needs to address two challenges. First, average q reflects the market value and the book value of intangible assets. Although stock prices can be used as a proxy for the former, the latter needs to be measured using appropriate accounting methods. Second, in the presence of intangible assets, marginal q is not equal to average q. We show that, when tax changes are temporary, marginal q can be approximated by average q after adjusting for the share of intangible assets.

Several episodes of temporary changes in tax depreciation allowances in the early 2000s—known as "bonus depreciation"—provide an opportunity to implement this empirical strategy. Under the 2002 tax bill, firms could immediately deduct an additional 30 percent of investment purchases of certain qualified physical assets and depreciate the remaining 70 percent under standard tax depreciation schedules. The immediate deduction was increased to 50 percent under the 2003 tax bill and only applied to investment made through the end of 2004. The temporary nature of these policies and differentiated treatments of assets based on asset class fits precisely into our analytical framework.

[2] Section 197 of the Internal Revenue Code does not allow companies to amortize certain purchased intangible assets (e.g., artistic assets, financial developments, leasehold improvement, brand equity, employee's skills) or internally developed assets.

[3] In our sample, intangible-intensive firms represent 64.6 percent of total physical assets and 85 percent of total intangible assets. The largest 500 firms represent 26 percent of total physical investment, the largest 1500 firms, 57 percent, and the largest 3500 firms, 82 percent.

We estimate the model using a new and comprehensive database. We combine firm-level data on physical investment and firm value from Compustat with self-collected industry-level data on the stocks of physical and intangible assets from 1998 to 2006. Our definition of intangible assets follows Corrado, Hulten, and Sichel's (2005) and includes a wide range of self-developed intangible assets on computerized information, scientific and non-scientific innovation property such as scientific and non-scientific research and development (R&D) and economic competencies such as firm-specific human capital, organizational skills, and advertising. The use of industry-level data on intangible assets allows us to include a wide range of intangible assets that could not be measured using firm-level data.[4] It also allows us to construct industrial-level data on physical asset stocks based on national accounts and compare our results to prior studies, which generally rely on industrial-level data (Desai and Goolsbee, 2004).

We report three main results. First, we replicate a standard model to estimate the investment response of a firm with only physical assets (henceforth *physical-only model*). Consistent with prior studies, we find moderate investment responses to tax incentives. Second, we introduce intangible assets and allow for heterogeneity in firms' intangible share (henceforth *intangible-adjusted model*). We find that intangible-intensive firms are more responsive to investment incentives than physical-intensive firms and these differences are accentuated among larger firms. For instance among the top 500 firms, a physical-only model estimates an investment price elasticity of 3.3 among intangible intensive firms while an intangible-adjusted model estimates an elasticity of 7.4. Third, estimated investment elasticity is generally larger in the intangible-adjusted model than in the physical-only model. For example, among the top 500 firms, investment response to bonus depreciation estimated from the intangible-adjusted model is 2.3 times as large as that from a physical-only model. It is 1.8 times as large among the top 1500 firms, and 1.2 times as large among the top 3500 firms. An intangible-adjusted model suggests that bonus depreciation increases overall investment by 14.3 percent between 2000 and 2004 among the top 500 firms, in contrast with 3.7 percent suggested by a physical-only model.

The finding that investment tax incentives have larger effect among intangible-intensive firms is very informative for policy purposes and the sources of this heterogeneity should be the subject of further research. Although we do not provide direct tests for it, one possible explanation may be that intangible-intensive firms are less likely to raise external funds and more likely to be dependent on internal cash financing (Falato, Kadyrzhanova, and Sim 2013). Another explanation may be that bonus depreciation encourages intangible investment indirectly because of complementarity between physical and intangible assets. If intangible investment is easier to adjust than physical investment, we expect overall investment in intangible-intensive firms to be less "sticky". Finally, bonus depreciation only applied to physical assets with a recovery period of 20 years or less (i.e. short-lived "equipment"). Intangible-intensive firms may have a larger fraction of investment eligible for the incentives. In our sample, almost 90 percent of intangible-intensive firms' stocks of physical assets are equipment eligible for bonus depreciation, compared to 70 percent among physical-intensive firms.

[4] At the firm level, several studies capitalize reported R&D or Sale, General, and Administrative (SG&A) expenses to construct intangible assets (Chen 2014, Eisfeldt and Papanikolaou 2013, Falato, Kadyrzhanova, and Sim 2013). However, SG&A does not have a breakdown of investment by asset types.

Our paper is closely related to a large literature that empirically estimates the relationship between investment and q. Our paper complements this literature by allowing firms' response to investment costs to vary with intangible intensity. It differs from prior studies with heterogeneous assets (Wildasin, 1984; Hayashi and Inoue, 1991; Cummins and Dey, 1998; Bontempi et al., 2004) because it considers the role of intangibles in both the theory and empirical measures of q.[5]

Previous studies generally find small response to investment tax incentives, suggesting implausibly high adjustment costs (Caballero and Engel, 1999), physical assets heterogeneity (Bontempi et al., 2004), low cash flows and asymmetries in taxable status (Edgerton, 2010), or low take-up rates (Knittel, 2007). We find large and intangible-intensive firms are very responsive to incentives, suggesting the importance of firm heterogeneity.

Section II develops a tax-adjusted q model with intangible assets and discusses its new implications for empirical estimation. Section III describes our empirical implementation of the model and the data. Section IV presents the results. Section V concludes.

II. Intangible Assets and Tax-Adjusted Q: Theory

A. The model

Consider a firm that produces with two types of assets K^m (physical assets, m for measured) and K^u (intangible assets, u for unmeasured) with a constant return to scale production technology $F\left(K^m, K^u, X\right)$, where X represents the stochastic productivity of the firm. The firm invests I^m and I^u in physical and intangible assets respectively to maximize the expected present value of its future income:

$$(1)\quad V_t = \max_{\substack{\left\{I^i_{t+s}, K^i_{t+s}\right\}_{s=0}^{\infty},\\ i=\{m,u\}}} E_t\left\{\sum_{s=0}^{\infty}\beta_{ts}\left[\begin{array}{c}\left(1-\tau_{t+s}\right)\left(F\left(K^m_{t+s}, K^u_{t+s}, X_{t+s}\right)-\sum_{i=\{m,u\}}\Psi\left(I^i_{t+s}, K^i_{t+s}\right)\right)\\ -\sum_{i=\{m,u\}}\left(1-k^i_{t+s}-\tau_{t+s}z^i_{t+s}\right)I^i_{t+s}\end{array}\right]\right\},$$

subject to

$$(2)\quad K^i_{t+s+1} = \left(1-\delta^i\right)K^i_{t+s} + I^i_{t+s},$$

for $i=\{m,u\}$. E_t is the expectations operator conditional on information available in period t and τ is the corporate tax rate. The firm faces differentiated tax treatments on physical and

[5] Most q models with heterogeneous assets focuses on physical assets. One exception is Bond and Cummins (2000) who ask whether the stock market correctly incorporates earning potentials of intangible assets.

intangible investment. k^i captures investment tax credit for assets i. z^m captures the present value of tax depreciation allowances on a dollar of investment in physical assets. In the US, expenditure on intangible assets is fully expensed and deducted from a firm's tax base, so $z^u = 1$. As is standard in the literature, adjustment cost is a quadratic and linear homogeneous function of assets i, and is parameterized as $\Psi\left(I_{t+s}^i, K_{t+s}^i\right) = \frac{\psi}{2} K_t^i \left(\frac{I_t^i}{K_t^i}\right)^2$. We do not allow for interrelated adjustment costs. β_{ts} is the real discount factor applicable in period t to s-period-ahead payoffs with $\beta_{t0} = 1$ and $\beta_{tj} = \beta_{t1} \cdot \beta_{t+1,1} \cdots \beta_{t+j-1,1}$.

We allow firms to accumulate intangible assets even though in standard accounting practices intangible investment is fully expensed. This distinction creates a discrepancy between the *economic* book value and the *accounting* book value of intangible assets unless intangibles fully depreciate in each period.

Let q_t^i be the Lagrangian multiplier associated with (2). The first order conditions with respect to I_t^i and K_{t+1}^i are,

$$q_t^i = 1 - k_t^i - \tau_t z_t^i + \left(1-\tau_t\right)\psi \frac{I_t^i}{K_t^i}, \tag{3}$$

$$q_t^i = E_t \left\{ \beta_{t1} \left[\left(1-\tau_{t+1}\right) \left(\frac{\partial F\left(K_{t+1}^m, K_{t+1}^u, X_{t+1}\right)}{\partial K_{t+1}^i} + \frac{\psi}{2} K_{t+1}^i \left(\frac{I_{t+1}^i}{K_{t+1}^i}\right)^2 \right) + \left(1-\delta^i\right) q_{t+1}^i \right] \right\}. \tag{4}$$

From (3), we obtain an expression for the investment rate:

$$\frac{I_t^i}{K_t^i} = \frac{q_t^i}{\left(1-\tau_t\right)\psi} - \frac{1-k_t^i-\tau_t z_t^i}{\left(1-\tau_t\right)\psi}. \tag{5}$$

It suggests that the investment rate depends on its own (before tax) marginal value $q_t^i / \left[\left(1-\tau_t\right)\psi\right]$ (henceforth *the marginal q*) and the difference between the tax and economic depreciation of assets $\left(1-k_t^i-\tau_t z_t^i\right) / \left[\left(1-\tau_t\right)\psi\right]$ (henceforth *the tax term*).

Let P_t denote the ex-dividend market value of the firm and q_t be the ratio of P_t to the book value of total assets: $q_t \equiv P_t / \left(K_{t+1}^m + K_{t+1}^u\right)$ (henceforth *the average q*). Proposition 1 shows that, under constant return to scale in the production technology and adjustment costs, average q is a weighted average of the marginal q of physical and intangible assets.

Proposition 1 *The ratio of the ex-dividend market value to the book value of assets is a weighted average of the book value of physical and intangible assets.*

(6) $$q_t = q_t^m S_{t+1}^m + q_t^u \left(1 - S_{t+1}^m\right),$$

where $S_{t+1}^m \equiv K_{t+1}^m / \left[K_{t+1}^m + K_{t+1}^u\right]$ *is the share of physical assets in total assets.*

Proof See Appendix E.

It is easy to see that the extended model nests as a special case a standing q model with only physical assets. Setting the share of physical assets $S_t^m = 1$ in (6) gives $q_t = q_t^m$, so average q is equal to the marginal value of physical assets. The general expression (5) becomes

(7) $$\frac{I_t^m}{K_t^m} = \frac{q_t}{(1-\tau_t)\psi} - \frac{1-k_t^m - \tau_t z_t^m}{(1-\tau_t)\psi},$$

But when $S_t^m \neq 1$, average q is not equal to the tax-adjusted q term in (5). We defer empirical implications of this result to the empirical section of the paper but summary here that properly accounting for intangible assets is essential to correctly evaluate the investment response to tax incentives.

B. Short-run Approximations of Long-lived Assets

We are interested in establishing an empirical relation in the extended q model. Following equation (5),

(8) $$\frac{I_t^m}{K_t^m} = \frac{q_t^m}{(1-\tau_t)\psi} - \frac{1-k_t^m - \tau_t z_t^m}{(1-\tau_t)\psi}.$$

Suppose the government credibly announces a temporary change in bonus depreciation allowances, which temporarily increases z_t^m. The exact solution to the impact of this change is complicated for two reasons. First, (3) and (4) imply that investment decisions are both forward-looking and backward-looking. Second, if physical and intangible assets are imperfect substitutes, investment depends on the shadow value of both types of assets. However we can use short-run approximations to simplify the problem if tax changes are sufficiently temporary. In this case, we can replace K_t^m, K_t^u, q_t^m and q_t^u by their steady-state values. Approximating long-lived assets with their steady-state values is standard in many settings.[6] When the economic rate of depreciation is low, the stock of assets is much larger than the flow of investment. As a result, K_t^m and K_t^u change only slightly in the short-run. The rationale for approximating q_t^m and q_t^u with their steady-state levels is less common. The rationale for this comes from the optimality conditions. Expanding (4) gives

[6] There is a long tradition in macroeconomic models to approximate capital stocks around their steady state values to analyze investment dynamics to temporary shocks (see Stokey, Lucas, and Prescott, 1989 for a discussion).

$$q_t^i = E_t \left\{ \sum_{s=0}^{\infty} \beta_{ts} \left(1-\delta\right)^s \left(1-\tau_{t+s+1}\right) \left[\frac{\partial F\left(K_{t+s+1}^m, K_{t+s+1}^u, X_{t+s+1}\right)}{\partial K_{t+s+1}^i} + \frac{\psi}{2} K_{t+s+1}^i \left(\frac{I_{t+s+1}^i}{K_{t+s+1}^i} \right)^2 \right] \right\},$$

for $i = \{m,u\}$. Because the tax change is temporary, the system will eventually return to its steady-state, which means that future values of variables remain close to their steady-state level. The approximation error comes from the first few terms in the expansion. If both the economic depreciation rate and the discount rate are small, then future terms will dominate the expression of q_t^i and the approximation error will be small. The interpretation is that the value of long-lived assets is forward-looking and mostly influenced by long-run considerations. Therefore, the effect of a temporary tax change only has mild effects.[7] The approximation of S_t^m and q_t follow immediately: $S_t^m \approx S^m = K^m / \left(K^m + K^u\right)$ and $q_t \approx q = q^m S^m + q^u (1-S^m)$.

Following (3), the steady-state value of investment rate I^i / K^i is:

$$q^i = 1 - k^i - \tau z^i + \left(1-\tau\right)\psi\left(\frac{I^i}{K^i}\right),$$

for $i = \{m,u\}$, which implies

$$q^u = \eta q^m,$$

where $\eta \equiv \left[1-k^u - \tau z^u + \left(1-\tau\right)\psi\left(\frac{I^u}{K^u}\right)\right] / \left[1-k^m - \tau z^m + \left(1-\tau\right)\psi\left(\frac{I^m}{K^m}\right)\right]$.

Combining these two equations gives an identity to express q^m through q:

(9) $$q^m = \frac{q}{S^m + \eta\left(1-S^m\right)}.$$

This expression is more than an accounting identity. It expresses the unobserved variable, q^m, though q and S^m. q can be observed—although imperfectly—from companies' financial statements. S^m can be constructed using physical and intangible assets. Calculating η requires the time-series of tax rates and investment rates on physical and intangible assets. It also requires

[7] House and Shapiro (2008) use simulation to show that the steady-state value is good approximation for marginal q. For example, with 5 percent depreciation rate, moderate adjustment costs and one year tax duration, the approximation error duration of tax is 0.016.

an assumption on the parameter ψ . In Section IV, we evaluate the sensitivity of our key findings with respect to different assumptions on this parameter.

Following (8) and (9),

$$\frac{I_t^m}{K_t^m} = \frac{q}{\left[S^m + \eta\left(1 - S^m\right)\right]\left(1 - \tau_t\right)\psi} - \frac{1 - k_t^m - \tau_t z_t^m}{\left(1 - \tau_t\right)\psi}. \quad (10)$$

It shows how the standard empirical relation between marginal q and average q can be restored by scaling the average q by $1/\left[S^m + \eta\left(1 - S^m\right)\right]$ (hereafter "*q factor*").

III. Methodology and Data

A. Bonus Depreciation Allowances

In an attempt to spur business investment, the Job Creation and Worker Assistance Act (JCWAA) was passed on March 11, 2002 and adopted the first "bonus depreciation" tax allowance. It enabled businesses to immediately write off 30 percent of the adjusted basis of new qualified physical property acquired after September 11, 2001 and placed in service before September 11, 2004. On May 28, 2003 the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) increased to 50 percent the first-year bonus depreciation allowance for qualified physical assets acquired after May 5, 2003 and placed in service before January 1, 2005. In both cases, eligible properties included assets with a MACRS recovery period of 20 years or less, water utility property, certain computer software, and qualified leasehold improvements.[8]

Two aspects of the bonus depreciation allowance make it a policy experiment suitable for our analytical framework. First, the provision provided differential treatments based on assets types. Among qualifying property, the present value of the provision was an increasing function of the depreciable lives of qualified, short-lived capital assets. Second, because the provision was explicitly temporary, it provided an incentive to move investment forward.

B. Methodology

Empirical specifications

Compared to a physical-only model, two empirical adjustments are necessary to incorporate intangible assets. First, the average q should account for the book value of intangible assets. Second, the q term should be adjusted by the "q factor" capturing the firm's intangible intensity (see (10)). To evaluate the quantitative importance of these two adjustments, we first estimate a model with a physical-only q term and a physical-only q proxy. We hen estimate a model with a

[8] See Appendix B for more details.

physical-only q term and an intangible-adjusted q proxy. Finally, we estimate a model with an intangible-adjusted q term and an intangible-adjusted q proxy.

Following (7), we specify a physical-only model as:

$$(11) \qquad \frac{I_{i,t}^{m}}{K_{i,t-1}^{m}} = \alpha \frac{q_{i,t}}{1-\tau_t} + \beta' \frac{1-\Gamma_{j,t}^{m}}{1-\tau_t} + \gamma_k X_{k,i,t} + \varepsilon_i + \varepsilon_{i,t},$$

where $\frac{I_{i,t}^{m}}{K_{i,t-1}^{m}}$ is the investment rate in physical assets, $\frac{q_{i,t}}{(1-\tau_t)}$ is the q term, $\frac{1-\Gamma_{j,t}^{m}}{1-\tau_t}$ is the tax term with the present value of investment tax incentives $\Gamma_{j,t}^{m} = k_{j,t}^{m} + \tau_t z_{j,t}^{m}$, and $X_{k,i,t}$ controls for firms' idiosyncratic characteristics, including proxies for financial constraints, $\frac{CF_{i,t}}{K_{i,t}}$, cash flow normalized by physical assets, and, $Lev_{i,t}$, the leverage ratio (Fazzari et al., 1988; Edgerton, 2010). Following Christiano et al (2005) and Eberly et al. (2012), we include lagged investment rate among explanatory variables.[9] $\varepsilon_{i,t}$ is an idiosyncratic error. During the period covered, no broad tax credits for physical investment was available.[10] The tax term Γ_j^m is computed as a weighted average of the present value of tax depreciation allowances $\Gamma_j^m = \sum_{a=1}^{N^m} \frac{I_{aj}}{I_j^m} z_a$, where $I_j^m = \sum_{a=1}^{N^m} I_{aj}$ is total investment in physical assets of industry j and z_a is the present value of tax depreciation allowances for a dollar of investment in asset a.

We specify an intangible-adjusted model following (10).

$$(12) \qquad \frac{I_{i,t}^{m}}{K_{i,t-1}^{m}} = \alpha' \frac{q^{m}{}_{i,t}}{1-\tau_t} + \beta' \frac{1-\Gamma_{j,t}}{1-\tau_t} + \gamma_k' X_{k,i,t} + e_i + e_{i,t},$$

where $q_{i,t}^{m} = \frac{q_{i,t}}{S_j^m + \eta_j (1 - S_j^m)}$, S_j^m and η_j are the average value in industry j.

[9] Eberly et al. (2012) find that when lagged investment is included as a regressor, the explanatory power of the q and cash flow terms are much smaller, but R-square almost doubles.

[10] During 1998-2006, only conditional tax credits were available for specific expenditures (e.g., renewable energy), small corporations, or qualified employment.

Econometric methods

Estimating panel models such as (11) and (12) poses a number of econometric challenges. A central issue is the endogeneity of explanatory variables. The error term $\varepsilon_i + \varepsilon_{i,t}$ contains firm-specific effects ε_i and idiosyncratic shocks $\varepsilon_{i,t}$. The choice of estimation method crucially depends on our assumption on the error term. For example, if the q term (or the tax term) is not strictly exogenous to $\varepsilon_{i,t}$, then fixed effects or GLS models are inconsistent. In this case, Generalized Method of Moments (GMM) estimator is consistent if a valid set of instruments is used (Arellano and Bond 1991, Blundell and Bond 2000). If we assume that $\varepsilon_{i,t}$ is not serially correlated, then properly lagged dependent variables can be used as instruments. In our model, the presence of intangible assets likely introduces permanent measurement errors to a physical-only model. In this case, using lagged values of average q alone cannot successfully correct for measurement errors. Properly accounting for intangibles is necessary.

We estimate (11) and (12) using the system GMM estimator (Blundell and Bond 2000).[11] Endogenous variables are contemporaneous values of firm-level financial variables, including the q term, cash flow rate, leverage ratio, and lagged the investment rate.[12] We use lagged values (4 periods or earlier) as instruments for the first-difference equations and lagged values of the first differences of instrumented variables in the level equations. Exogenous variables include the tax terms and year dummies, and are also used as instruments.

We report three diagnostic tests. The AR(1) statistic (Arellano and Bond 1991) tests for first-order serial correlation of the full error term. The AR(2) statistic tests serial correlation in the innovation terms ($\varepsilon_{i,t}$ and $e_{i,t}$). Hansen statistic tests over-identification or the join validity of instruments.[13] We note that a firm's market value in excess of the value of its physical assets likely includes the value of intangible assets or overvaluation. Our empirical methodology does not allow us to distinguish these two; however, as long as we can appropriately account for intangibles and if the remaining *abnormal* component in market value is not correlated with firms' intangible intensity or their tax treatment, our findings are still valid. This condition seems to hold in prior studies. For example, Bond and Cummins (2000) show that the stock market does not seem to mismeasure the value of IT of intangible-intensive firms more than other firms.

[11] We also use fixed effects estimations. These results are not omitted for space consideration but available upon request.

[12] Specification tests show that serial correlation is not a main concern here after including lagged investment.

[13] Under the null hypothesis, AR(1) and AR(2) have standard normal distributions. If AR(1) is rejected but not AR(2), variables dated t-3 or earlier are valid instruments for the first difference equations. The Hansen test is distributed as chi-square under the null hypothesis of the joint validity of instruments.

C. Data

We use a comprehensive dataset on investment, assets, and relevant financial and tax information at the firm and industry levels. The sample period is 1998 to 2006, which includes several episodes of temporary investment tax incentives as described in Section IV.A. We end the sample period in 2006, before the start of the 2008 recession because economists recognize that this recession is different from previous business cycles in its causes and duration, and that the recovery has had unusual and unpredictable features (CBO, 2011).[14] Our results are not sensitive to the use of an earlier ending year of 2004 or 2005.

Firm-specific variables are from Compustat. We exclude firms in finance, insurance, and utilities because they are subject to specific tax treatments. To construct industry-level physical assets, we use BEA's capital flow table on investment in equipment, software and structures for 20 two-digit industries and 51 asset types. We separate corporate from non-corporate investment using the annual BEA's Surveys of Current Businesses. Stocks of physical assets are calculated based on the perpetual inventory method (PIM).

We construct intangible assets using investment data by detailed asset types, following the comprehensive methodology developed by Corrado, Hulten, and Sichel (2005) (CHS). This method carefully identifies intangibles assets that are essential factors of production such as including computerized information, scientific and non-scientific research and development (R&D), firm-specific human capital, organizational skills, and brand equity. [15] Self-developed intangible assets and purchased managerial assets are generally expensed for accounting purposes. In sum, we carefully include intangible assets that are likely to be included in the market values of the firms, but are ignored in usual proxies of q. We construct industry-level measures from 1998 to 2006 for 20 two-digit (also excluding finance, insurance and utilities). This data for intangible assets is, to our knowledge, the most comprehensive to this date for this time period.

Using our data on physical and intangible assets, we calculate the share of physical assets in each industry. We define the physical-only q proxy as the ratio of the market value of equity and debt to the book value of physical assets. For the book value of physical assets we experimented with proxies used in the literature, but chose to present results based on the book value of plant, property, and equipment.[16] To construct the book value of assets including intangible assets we scale a firm's book value of physical assets by the industry-level ratio of physical assets to total

[14] Business investment in equipment, software, and structures was at its lowest in more than half a century, ("The Budget and Economic Outlook: An Update", CBO 2011).

[15] The 2013 comprehensive revision on US National Income and Product Accounts (NIPA) was the first attempt to capitalize R&D and certain intangible investment, such as entertainment, literary, and artistic original, in national accounts. It uses a methodology similar to CHS (http://www.bea.gov/gdp-revisions/).

[16] Eberly et al. (2012) and Bond and Cummins (2000) use the book value of plant, property and equipment; Desai and Goolsbee (2004) and Edgerton (2010) use the book value of total assets as the denominator of q. For the book value of assets, the literature generally uses firms' reported total assets.

assets S_j^m. We denote by q* this intangible-adjusted q proxy. Finally, we adjust q* by the "q factor" and denote it by q^{*m}. We present detailed data and variable definitions in Appendix A and Table A8.

D. Summary Statistics

We present summary statistics in Table 1. Investment rate, physical-only q as well as the equipment tax term (ETT) and structure tax term (STT) are similar to those of prior studies (Bond and Cummins, 2000; Desai and Goolsbee, 2004; Edgerton, 2010). We follow the literature by winsorizing the data at the two percent level.[17] Recall that, although we experimented with alternative definitions of the physical-only q, we chose to present results where we proxy for the book value of physical assets with the value of property plant and equipment. This variable is generally much smaller than total assets, implying a value of average q about 5 times larger than that based on total assets. The resulting proxy for average q is skewed towards the upper end of the distribution, consistent with the literature.

The main source of variation in the two intangible-adjusted q terms (q_{ijt}^{*} and q_{ijt}^{*m}) comes from the ratio $S_j^m$of physical to total assets and the adjustment factor η_{jt} (or, equivalently, from the "q factor"). The variation in S_j^m is essentially at the industry level because the composition of asset stocks does not change much over time. Bonus depreciation significantly increased the present value of depreciation allowances z_{jt}^m from 2000 to 2004. As a result, the main source of variation in the ETT term is at the industry-level and over time. The variation in the STT term is mainly across industries, as few structures assets were eligible for bonus depreciation.

Figures 1 and 2 show intangible intensity among intangible-intensive industries (Fig.1) and physical-intensive industries (Fig.2). We see large and persistent differences in intangible intensity across industries. Among intangible-intensive industries, intangible assets represent close to a quarter of total assets in manufacturing, wholesale trade, information, and professional, scientific, and technical services. In contrast, physical assets represent over 97 percent of total assets in agriculture, mining, and real estate. In most industries, the intangible share is relatively stable overtime. In general, intangible share saw a modest increase at the beginning of the sample period but stabilized since the early 2000s.

Figures 3 to 5 show the interquartile range, mean, and median of the physical-only q and intangible-adjusted q (q^{*} and q^{*m}) by industry. All three proxies feature large cross-sectional variation both within industry and across industries. Not surprisingly, adjusting for intangible assets affects the q proxy of intangible-intensive industries more than that of physical-intensive industries.

[17] Many prior studies excludes negative q values, and either winsorize or truncate the data (Desai and Goolsbee, 2004, Edgerton 2010, Bond and Cummins 2000).

IV. RESULTS

A. Baseline Results

In Tables 2 to 5, we present results for different samples of firms based on size and intangible intensity. Our key findings can be summarized as follows.

1. Estimated investment responses differ between intangible- and physical-intensive firms. This result holds in the physical-only model and intangible-adjusted model. The difference increases with firm size.

2. Estimated investment responses are generally larger in intangible-adjusted models than physical-only models. The differences between ETT coefficients are generally larger among intangible-intensive firms, implying that adjusting for intangible assets is more important for this sample.

3. Adjusting for the book value of intangible assets in the q proxy accounts for the majority of the difference between intangible-adjusted and physical-only estimations.

4. The physical-only q proxy is correlated with ETT and STT.

For a detailed discussion of these results, we start with large firms and move to a more general sample. The sample of large firms is selected in each year based on the size of total assets. Large firms are less likely to be financially constrained (Almeida et al., 2007), so their investment may be more responsive to changes in the cost of capital. On the other hand, if tax incentives somehow relax financial constraints of smaller firms, they might show large responses as well. We leave the data to sort out which of these effects is larger.

Table 2 presents results among the largest 500 firms. Columns 1 to 3 are base on the physical-only model (11), for all firms (column 1), intangible-intensive firms (column 2) and, physical-intensive firms (column 3). We define an industry to be intangible-intensive if its intangible to total assets ratio is greater than the median of the sample and physical-intensive otherwise. Columns 4 to 6 are based on the model with an intangible-adjusted q proxy and physical-only q term (i.e. with q^*). Columns 6 to 9 are base on the model with intangible-adjusted q proxy and intangible-adjusted q term (i.e. with q^{*m}).

In Column 1, the coefficients of ETT and STT are significant. While the coefficients of STT are always significant and larger for intangible-intensive firms than physical-intensive firms, the coefficients of ETT are not significant. The Hansen test decisively rejects the joint test of model and instrument validity for all firms (column 1), and for intangible-intensive firms at the 5 percent level (column 2). These results suggest that measurement error in the physical-only model is persistent and correlated with our instruments, particularly for intangible-intensive firms.

Using the intangible-adjusted q proxy (q^*), we obtain larger coefficients of ETT and STT for all firms (comparing column 4 to column 1). The difference is larger for intangible-intensive firms (comparing column 5 to column 2). For intangible-intensive firms, the coefficients of ETT and STT change from not significant to large and significant in the model with q^*. The Hansen test no longer rejects the validity of instruments. For physical-intensive firms, the coefficients of ETT and STT also become larger compared to the physical-only q model, but the difference is less pronounced. Estimations with an intangible-adjusted q proxy and an intangible-adjusted q term (columns 7 to 9) lead to similar conclusions: the tax terms are larger than in models with a physical-only q proxy and the difference is again larger for intangible-intensive firms. Results in columns 7 to 9 are very similar to those in columns 4 to 6, suggests that after using more reliable proxies for the book value of intangible assets, the additional gain from adjusting for the discrepancy between average q and marginal q is small. This is not surprising considering that we have essentially used the same additional information of intangible share for both adjustments.

As we move from physical-only models to intangible-adjusted models, coefficients of cash flow become less significant. Our interpretation is that intangible-adjusted q contains less measurement error than physical-only q.

Our results show that measurement error in physical-only q is correlated with the tax terms, contrary to what is assumed in prior studies (Desai and Goolsbee 2004, Edgerton 2010). One reason is that physical- and intangible-intensity firms differ in their composition of assets eligible for bonus depreciation. Our results also show that accounting for intangible assets is more important for intangible-intensive firms than for physical-intensive firms.

We reach similar conclusions using larger samples. Table 3 shows results for the largest 1500 firms, Table 4 for the largest 3500 firms, and Table 5 for all firms. Intangible-adjusted models generally have larger ETT and STT coefficients physical-only models term. Again, the difference is larger for intangible-intensive firms and most of the difference can be captured by models where the denominator of the q term is adjusted for the book value of intangible assets. The Hansen tests in intangible-adjusted models remain valid at the 3 percent level in most cases, although it is rejected for the largest 3500 firms and the full sample when intangible-intensive and physical-intensive firms are not separated.

As we move from the largest firms to a more general sample, the differences in ETT and STT coefficients between physical-only intangible-adjusted models become less pronounced, which implies the physical-only model leads to more biased results for larger firms than for smaller firms.

Finally, we note the limitation of using consolidated data such as the Compustat because they including foreign and domestic investment. The data should work against finding large effects of bonus depreciation because it only applies to domestic investment. If intangible-intensive firms are also more worldwide oriented, our finding of the differences between physical- and intangible-intensive firms serves as a conservative lower bound of their actual difference.

B. Results Comparison

How do our results compare to the literature? How does incorporating intangible assets affect our assessment of temporary tax incentives? To answer questions, we design our physical-only model to replicate standard q models. We use it to check the consistency of our result to the literature and to compare with results of intangible-adjusted models.

The literature has not reached a consensus about the elasticity of investment with respect to the cost of capital. Early estimations using aggregate data suggest small elasticity. More recent estimations using firm-level data generally suggest larger numbers. For example, Desai and Goolsbee (2004) and Edgerton (2010) estimate the ETT coefficient to be between -0.6 and -0.9. The result likely depends on tax regime. The ETT and q coefficients in Desai and Goolsbee (2004) show are strikingly different across periods. House and Shapiro (2008) find that the supply elasticity of investment to bonus depreciation in the early 2000s is much larger than precious estimates using longer time-series data. Their result implies an ETT coefficient to be between -0.33 and -0.7. Our ETT coefficient from the physical-only model is -0.61 for all firms, consistent with the literature.

We find that larger and more intangible-intensive firms are more responsive than an average firm. Some recent papers similarly show the importance of firm heterogeneity. Edgerton (2008) finds that larger firms and firms with more cash flows are more responsive to bonus depreciation. Mahon and Zwick (2014) find that firms with larger short-run cash flow benefits from bonus depreciation are more responsive.

The literature also has a wide range of results for the STT coefficient. Desai and Goolsbee (2004) estimate it to be -0.02 and significantly different from zero in 1961-2003, but positive in 1997-2003. Edgerton's (2010) result ranges from -0.05 to 0.11 and is significant for large firms. Our result is larger, ranging from 1.15 to 1.49. It likely reflects differences in the share of structure assets across industries.

One caveat to these comparisons is that different results may capture differences in sample and policy regimes across studies. This is not a concern if we compare estimates internally. By comparing results of the intangible-adjusted model with those of a physical-only model, we find clear evidence of how accounting for intangible assets play a non-negligible role estimating firms' responsive to tax incentives, as we summarized in the beginning of this section.

C. The Economic Size of the Impact of Bonus Depreciation

We use a back-of-the-envelope calculation to recover the elasticity of investment and the aggregate impact of bonus depreciation. From 2000 (i.e., one year before bonus depreciation started) to 2004 (the last year when it was in effect), among the largest 500 firms, the average ETT term decreased by 0.025 units. With an average value of the investment rate of 0.26 in 2000, the physical-only model (column 1) implies an after-tax cost elasticity of investment of

1.7. In an intangible-adjusted model (column 7), the estimated elasticity increases to 1.9.[18] The differences between these estimations are more pronounced when we separate firms by intangible intensity. Among intangible-intensive firms, the physical-only model implies an elasticity of 3.3 while an intangible-adjusted model implies an elasticity of 7.4. Among physical-intensive firms, the implied elasticity is 1.1 for the physical-only estimation and 1.7 for intangible-adjusted estimation.

Taking into account these different responses is important to evaluate the aggregate investment effect. In Table 6, we summary total investment changes in 2000-2004 using an asset-weighted-average of physical- and intangible-intensive firms. For the largest 500 firms, an intangible-adjusted model implies that the mean investment rate increased by 3.7 percentage point from 25.8 percent in 2000 to 29.5 percent in 2004. In contrast, a physical-only model implies an increase of only 0.95 percentage points. These increases correspond to 14.3 percent and 3.7 percent of aggregate investment in 2000 respectively. For the largest 1500 firms, the increases in investment rate is 3.13 percentage points from an intangible-adjusted model and 0.96 percentage points from a physical-only model, for the largest 3500 firms, 3.17 percentage points and 1.32 percentage points respectively, and for all firms, 3.46 percentage points and 1.54 percentage points respectively. In other words, our results suggest that the impact of bonus depreciation estimated by the intangible-adjusted q-model is 3.9 times as large as that of a physical-only model among the largest 500 firms, 3.25 times as large among the largest 1500 firms, 2.34 times as large among the largest 3500 firms, and 2.25 as large among all firms.

V. Conclusion

This paper sheds new lights on the effectiveness of investment tax incentives. We use a new and comprehensive database including physical and intangible assets to re-estimate investment responses to bonus depreciation in the US in the early 2000s.

We fine that intangible-intensity is an important source of firm heterogeneity. Investment responses to tax incentives differ between intangible-intensive firms and physical-intensive firms and their difference increases with firm size. Incorporating these results imply a much larger impact of bonus depreciation than otherwise.

Why are larger and intangible-intensive firms more responsive to bonus depreciation? We provide several explanations: They are more likely to be financially constraint and be dependent on internal cash financing; their overall investment is less “sticky” because intangible investment is less costly to adjust than physical investment; also, on average they have a larger fraction of investment eligible for bonus depreciation. Direct tests for these explanations are useful topics for future research.

[18] We show average ETT and investment rates in Tables A6 to A8. We calculate the elasticity as $e = -\hat{\beta} * \overline{ETT_{2000}} / \overline{I/K_{2000}}$ = 0.383*(1.16)/(0.26) = 1.7.

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Table 1. Summary Statistics, 1998-2006

	All N=45,064		Top 3500 N=35,732		Top 1500 N=23,753		Top 500 N=10,691	
Variable	Median /Mean	Std. Dev.	Median /Mean	Std. Dev.	Median /Mean	Std. Dev.	Median /Mean	Std. Dev.
Panel A: All firms								
I_{ijt}/K_{ijt-1}	0.209	0.374	0.201	0.349	0.186	0.316	0.173	0.290
q_{ijt} [1/]	4.45/19.2	57.0	4.38/18.4	55.5	4.30/17.5	53.0	3.9/15.8	46.8
q^*_{ijt} [1/]	3.66/15.7	46.3	3.62/15.0	45.0	3.52/13.3	41.0	3.28/12.1	38.0
q^{*m}_{ijt} [1/]	4.19/18.1	53.5	4.15/17.4	52.1	4.01/15.4	47.5	3.75/14.0	44.2
q_factor_{jt}	1.142	0.080	1.141	0.080	1.141	0.080	1.142	0.079
η_{jt}	1.374	0.108	1.376	0.109	1.377	0.109	1.378	0.111
CF_{ijt}/K_{ijt-1}	-0.895	4.706	-0.607	4.191	-0.408	3.638	-0.320	3.408
Lev_{ijt}	0.405	1.307	0.450	1.323	0.485	1.309	0.515	1.286
S^m_{jt}	0.833	0.079	0.834	0.079	0.834	0.079	0.833	0.079
ETT_{jt}	1.153	0.075	1.154	0.075	1.153	0.075	1.151	0.072
STT_{jt}	1.485	0.052	1.485	0.052	1.486	0.051	1.486	0.050
Panel B: Intangible-intensive firms								
I_{ijt}/K_{ijt-1}	0.195	0.359	0.183	0.324	0.170	0.290	0.160	0.261
q_{ijt} [1/]	5.38/17.7	42.9	5.35/16.9	41.5	5.34/16.3	40.2	4.94/15.6	39.3
q^*_{ijt} [1/]	4.16/13.8	33.9	4.17/13.2	32.7	4.1/12.1	30.0	3.81/11.4	27.9
q^{*m}_{ijt} [1/]	5.01/16.6	40.4	5.02/15.9	39.0	4.92/14.5	35.8	4.59/13.7	33.4
q_factor_{jt}	1.205	0.034	1.204	0.034	1.203	0.035	1.201	0.035
η_{jt}	1.329	0.106	1.333	0.108	1.334	0.109	1.339	0.113
CF_{ijt}/K_{ijt-1}	-0.874	4.600	-0.505	3.846	-0.318	3.330	-0.270	3.171
Lev_{ijt}	0.321	1.200	0.364	1.229	0.398	1.255	0.429	1.227
S^m_{jt}	0.773	0.012	0.773	0.012	0.774	0.012	0.774	0.012
ETT_{jt}	1.119	0.018	1.119	0.018	1.119	0.017	1.120	0.017
STT_{jt}	1.505	0.013	1.505	0.013	1.505	0.013	1.505	0.012
Panel C: Physical-intensive firms								
I_{ijt}/K_{ijt-1}	0.219	0.357	0.214	0.337	0.200	0.313	0.190	0.301
q_{ijt} [1/]	2.81/14.2	46.7	2.82/13.7	44.3	2.74/13.1	2.61/11.9	12.0	36.4
q^*_{ijt} [1/]	2.6/12.5	39.5	2.63/12.1	37.3	2.58/10.1	2.51/9.35	9.3	27.7
q^{*m}_{ijt} [1/]	2.71/13.6	44.3	2.75/13.1	41.8	2.68/10.9	2.61/10.1	10.1	31.6
q_factor_{jt}	1.051	0.046	1.050	0.046	1.049	0.046	1.050	0.047
η_{jt}	1.436	0.094	1.437	0.096	1.438	0.095	1.438	0.098
CF_{ijt}/K_{ijt-1}	-0.598	3.824	-0.416	3.507	-0.277	3.162	-0.181	2.677
Lev_{ijt}	0.544	1.448	0.588	1.443	0.628	1.374	0.653	1.364
S^m_{jt}	0.925	0.058	0.926	0.058	0.928	0.058	0.927	0.059
ETT_{jt}	1.215	0.098	1.215	0.097	1.214	0.097	1.209	0.097
STT_{jt}	1.447	0.071	1.447	0.070	1.448	0.070	1.449	0.071

Notes: 1/ Our different proxies of q are heavily skewed. The skewness of q has been shown in prior papers using similar dataset. Instead of top censoring the data, we winsorize it at 2 percent and show both median and mean in this table. The skewness is reduced with higher levels of winsorization (5 percent and 10 percent). However, higher levels of winsorization do not affect our baseline regression results.

Table 2. System GMM Regressions, Top 500 Firms

	Physical-Only Q Proxy			Intangible-Adjusted Q Proxy					
	Physical-Only Q Term			Physical-Only Q Term			Intangible-Adjusted Q Term		
	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$q_{iijt}/(1-\tau_t)$	0.001	0.002***	0.003***						
	[0.001]	[0.000]	[0.001]						
$q^*_{iijt} / (1-\tau_t)$				0.002***	0.003***	0.003***			
				[0.001]	[0.001]	[0.001]			
$q^{*m}_{iijt} / (1-\tau_t)$							0.002***	0.003***	0.003***
							[0.000]	[0.001]	[0.001]
ETT_{it}	-0.383***	-0.894	-0.172	-0.435***	-2.051***	-0.288**	-0.423***	-2.016***	-0.278**
	[0.139]	[0.685]	[0.119]	[0.112]	[0.676]	[0.123]	[0.113]	[0.681]	[0.121]
STT_{it}	-1.152***	-1.604**	-0.829***	-1.061***	-1.832***	-1.017***	-1.054***	-1.811***	-1.012***
	[0.208]	[0.672]	[0.211]	[0.182]	[0.512]	[0.198]	[0.182]	[0.520]	[0.196]
CF_{iijt}/K_{iijt-1}	-0.025***	-0.022**	-0.017	-0.000	0.007	-0.007	-0.000	0.006	-0.006
	[0.008]	[0.010]	[0.015]	[0.008]	[0.010]	[0.009]	[0.008]	[0.010]	[0.009]
Lev_{it}	-0.006	0.044***	0.018	0.026**	0.024**	0.054**	0.025**	0.024**	0.052**
	[0.016]	[0.016]	[0.032]	[0.011]	[0.012]	[0.024]	[0.011]	[0.012]	[0.023]
Lag (I_{iijt}/K_{iijt-1})	0.039	-0.085	0.251*	0.228***	-0.010	0.162	0.228***	-0.019	0.166
	[0.080]	[0.090]	[0.137]	[0.075]	[0.082]	[0.107]	[0.075]	[0.085]	[0.108]
Const.	2.312***	3.537**	1.542***	2.177***	5.167***	1.946***	2.156***	5.097***	1.927***
	[0.465]	[1.657]	[0.435]	[0.400]	[1.429]	[0.426]	[0.402]	[1.446]	[0.422]
Obs.	10,745	5,538	3,674	10,962	5,752	3,617	10,962	5,752	3,617
N. of fixed effects	1,818	999	747	1,845	1,024	750	1,845	1,024	750
AR(1)	-2.775	-0.391	-3.432	-5.125	-1.716	-3.356	-5.096	-1.593	-3.355
p-val (AR(1))	0.00552	0.696	0.000600	2.98e-07	0.0862	0.000792	3.46e-07	0.111	0.000794
AR(2)	-2.633	-2.690	-1.311	0.0284	0.829	-0.132	0.0331	0.818	-0.0731
p-val (AR(2))	0.00846	0.00715	0.190	0.977	0.407	0.895	0.974	0.413	0.942
Hansen	123.9	95.57	77.26	81.08	89.80	88.43	81.65	91.34	89.46
p-val	0.000434	0.0640	0.438	0.324	0.133	0.156	0.308	0.111	0.139

Table 3. System GMM Regressions, Top 1500 Firms*

	Physical-Only Q Proxy			Intangible-Adjusted Q Proxy					
	Physical-Only q Term			Physical-Only Q Term			Intangible-Adjusted Q Term		
	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$q_{iit}/(1-\tau_t)$	0.002***	0.002***	0.002**						
	[0.000]	[0.001]	[0.001]						
$q^*_{iit} / (1-\tau_t)$				0.002***	0.002***	0.002***			
				[0.000]	[0.001]	[0.001]			
$q^{*m}_{iit} / (1-\tau_t)$							0.001***	0.002***	0.001***
							[0.000]	[0.000]	[0.001]
ETT_{it}	-0.368***	-0.993*	-0.219***	-0.421***	-1.799***	-0.251***	-0.412***	-1.745***	-0.252***
	[0.095]	[0.546]	[0.078]	[0.078]	[0.477]	[0.076]	[0.079]	[0.483]	[0.076]
STT_{it}	-1.202***	-1.299***	-0.856***	-1.098***	-1.556***	-0.802***	-1.098***	-1.519***	-0.804***
	[0.147]	[0.427]	[0.141]	[0.129]	[0.407]	[0.136]	[0.129]	[0.413]	[0.136]
CF_{iit}/K_{iit-1}	-0.006	-0.017	-0.014	-0.000	-0.005	-0.013	-0.001	-0.006	-0.012
	[0.008]	[0.011]	[0.013]	[0.007]	[0.010]	[0.010]	[0.007]	[0.010]	[0.009]
Lev_{it}	0.021*	0.024*	0.009	0.026**	0.016	0.016	0.026**	0.016	0.015
	[0.013]	[0.014]	[0.021]	[0.011]	[0.013]	[0.019]	[0.011]	[0.013]	[0.019]
Lag (I_{iit}/K_{iit-1})	0.157**	-0.002	0.345***	0.274***	0.070	0.428***	0.271***	0.070	0.426***
	[0.063]	[0.085]	[0.103]	[0.055]	[0.064]	[0.091]	[0.055]	[0.064]	[0.092]
Const.	2.322***	3.170***	1.632***	2.222***	4.482***	1.580***	2.213***	4.365***	1.588***
	[0.329]	[1.175]	[0.294]	[0.283]	[1.091]	[0.291]	[0.284]	[1.108]	[0.291]
Obs.	23,918	12,226	8,472	24,050	12,190	8,587	24,050	12,190	8,587
N. of fixed effects	4,186	2,245	1,770	4,199	2,228	1,801	4,199	2,228	1,801
AR(1)	-5.472	-1.767	-4.012	-6.807	-2.944	-4.592	-6.787	-2.924	-4.571
p-val (AR(1))	4.44e-08	0.0773	6.03e-05	0	0.00324	4.38e-06	0	0.00346	4.85e-06
AR(2)	-1.634	-1.724	-0.920	0.770	-0.0130	0.000232	0.723	0.00470	-0.0276
p-val (AR(2))	0.102	0.0847	0.358	0.441	0.990	1.000	0.469	0.996	0.978
Hansen	105.0	97.91	98.83	100.4	94.30	99.57	101.0	95.71	100.2
p-val	0.0154	0.0461	0.0404	0.0320	0.0760	0.0362	0.0292	0.0629	0.0329

Table 4. System GMM Regressions, Top 3500 Firms

	Physical-Only Q Proxy			Intangible-Adjusted Q Proxy					
	Physical-Only Q Term			Physical-Only Q Term			Intangible-Adjusted Q Term		
	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$q_{iit}/(1-\tau_t)$	0.001***	0.001***	0.001**						
	[0.000]	[0.000]	[0.001]						
$q^*_{iit} / (1-\tau_t)$				0.001***	0.002***	0.002**			
				[0.000]	[0.001]	[0.001]			
$q^{*m}_{iit} / (1-\tau_t)$							0.001**	0.001***	0.002**
							[0.000]	[0.000]	[0.001]
ETT_{it}	-0.527***	-1.475***	-0.323***	-0.547***	-1.823***	-0.277***	-0.544***	-1.785***	-0.283***
	[0.088]	[0.447]	[0.072]	[0.083]	[0.427]	[0.068]	[0.086]	[0.431]	[0.069]
STT_{it}	-1.319***	-1.669***	-0.911***	-1.348***	-1.724***	-0.904***	-1.352***	-1.697***	-0.908***
	[0.136]	[0.444]	[0.129]	[0.134]	[0.410]	[0.120]	[0.135]	[0.415]	[0.122]
CF_{iit}/K_{iit-1}	-0.011	-0.019*	-0.016	-0.014*	-0.021*	-0.028***	-0.015*	-0.021*	-0.029***
	[0.008]	[0.011]	[0.010]	[0.008]	[0.013]	[0.010]	[0.008]	[0.013]	[0.010]
Lev_{it}	0.026**	0.019	0.020	0.026**	0.023*	-0.002	0.027**	0.023*	-0.002
	[0.011]	[0.013]	[0.018]	[0.011]	[0.013]	[0.019]	[0.011]	[0.013]	[0.018]
Lag (I_{iit}/K_{iit-1})	0.210***	0.073	0.380***	0.191***	0.070	0.321***	0.189***	0.071	0.314***
	[0.052]	[0.074]	[0.102]	[0.054]	[0.073]	[0.089]	[0.054]	[0.072]	[0.090]
Const.	2.690***	4.283***	1.841***	2.756***	4.764***	1.787***	2.762***	4.679***	1.806***
	[0.306]	[1.132]	[0.284]	[0.299]	[1.056]	[0.257]	[0.304]	[1.069]	[0.261]
Obs.	35,692	18,063	12,781	35,789	17,986	12,952	35,789	17,986	12,952
N. of fixed effects	6,693	3,498	2,846	6,703	3,477	2,874	6,703	3,477	2,874
AR(1)	-7.030	-2.961	-4.774	-6.628	-3.065	-4.769	-6.580	-3.087	-4.692
p-val (AR(1))	0	0.00307	1.80e-06	0	0.00217	1.85e-06	0	0.00202	2.70e-06
AR(2)	-0.338	-0.869	0.407	-0.538	-1.026	0.116	-0.660	-1.012	-0.0271
p-val (AR(2))	0.735	0.385	0.684	0.590	0.305	0.908	0.510	0.312	0.978
Hansen	149.4	98.34	104.4	142.7	89.51	101.3	142.8	88.87	102.7
p-val	1.06e-06	0.0434	0.0171	5.75e-06	0.138	0.0277	5.60e-06	0.148	0.0225

Table 5. System GMM Regressions, All Firms

	Physical-Only Q Proxy			Intangible-Adjusted Q Proxy					
	Physical-Only Q Term			Physical-Only Q Term			Intangible-Adjusted Q Term		
	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms	All Firms	Intangible-Intensive Firms	Physical-Intensive Firms
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$q_{iit}/(1-\tau_t)$	0.002***	0.002***	0.002**						
	[0.000]	[0.000]	[0.001]						
q^*_{iit} / $(1-\tau_t)$				0.002***	0.002***	0.002***			
				[0.000]	[0.001]	[0.001]			
q^{*m}_{ijt} / $(1-\tau_t)$							0.002***	0.002***	0.002**
							[0.000]	[0.000]	[0.001]
ETT_{it}	-0.614***	-1.992***	-0.336***	-0.623***	-2.036***	-0.335***	-0.616***	-1.990***	-0.338***
	[0.084]	[0.448]	[0.071]	[0.081]	[0.446]	[0.070]	[0.084]	[0.450]	[0.071]
STT_{it}	-1.485***	-1.938***	-1.025***	-1.471***	-1.962***	-1.014***	-1.482***	-1.934***	-1.020***
	[0.134]	[0.446]	[0.130]	[0.133]	[0.444]	[0.129]	[0.134]	[0.448]	[0.130]
CF_{iit}/K_{iit-1}	-0.003	-0.021**	-0.013	-0.002	-0.021**	-0.013	-0.003	-0.021**	-0.014
	[0.007]	[0.009]	[0.009]	[0.007]	[0.009]	[0.009]	[0.007]	[0.009]	[0.009]
Lev_{it}	0.040***	0.034**	0.048**	0.039***	0.033**	0.047**	0.040***	0.034**	0.047**
	[0.011]	[0.013]	[0.024]	[0.011]	[0.013]	[0.024]	[0.011]	[0.013]	[0.024]
Lag (I_{iit}/K_{iit-1})	0.192***	0.065	0.364***	0.198***	0.066	0.367***	0.191***	0.065	0.363***
	[0.048]	[0.064]	[0.087]	[0.048]	[0.064]	[0.086]	[0.048]	[0.064]	[0.087]
Const.	3.029***	5.261***	2.003***	3.017***	5.345***	1.982***	3.026***	5.252***	1.998***
	[0.300]	[1.146]	[0.278]	[0.295]	[1.140]	[0.276]	[0.299]	[1.151]	[0.278]
Obs.	45,064	22,702	16,005	45,064	22,702	16,005	45,064	22,702	16,005
N. of fixed effects	9,587	5,000	3,937	9,587	5,000	3,937	9,587	5,000	3,937
AR(1)	-7.657	-3.241	-5.362	-7.763	-3.256	-5.419	-7.633	-3.226	-5.361
p-val (AR(1))	0	0.00119	8.22e-08	0	0.00113	6.00e-08	0	0.00108	8.29e-08
AR(2)	-0.136	-1.528	1.162	0.0591	-1.516	1.249	-0.144	-1.544	1.102
p-val (AR(2))	0.892	0.126	0.245	0.953	0.129	0.212	0.885	0.122	0.270
Hansen	174.4	99.79	97.35	170.5	100.2	97.56	173.2	100.1	97.98
p-val	1.04e-09	0.0350	0.0500	3.26e-09	0.0332	0.0486	1.51e-09	0.0336	0.0457

Notes for Table 3 to 6: 1/ $q_{ijt}/(1-\tau_t)$ is physical-only q; $q^*_{ijt}/(1-\tau_t)$ adjusts for the book value of intangible assets, q^{*m}_{ijt} $/(1-\tau_t)$ additionally adjusts for the difference between average and marginal q. 2/ Firm-level variables are winsorized (2 percent) each year. 3/ Intangible intensity is based on the ratio of intangible to total assets of an industry. The cutoff point is the median of all industries. 4/ Large firms are selected each year based on total assets. 5/ Standard errors (in brackets) are clustered at the firm level, *** for p<0.01, ** for p<0.05, * for p<0.1. 6/ AR(1) and AR(2) are tests of first order and second order serial correlation of residuals. The Hansen statistic is a test of overidentification restrictions. 8/ Instrumented variables are Lag (I_{ijt}/K_{ijt-1}), $q_{ijt}/(1-\tau_t)$, q^*_{ijt} $/(1-\tau_t)$, q^{*m}_{ijt} $/(1-\tau_t)$, CF_{ijt}/K_{ijt-1}, and Lev_{jt}. Instruments for the first difference equation are lagged values of instrumented variable. We use the fourth lags and earlier values. Instruments for levels equation are ETT, STT, year, and one lag difference of instrumented variables.

Table 6. Implied Investment Elasticity and the Total Effect of Bonus Depreciation, 2000 to 2004

	Conventional q proxy			q proxy adjusted for the book value of intangible assets					
	Conventional model			Conventional model			Chen & Dauchy model		
	All firms	Intangible intensive firms	Physical intensive firms	All firms	Intangible intensive firms	Physical intensive firms	All firms	Intangible intensive firms	Physical intensive firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Implied price elasticity of I/K									
All Firms	-2.11	-5.51	-1.74	-2.15	-5.63	-1.74	-2.12	-5.51	-1.75
Top 3,500	-1.82	-4.34	-1.68	-1.88	-5.36	-1.44	-1.87	-5.25	-1.47
Top 1,500	-1.50	-3.23	-1.29	-1.71	-5.86	-1.48	-1.67	-5.68	-1.49
Top 500	-1.72	-3.30	-1.08	-1.96	-7.58	-1.81	-1.90	-7.45	-1.74
Total effect on I from 2000 to 2004									
All Firms	1.54%	3.46%		1.56%	3.55%		1.55%	3.46%	
Top 3,500	1.32%	2.56%		1.37%	3.24%		1.36%	3.17%	
Top 1,500	0.96%	1.73%		1.10%	3.23%		1.08%	3.13%	
Top 500	0.95%	1.60%		1.08%	3.75%		1.05%	3.69%	
Implied growth of I from 2000 to 2004									
All Firms	4.6%	10.3%		4.6%	10.5%		4.6%	10.3%	
Top 3,500	3.9%	7.6%		4.1%	9.6%		4.1%	9.4%	
Top 1,500	3.4%	6.1%		3.9%	11.3%		3.8%	11.0%	
Top 500	3.7%	6.2%		4.2%	14.5%		4.1%	14.3%	

Figure 1: Intangible Intensity: Intangible-Intensive Industries

(By 2-Digit NAICS)

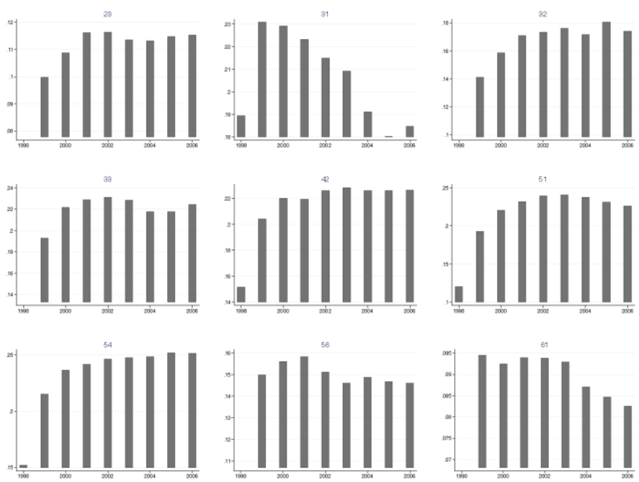
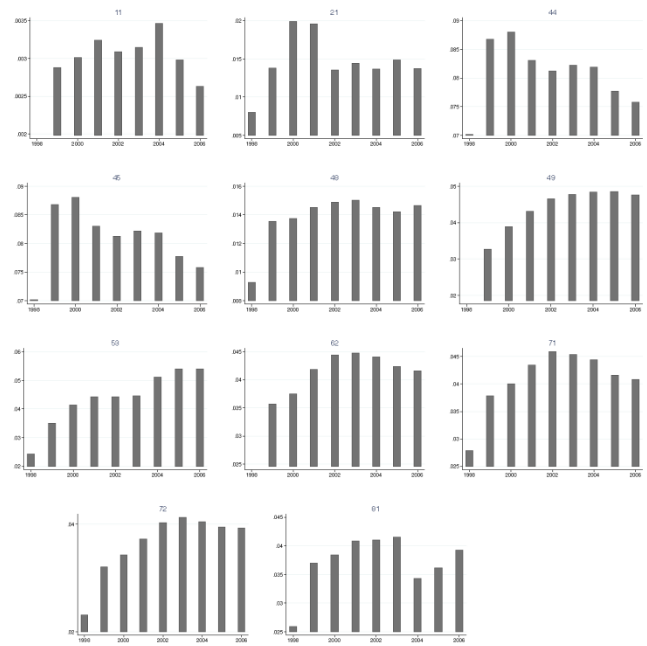


Figure 2: Intangible Intensity: Physical-Intensive Industries

(By 2-Digit NAICS)



See Appendix Tables A3 for industry lists

Figure 3: Physical-Only Q, Mean, Median, and IQR

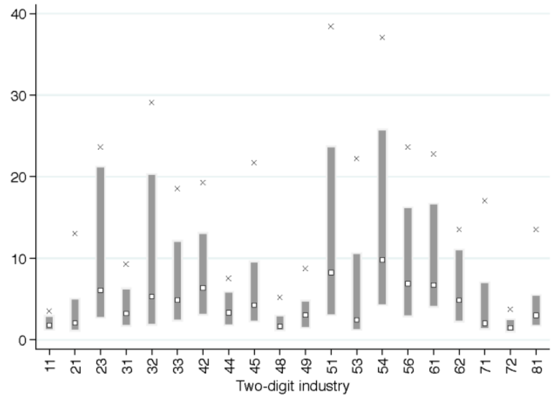


Figure 4: Intangible-Adjusted Q, Mean, Median, and IQR (Average Q, Adjusted for the Book Value of Intangible Assets)

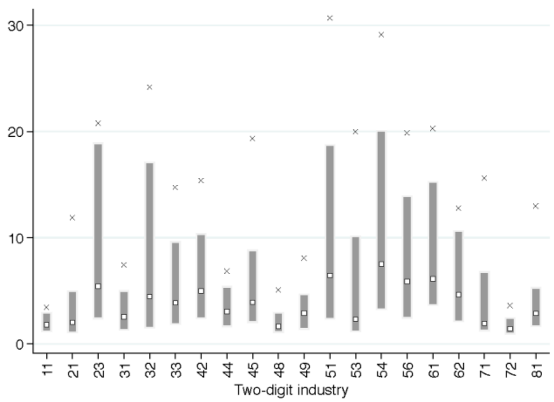
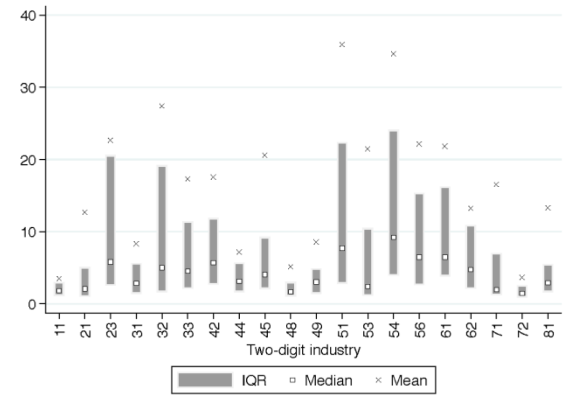


Figure 5: Intangible-Adjusted Q, Mean, Median, and IQR (Marginal Q, Adjusted for the Book Value of Intangible Assets)



ONLINE APPENDIX (NOT FOR PUBLICATION)

A. Measuring the Stocks and Flows of Intangible and Physical Assets

A1. Intangible Assets

We construct intangible assets of US firms following the methodology of Corrado et al. (2005) (hereafter CHS). We extend CHS and construct intangible assets by two-digit NAICS industries from 1998 through 2006. To our knowledge, this data provides the most comprehensive measure of corporate intangible assets to this date for this time period.

The CHS methodology uses various sources for intangible assets, including the Bureau of Economic Analysis (BEA)'s Survey of Current Businesses for intangibles that are included in national NIPA accounts as physical assets (e.g., computer software). Other sources for non-NIPA intangible assets are presented in Table A2.

NIPA aggregate investment and capital stocks are based on data collected from either "establishments" or "companies." In the Industry section of A Guide to the NIPA's, the BEA states that19

> *Establishments are classified into an SIC industry on the basis of their principal product or service, and companies are classified into an SIC industry on the basis of the principal SIC industry of all their establishments. Because large multi-establishment companies typically own establishments that are classified in different SIC industries, the industrial distribution of the same economic activity on an establishment basis can differ significantly from that on a company basis.*

This is very important because multi-establishment corporations (such as Multinational corporations or MNCs) can operate in industries that are radically different from their establishments (or branches); however, corporate tax filings are prepared by the parent company and the corporate group's industry classification is generally that of the parent. For purposes of calculating tax allowances and the welfare impact of corporate taxation, we need to focus on industry classifications from tax filings, which may radically differ from filings in NIPA. Nevertheless, the distribution found in NIPA accounts has at least one advantage over that found in tax filings. Tax filings are based on consolidated returns, including not only domestic corporations and their domestic subsidiaries, but also their foreign subsidiaries. By contrast, NIPA accounts only cover domestic operations. In order to accurately calculate depreciation allowances and the welfare impact of taxation, we are only interested in domestic corporations.

Fortunately, the BEA's Survey of Current Businesses also collects information on the corporate status of the companies surveyed. Corporations—including parents and their subsidiaries—file tax returns separately from their owners. By contrast, non-corporate businesses (such as partnerships) do not pay the corporate tax. Since our focus is on the corporate sector, we start by

[19] http://www.bea.gov/scb/account_articles/national/0398niw/maintext.htm

separating corporate from non-corporate investment. Then we distribute corporate investment across industries based on NIPA accounts by assuming that intangible assets have the same distribution across sectors than equipment and software assets. The latter are obtained from the Bureau of Economic Analysis (BEA)'s current cost net stocks and investments in physical assets (as explained below); however, when industry classification of corporate investment is also available from the IRS/SOI, we use industry-level data from the Internal Revenue Service (IRS/SOI). This is the case for two intangible assets: research and development or R&D spending and advertising.

We recognize that the distribution of investment across industries might still suffer from classification error but we believe that our careful approach greatly reduces this error. To provide evidence that the remaining classification error is not large, we present in appendix table A1 a simple comparison of measuring corporate intangible investment from the corporate part of BEA's Survey of Current Businesses as compared to IRS/SOI Tax Filings for R&D intangibles, which are common to both sources. The table shows that, although the distribution of R&D expenditures across industries is not precisely the same between BEA/NSF accounts and IRS tax filings, the industry ranking and the relative importance (size) of R&D across industries are generally preserved. For example, both in the IRS and the BEA's distributions, the share of R&D spending is the largest for the manufacturing industry, followed by information and finance.

Investment in physical assets is also obtained from BEA's NIPA accounts.

In order to accurately estimate the stock and the depreciation rate of intangible assets, whenever possible, we collect investment in intangible assets over as many years as their economic lives. When investment data in intangible assets is not available for all years, we extend the available data over time based on each industry's growth rate of gross domestic value added, obtained from the BEA.

We obtain data for six broad types of intangible assets, including computerized information, scientific and non-scientific R&D, firm-specific human capital, organizational skills, and brand equity. Table A2 presents in detail our sources for measuring various types of intangible assets, as well as the methodology we use to calculate the part of these assets that generates long-term revenue (and therefore can be considered as investment). CHS (2005) provide more details on the reason why these data provide a comprehensive measure of detailed intangible assets available. The first column shows non-NIPA intangible assets. The second column shows our data sources. The third column defines each intangible asset. Some corporate intangible assets can be directly measured. For other intangible assets, the disaggregation between the corporate and the non-corporate sectors is based on NIPA shares of physical assets between the corporate and the non-corporate sectors, and specified in column 4. This method is also used to separate corporate and non-corporate physical assets within industries (see appendix A2 on physical assets).

Table A3 shows the total value and the average annual growth rate of investment in intangible assets by industry from 1998 to 2006. Over this period, investment in intangible assets amounted to $7.2 trillion, represented about 45 percent of total corporate investment, and grew at an average annual rate of 3.7 percent. Almost 47 percent of this investment was concentrated in 3 industries: finance and insurance, metals, machinery, electronic, electrical, and transportation equipment manufacturing, and information.

To construct the stocks of intangible asset, we use the perpetual inventory method (PIM). The PIM is also used by NIPA accounts to construct the stock of physical assets (Meinen et al. 1998). The net stock of asset in year t and in year t prices is defined as:

$$\text{(A1)} \quad NCS_{t,t} = \sum_{i=0}^{d-1} \left(I_{t-i} * P^{I}_{t-i,t} - \sum_{j=0}^{i} CC_{t-j} \right),$$

where d is the recovery period of the asset, I_t is the amount invested in the asset in current dollars, $P^{I}_{t-i,t}$ is the price index of year t with base year t-i, and CC_t is the consumption of the capital asset in year t. Assuming straight-line depreciation of intangible assets, we have

$$\text{(A2)} \quad CC_t = {}^{1}\!/_{d} * \left({}^{\left(GCS_{t,t} + GCS_{t,t-1}\right)}\!/_{2} \right), \text{ where}$$

$$GCS_{t,t} = \sum_{i=0}^{d-1} I_{t-i} * P_{t-i,t}.$$

Equation (A2) assumes that investment is made throughout the year, while the gross capital stock in year t and in year t prices $(GSC_{t,t})$ is generally obtained in December.

Table A4 shows our assumed values of economic depreciation of various assets. Table A5 shows the total stock of intangible assets over 1998-2006 and the compounded annual growth rate. The stock of intangible assets is about \$10.6 trillion, or 11 percent of total assets, which in relative terms is the much smaller as a share of total assets than investment in intangible assets. The reason is that the initial stock of intangible assets is a small share of total assets (about 7 percent in 1998) and intangible assets depreciate at a faster rate than most physical assets.

<u>Source BEA tables:</u>

BEA value added table: "GDPbyInd_VA_NAICS_1998-2006.xls"- industry value added, gross output and intermediate inputs, and components of value added, in current dollars and corresponding quantity and price indexes (2005=100) for 1998-2006.

A2. Physical Assets

We obtain physical investment by industry and assets from BEA tables. We use the stocks and flows of non-residential (tables 4.1 and 4.7) and residential (Tables 5.1. and 5.7) physical assets by legal form of organization to isolate corporate stock (or investment) in equipment and structures each year. We distribute the corporate amounts of investment and stocks in these broad asset types across detailed asset types, using BEA tables 2.1 and 2.7, which provide detailed stocks and flows of private physical assets for 75 asset types. For each year and each asset, we distribute the resulting corporate stocks and flows across industries, using the 1997 BEA's capital flow data, based on the Survey of Current Businesses.

We obtain one matrix for each year showing the distribution of corporate stocks (or flows) across detailed physical assets and two-digit industries: 9 matrices (one for each year from 1998 to 2006) showing the distribution, across assets and within industries, of industrial corporate physical asset stocks; and 9 matrices showing the distribution, across assets and within industries, of industrial corporate physical asset flows.

MS[ms_a,i,t] = matrix showing total stocks (or levels) ms in physical assets a (a=1-A1), by industry I (i=1 to N) at time t (t=1998-2006). A1 is the number of tangible assets and N is the number of industries.

MF[mf_a,i,t] = matrix showing total investment (or flow) mf in physical assets a (a=1-A1), by industry I (i=1 to N) at time t (t=1998-2006).

Tables A3 and A5 show the total amount of physical assets by type and industry from 1998 to 2006. Total investment in physical assets was $8.8 trillion over 9 years, representing 55 percent of total assets, three fourth of which were in equipment and software. The stock of physical assets was $82.1 trillion over 9 years, or 89 percent of all capital stock, two third of which were in structure assets, due to their longer recovery period.

<u>Source BEA tables:</u>

Table 2.1. Current-Cost Net Stock of Private Physical Assets, Equipment and Software, and Structures by Type

Table 2.7. Investment in Private Physical Assets, Equipment and Software, and Structures by Type

Table 4.1. Current-Cost Net Stock of Private Nonresidential Physical Assets by Industry Group and Legal Form of Organization

Table 4.7. Investment in Private Nonresidential Physical Assets by Industry Group and Legal Form of Organization

Table 5.1. Current-Cost Net Stock of Residential Physical Assets by Type of Owner, Legal Form of Organization, Industry, and Tenure Group

Table 5.7. Investment in Residential Physical Assets by Type of Owner, Legal Form of Organization, Industry, and Tenure Group

Capital Flows: table 4-“NIPAx123EqSoft”-Capital flow table, in purchasers' prices, with NIPA equipment and software categories as rows, with 123 columns of using industries, and table 5-“NIPAx123Struc”-Capital flow table, in purchasers' prices, with NIPA structures categories as rows, with 123 columns of using industries.

A3. The distribution of corporate investment and stock by asset, industry, and over time

Appendix A2 provides two groups of matrices: (i) 9 matrices distributing physical asset stocks by asset and across industries, one for each year from 1998 to 2006, and (ii) the same as (i) for physical asset investment. Appendix A1 provides the stocks and flows of corporate intangible assets over time and by industry, for 6 types of intangible. We update the annual matrices of physical assets from appendix A2 with intangible assets. This provides 9 new matrices (one for each year from 1998 to 2006) showing the distribution, across assets and within industries, of industrial corporate physical and intangible asset stocks, and 9 similar matrices for corporate physical and intangible asset investment flows.

NS[ns_a,i,t] = matrix showing total stocks (or levels) ns in physical assets a (a=1-A2), by industry I (i=1 to Ni) at time t (t=1998-2006), where A2 is the number of physical and intangible assets.

NF[nf_a,i,t] = matrix showing total investment (or flow) nf in physical assets a (a=1-A2), by industry I (i=1 to Ni) at time t (t=1998-2006).

These matrices permit to calculate the weight $w_{i,a,t}$ of each assets stocks (or flows) within industries, which are critical in order to calculate the present value of depreciation allowances of $1 of investment in industry i, as explained in appendix B.

B. Tax

Under JCWAA, a one-year extension of the placement in service deadline was available for certain property with recovery period of 10 years of more and for transportation equipment. Taxpayers who had already filed their 2001 tax returns before this new provision was passed could still take advantage of the bonus depreciation provision by filing an amended return (see bill number H.R. 3090). JGTRRA also increased the relevant threshold for Section 179 property from $25,000 to $100,000. Section 179 was created in and applies to smaller companies. Under this section taxpayers may elect to expense qualifying investment up to a specified limit ($25,000 before 2003). Contrary to bonus depreciation, which applies to newly acquired property, Section 179 only applies to used property. In our baseline regressions we exclude companies potentially affected by Section 179 (about 10 percent of companies in our sample and 0.05 percent of total qualified investment). Excluding them does not affect our findings.

We follow Cummins, Hasset, and Hubbard (1994) and House and Shapiro (2008) to construct the tax terms. The calculation of the present value of tax depreciation allowances takes account of the fact that the periods covering bonus depreciation were not always the same as the calendar year. In this case, the PV of depreciation allowance for a given asset and a given calendar year is calculated as the weighted average of the PV of depreciation allowances available for that year, weighted by the number of days when the policy was effective:

$$DA_a = \left({}^{\#days_1}/_{365} \right) * DA_{a,1} + \left({}^{\#days_2}/_{365} \right) * DA_{a,2},$$

where $DA_{a,1}$ and $\#days_1$ (respectively $DA_{a,2}$ and $\#days_2$) are respectively the present values of depreciation allowances and the number of calendar days when they are available under policies 1 (respectively policy 2). Table A4 shows the PV of depreciation allowances for each asset and under alternative policies effective during 1998-2006. The table below shows the number of effective days of each policy.

Calendar year	MACRS	BD 30%	BD 50%
1998 - 2001	365 or 366		
2002		365	
2003		125	240
2004			366
2005 – 2006	365		

Note: MACRS = modified accelerated recovery system under current law. BD = first-year bonus depreciation allowance. The Job Creation and Worker Assistance Act of 2002 created 30 percent bonus depreciation for qualified capital put in place after September 11, 2001. However, because the Act was passed in March 2002, investors sitting in 2001 did not make their investment decisions based on the reduced asset cost for that year. The Jobs and Growth Tax Relief Reconciliation Act of 2003 provided 50 percent first-year depreciation allowance was for capital put in place after May 28.

For instance, as shown in table A4, the present value of depreciation allowances of software, which has a tax life of 5 years, is 0.933 under 30 percent bonus depreciation and 0.952 under 50 percent bonus depreciation. Because both policies overlap in year 2003, the PV of depreciation allowances of software in 2003 is given by (125/365)* 0.933 +(240/365)* (0.952), or 0.945. The present value of depreciation allowances for each physical asset is calculated based on the applicable MACRS rule, with mid-year convention (IRS, 2010). A discount rate of 5 percent is assumed, which is roughly the average of the rate on 10-year treasury bonds over the 9 years considered. Finally, the present value of depreciation allowances for physical assets in a given industry and a given year $(DA_{i,t})$ is measured as the weighted average of depreciation allowances of each types of physical assets in the industry, weighted by investment in the asset:

$$DA_{i,t} = \sum_{a=1}^{A} w_{i,a,t} * DA_{a,t},$$

where $w_{i,a,t} = {}^{I_{i,a,t}}/_{I_{i,t}}$ is the proportion of investment in asset a and industry i in year t.

As this paper is interested in explaining investment in physical assets, calculations of the tax term of the cost of capital disregard intangible assets, implying that the denominator of

$w_{i,a,t}$ only includes total investment in fixed assets. Using matrix MF from appendix A2, this gives $w_{i,a,t} = {mf_{i,a,t}}/{\sum_{k=1}^{A1} mf_{i,k,t}}$.

Tables A6, A7, and A8 show summary statistics of the equipment tax term and the structures tax terms among the sample of Compustat companies used in our empirical strategy, per year, for all firm and by firms' intangible intensity. Intangible intensity is constructed as a simple dummy equal to 1 if a firm's ratio of (industry-level) intangible stock is above the sample's median in a given year, and zero otherwise. The tax term of each group of assets is $\text{TaxTerm}_{i,t} = \left(1 - DA_{i,t} * \tau / 1 - \tau\right)$, where τ is the statutory top corporate tax rate, and equal to 35 percent over the period considered.

C. Selected summary statistics

We present summary statistics of the equipment and structures tax terms (ETT and STT) and of the investment rates, over time and for all companies that are included in our regressions. These statistics are shown in Tables A6 to A8, for all companies and for sub-samples based on intangible intensity, and on firm size. We further describe these statistics in the methodology section and the results section of the main paper.

D. Data Source and Variable Definitions

Price indices (PPI), used to calculate the stock of intangible assets based on the PIM methodology (see above) are obtained from tables 64 ERP. The 10-year federal funds rate, used as a proxy for the discount rate (see Appendix B) is taken from Board of Governors of the Federal Reserve System, table H.15 (seasonally adjusted).

Firm-level data is from Compustat. Table A.9. gives variable definitions.

E. Proof of Proposition 1

We shall first show that the ex-dividend value of the firm P_t is equal to the value of tangible assets and intangible assets under the assumption of constant return to scale in the production technology and adjustment costs:

$$P_t = q_t^m K_{t+1}^m + q_t^u K_{t+1}^u,$$

where q_t^m and q_t^u are the marginal value of K_{t+1}^m and K_{t+1}^u respectively.

To show this, let V_t denote the cum-dividend market value. V_t is the sum of the firm's ex-dividend market value plus dividend payout:

$$V_t = P_t + D_t, \tag{A3}$$

where dividend D_t is given by

$$D_t = (1-\tau_t)\left(F\left(K^m_{t+s}, K^u_{t+s}, X_{t+s}\right) - \sum_{i=\{m,u\}} \Psi\left(I^i_{t+s}, K^i_{t+s}\right)\right) - \sum_{i=\{m,u\}} \left(1 - \kappa^i_{t+s} - \tau_{t+s}\zeta^i_{t+s}\right) I^i_{t+s}.$$

Profit maximization in (1) implies

$$V_t = E_t\left\{\sum_{s=0}^{\infty} \beta_{ts}\left[\begin{array}{l}(1-\tau_{t+s})\left(F\left(K^m_{t+s}, K^u_{t+s}, X_{t+s}\right) - \sum_{i=\{m,u\}} \Psi\left(I^i_{t+s}, K^i_{t+s}\right)\right) \\ -\sum_{i=\{m,u\}} \left(1 - \kappa^i_{t+s} - \tau_{t+s}\zeta^i_{t+s}\right) I^i_{t+s} + \sum_{i=\{m,u\}} q^i_t\left[\left(1-\delta^i\right)K^i_{t+s} + I^i_{t+s} - K^i_{t+s+1}\right]\end{array}\right]\right\}. \tag{A4}$$

Linear homogeneity of adjustment costs imply $\Psi\left(I^i_{t+s}, K^i_{t+s}\right) = \psi \frac{I^i_{t+s}}{K^i_{t+s}} I^i_{t+s} - \frac{\psi}{2}\left(\frac{I^i_{t+s}}{K^i_{t+s}}\right)^2 K^i_{t+s}$. Using the first order condition (3) gives

$$V_t = {}_t\left\{\sum_{s=0}^{\infty} \beta_{ts}\left[\begin{array}{c}(1-\tau_{t+s})\left(F\left(K^m_{t+s}, K^u_{t+s}, X_{t+s}\right) + \sum_{i=\{m,u\}} \frac{\psi}{2}\left(\frac{I^i_{t+s}}{K^i_{t+s}}\right)^2 K^i_{t+s}\right) \\ + \sum_{i=\{m,u\}} q^i_{t+s}\left[\left(1-\delta^i\right)K^i_{t+s} - K^i_{t+s+1}\right]\end{array}\right]\right\}.$$

Recursively substituting the first order condition (4) gives

$$V_t = (1-\tau_t)\left(F\left(K^m_t, K^u, X_t\right) + \sum_{i=\{m,u\}} \frac{\psi}{2}\left(\frac{I^i_t}{K^i_t}\right)^2 K^i_t\right) + \sum_{i=\{m,u\}} q^i_t\left(1-\delta^i\right)K^i_t$$

Equating (A3) and (A4) and collecting terms gives

$$
\begin{aligned}
P_t &= \sum_{i=\{m,u\}} \left[1 - \kappa_t^i - \tau_t z_t^i + (1-\tau_t)\psi \frac{I_t^i}{K_t^i} \right] I_t^i + \sum_{i=\{m,u\}} q_t^i \left(1-\delta^i\right) K_t^i \\
&= \sum_{i=\{m,u\}} q_t^i \left[I_t^i + \left(1-\delta^i\right) K_t^i \right] \\
&= q_t^m K_{t+1}^m + q_t^u K_{t+1}^u
\end{aligned}
$$

where the first equality follows from the first order condition (3) and the last equality follows from the law of motion (2). Finally, by definition of $q_t = \frac{P_t}{K_{t+1}^m + K_{t+1}^u}$, it follows that

$$q_t = q_t^m \frac{K_{t+1}^m}{K_{t+1}^m + K_{t+1}^u} + q_t^u \frac{K_{t+1}^u}{K_{t+1}^m + K_{t+1}^u}.$$

Q.E.D

APPENDIX REFERENCES

Internal Revenue Service, 2010. "How To Depreciate Property." Department of the Treasury, IRS Publication 946. http://www.irs.gov/publications/p946/index.html.

Meinen, Gerhard, Piet Verbiest, and Peter-Paul de Wolf, 1998. "Perpetual Inventory Method: Service Lives, Discard Patterns, and Depreciation Methods." Statistics Netherlands, Department of National Accounts.

Table A1. R&D Expenditures, By Industry: BEA/NSF vs. IRS/SOI ($ Mil. And % of All Industries) 1/

NSF/BEA	**1998**	**1999**	**2000**	**2001**
FIRE 2/	1,792	1,699	4,172	2,631
	1.2%	1.0%	2.2%	1.3%
Information	10,054	11,633	11,109	12,069
	7.9%	8.7%	9.5%	12.7%
Manufacturing (incl.)	79,475	85,547	96,078	101,099
Chemical manufacturing	16.0%	16.0%	15.6%	16.5%
Computer and electronic product manufacturing	21.4%	19.0%	21.4%	23.2%
Transportation equipment manufacturing	14.2%	14.8%	12.7%	11.6%
--> incl. aerospace	4.4%	3.3%	2.2%	2.2%
IRS/SOI				
FIRE 2/	1,318	1,424	1,612	1,791
	1.2%	1.2%	1.3%	1.5%
Information	12,161	14,908	18,427	25,131
	9.1%	10.1%	9.2%	10.4%
Manufacturing (incl.)	86,428	88,234	92,304	86,279
Chemical manufacturing	25.4%	24.7%	22.0%	23.7%
Computer and electronic product manufacturing	18.5%	18.3%	16.5%	19.1%
Transportation equipment manufacturing	22.0%	20.0%	18.6%	18.7%
--> incl. aerospace	3.2%	2.5%	2.5%	3.1%

Notes: 1/ Sources: IRS/SOI: R&E tax credit claims and U.S. corporate tax returns claiming the credit, by selected NAICS industry; and National Science Foundation (used by the BEA): Table 5.1: Investment in R&D. 2/ Finance, insurance, and real estate.

Table A2 (Part 1) List of Corporate Intangible Assets Not-Included In NIPA Accounts, Definitions and Sources

Type of Intangible Asset	**Source 1/**	**Definition**	**Investment**	**Stock**
			(% of intangible, 1998-06)	
<u>1-Computerized Information</u>				
This only includes development of software because software is included in NIPA since 1998	SAS (see CHS 2005, 2009), and NIPA accounts I-O use tables for industry use. NIPA accounts for the corporate share. 1/	Total revenue from subscription to "Online directories, databases, and other collections of information" from publishers of databases (NAICS 51114); does not include print directories, databases, other collections of information (other media directories, databases, and other).	**0.26%**	**0.25%**
<u>2- Innovative Property</u>			**42.6%**	**61.8%**
2-1- R&D	Internal Revenue Service Form 6567. Corporate share obtained from source.	R&E qualified expenditures reported by corporations. Does not include mineral exploration, because this is included in NIPA.	15.1%	21.90%
2-2- Copyrights and license costs	CHS (2005, 2009) NIPA accounts for the corporate share. 2/	These innovation expenses lead to new copyrights and licenses. Cost of developing original performances or products in the arts and entertainment industry. These costs lead to new copyrights ad licenses. Composed of (1) development costs in the motion picture industry, and (2) in the radio and television, sound recording, and book publishing industries. (No estimate for the arts is included.)		
2-3- Other product development, design, and research expense	Bureau of Economic Analysis (BEA) and accounts and SAS (see CHS 2005, 2009); NIPA accounts I-O use tables for industry use. NIPA accounts for the corporate share. 1/	These costs do not necessarily lead to new a patent or a copyright. This item covers non-scientific R&D in finance and services industries. Includes (i) New product development costs in the financial services industries, crudely estimated as 20 percent of intermediate purchases (from BEA), 3/, (ii) Costs in new architectural and engineering designs, estimated as half of industry revenue for taxable employers in architecture and engineering services (NAICS 5413), including geophysical and mapping surveys, and (iii) R&D in social sciences and humanities, estimated as twice industry revenue for taxable employers in R&D in the social sciences and the humanities (NAICS 54172). 4/	27.5%	39.9%

Table A2 (Part 2 and End). List of Corporate Intangible Assets Not-Included In NIPA Accounts, Definitions and Sources

<u>3- Economic Competencies</u>			**57.2%**	**38.0%**
3-1- Firm-specific human capital	Based on a broad survey of employer-provided training, conducted by the Bureau of Labor Statistics (BLS) in 1994 and 1995. NIPA accounts for the corporate share.	Cost of developing labor force skills	6.94%	5.47%
3-1-1- On the job training cost	BLS and BEA (see CHS, 2005, 200)9. NIPA accounts for the corporate share. 5/	Direct firm expenses (Wages and salaries of in-house trainers, payments to outside trainers, tuition reimbursement, and contributions to outside training funds)		
3-1-2- Payments for job-related education	BLS and BEA (see CHS, 2005, 2009). NIPA accounts for the corporate share. 6/	Tuition payments for job-related education. Wage and salary costs of employee time in formal and informal training.		
3-2- Organizational capital	SAS, and Occupational Employment Statistics (OES) Surveys from the Bureau of Labor Statistics. (see CHS, 2005, 2009). NIPA accounts for the corporate share.	(i) Purchased "organizational" or "structural" capital, estimated using SAS data on the revenues of the management consulting industry, and distributed across industries using BEA I/O use tables, and (ii) Own-organizational skills, estimated as one fifth of the value of executive time using BLS data on employment and wages in executive occupations (OES). 5/	21.6%	17.1%
3-3- Brand Equity			**28.7%**	**15.4%**
3-3-1- Advertising	Internal Revenue Service. Corporate share from the source.	Expenditures on advertising services, from IRS/SOI data on corporate expenses on advertising. 7/		
3-3-2- Market Research	SAS (see CHS 2005, 2009), and NIPA accounts I-O use tables for industry use. NIPA accounts for the corporate share. 1/	Market research for the development of brands and trademarks, estimated as twice industry purchased services (revenues of the market and consumer research industry as reported in SAS), and distributed across industries based on BEA I/O use tables.		

Notes: 1/ Input-Output tables from NIPA over time are used to distribute professional services across industries based on their use. 2/ CHS (2005, 2009) use data from the Motion Picture Association of America (MPAA). 3/ Intermediate purchases for finance industries (NAICS 521,523,525) from BEA's GDP-by-industry data. 4/ SAS, Table 6.1 for professional, scientific, and technical services (NAICS 54). 5/ Estimates for other years were derived from (1) the detail by industry on per employee costs reported in BLS surveys in 1994 (Table 9 for Selected expenditures by industry), and (2) trends in the use of education / educational costs by industry (from BEA I/O use table). 6/ Estimates for other years were derived from (1) the detail by industry on per employee costs reported in BLS surveys in 1994 (Table 11), and (2) trends in aggregate FTE employment by industry (from BEA). 7/ Internal Revenue Service, Returns of Active Corporations (Table 6).

Table A3. Investment (Total) and Average Annual Growth Rate Of Corporate Physical And Intangible Assets (1998 – 2006) ($ Bil.)

	Investment				AAGR			
Industry	Total	Equipment, Software	Structures	Intangibles	Total	Equipment, Software	Structures	Intangibles
Agriculture, forestry, fishing, hunting (11)	$308	86%	12%	2%	0.61%	0.02%	5.14%	1.44%
Mining (21)	543	33.2	57.8	9.0	10.4	4.5	15.2	7.8
Utilities (22)	522.36	51.6	43.2	5.2	5.8	2.0	9.9	5.7
Construction (23)	622.11	67.7	1.4	30.8	(0.4)	(1.6)	4.3	1.9
Food, beverage, tobacco, textile, apparel, leather (31)	577.59	27.5	3.1	69.4	0.5	0.6	5.7	0.4
Wood, paper, printing, petroleum, chemical (32) 1/	1,144	43.4	4.4	52.3	2.1	0.9	5.8	3.0
Metal, machinery, computer, electronic (33) 2/	2,040	38.0	4.2	57.9	1.4	0.9	5.7	1.4
Wholesale (42)	708	33.2	5.1	61.8	2.6	0.1	1.4	4.1
Retail (44, 45)	1,020	25.8	21.6	52.6	1.1	(0.2)	1.4	2.0
Transportation, Couriers and Warehousing (48, 49)	875	77.7	11.1	11.2	1.4	0.1	6.7	0.0
Information (51)	1,969	37.8	8.3	53.9	2.7	0.7	4.3	4.1
Finance and insurance (52)	1,673	25.1	5.6	69.3	5.0	1.8	1.4	6.5
Real estate, rental & leasing (53)	518.49	62.9	14.2	22.8	0.0	(2.7)	1.6	6.2
Professional & technical services (54)	803	49.5	3.5	47.0	3.8	2.8	1.4	4.9
Management of companies & enterprises (55)	246.49	21.9	3.2	74.9	3.7	2.2	1.4	4.3
Administrative & waste services (56)	325.26	48.4	5.2	46.4	2.3	0.9	0.8	3.8
Educational services (61)	303.98	25.0	27.9	47.1	4.5	3.4	4.5	5.3
Health care & social assistance (62)	900	52.2	23.5	24.4	5.7	5.1	5.3	7.5
Arts, entertainment, & recreation (71)	142.25	27.7	40.2	32.2	2.6	1.1	2.5	4.8
Accommodation and food services (72)	570.32	26.5	40.7	32.9	2.9	0.4	2.5	6.3
Other services, excluding public administration (81)	292.7	34.9	34.4	30.8	1.6	(0.9)	0.8	5.6
US Totals	**16,106**	**41.5**	**13.4**	**45.1**	**2.8**	**1.0**	**5.3**	**3.7**

Notes: 1/ Includes plastics, rubber, nonmetallic minerals manufacturing; 2/ includes electrical equipment, transportation equipment, furniture, miscellaneous manufacturing.

Table A4 (Part 1). Rate Of Economic Depreciation And Present Value Of Tax Depreciation Allowances 1/

Physical assets 2/				NPV of tax depreciation allowances		
					Bonus depreciation	
Capital structures category in purchasers' prices	Tax life	Tax method (Declining balance)	Economic depreciation	MACRS	30%	50%
(4), (5), (9) Computers, peripheral, software, office, accounting equipment	5	200	0.312	0.904	0.933	0.952
(6) Communication equipment	5	200	0.15	0.904	0.933	0.952
(7a), (7b) Nonmedical and medical instrument and related equipment	7	200	0.135	0.84	0.905	0.92
(8) Photocopy and related equipment	5	200	0.18	0.904	0.933	0.952
(11) Fabricated metal products	7	200	0.092	0.84	0.905	0.92
(12) Engines and turbines	15	150	0.052	0.694	0.786	0.847
(13) Metalworking machinery	7	200	0.123	0.84	0.905	0.92
(14) Special industry machinery, n.e.c.	7	200	0.103	0.84	0.905	0.92
(15) General industrial, incl. materials, equipment	7	200	0.107	0.84	0.905	0.92
(16) Electrical transmission, distribution & industrial apparatus	7	200	0.05	0.84	0.905	0.92
(18a), (18b) Light and other trucks, buses and trailers	5	200	0.123	0.904	0.933	0.952
(19) Autos	5	200	0.165	0.904	0.933	0.952
(20) Aircraft	7	200	0.11	0.84	0.905	0.92
(21) Ships and boats	10	200	0.061	0.781	0.868	0.89
(22) Railroad equipment	7	200	0.059	0.84	0.905	0.92
(24) Furniture and fixtures	7	200	0.138	0.84	0.905	0.92
(26*) Agricultural machinery, including tractors	7	150	0.145	0.84	0.905	0.92
(27*) Construction machinery, including tractors	5	200	0.163	0.904	0.933	0.952
(28) Mining and oilfield machinery	7	200	0.15	0.84	0.905	0.92
(29) Service industry machinery	7	200	0.165	0.84	0.905	0.92
(30) Electrical equipment, n.e.c.	7	200	0.183	0.84	0.905	0.92
(31) Other nonresidential equipment	7	200	0.147	0.84	0.905	0.92
(33) Residential (landlord durables)	5	200	0.118	0.904	0.933	0.952

Table A4 (Part 2). Rate Of Economic Depreciation And Present Value Of Tax Depreciation Allowances 1/

Physical assets 2/				NPV of tax depreciation allowances		
					Bonus depreciation	
Capital structures category in purchasers' prices	Tax Life	Tax Method (Declining balance)	Economic depreciation	MACRS	30%	50%
(6) Commercial buildings	39	SL	0.022	0.395	0.395	0.395
(11) Hospital and institutional buildings	39	SL	0.019	0.395	0.395	0.395
(12) Other nonresidential buildings, excluding farm	39	SL	0.025	0.395	0.395	0.395
(5) Industrial buildings	39	SL	0.031	0.395	0.395	0.395
(16) Electric light and power	20	150	0.021	0.622	0.811	0.811
(15) and (17) Gas and Telecommunications	15	150	0.024	0.694	0.847	0.847
(21a) Petroleum and natural gas--wells	15	150	0.075	0.694	0.847	0.847
(22) Other mining construction	5	200	0.045	0.904	0.952	0.952
(9), (10) Religious buildings and Educational buildings	39	SL	0.019	0.395	0.395	0.395
(14) Railroads	20	150	0.028	0.622	0.811	0.811
(19) Farm nonresidential structures	20	150	0.024	0.622	0.811	0.811
(23) Other nonresidential non-building structures	39	SL	0.023	0.395	0.395	0.395
(30a) - (32) Single & multi family structures, nonfarm, Manufactured homes	27.5	SL	0.014	0.504	0.504	0.504
(33) Improvements	15	150	0.023	0.694	1	1
(34) Other	27.5	n/a	0.023	0.504	0.504	0.504

Table A4 (Part 3 and end) Rate Of Economic Depreciation And Present Value Of Tax Depreciation Allowances 1/

Physical assets 2/		Tax		NPV of tax depreciation allowances		
	Tax	Method (Declining	Economic Depreciati		Bonus depreciation	
Capital structures category in purchasers' prices	Life	balance)	on	MACRS	30%	50%
Intangible assets 3/						
Computerized Information	n/a	n/a	0.33	1	1	1
Scientific and non scientific R&D	n/a	n/a	0.2	1	1	1
Firm-Specific Human Capital, organizational capital	n/a	n/a	0.4	1	1	1
Brand Equity	n/a	n/a	0.6	1	1	1

Notes: n.e.c. = not elsewhere classified; 1/ The half-year convention is assumed. (i.e., investment is assumed to be installed in the middle of the first year, and therefore depreciates during half of the first year. The present value of tax depreciation allowances is calculated with a discount rate of 6% (approximately equal to the average nominal federal fund rate on 10-year Treasury bonds over the period). Under MACRS, assets with recovery periods above 20 years are depreciated based on straight-line. For assets with recovery periods of 20 years or less, the tax depreciation allowances each year is the maximum between straight line and declining balance. 2/ The numbers in parenthesis preceding asset types are conform to the ones used in BEA physical assets tables. 3/ The rates of economic depreciation of intangible assets are the same as in CHS (2005), except for computerized information, which is based on estimates by Fraumeni (1997).

Table A5. Stock (Total) and Compounded Annual Growth Rate Of Corporate Physical And Intangible Assets (1998 To 2006) ($ Bil.)

	Stock				CAGR			
Industry	Total	Equipment, Software	Structures	Intangibles	Total	Equipment, Software	Structures	Intangibles
Agriculture, forestry, fishing, hunting (11)	3,168	49%	51%	0.29%	3.17%	3.31%	3.03%	5.54%
Mining (21)	4,721	21.5	77.1	1.5	0.7	0.9	1.6	707
Utilities (22)	8,602	23.6	75.9	0.5	0.1	0.6	0.1	17.4
Construction (23)	2,489	79.2	9.9	10.9	0.1	0.3	0.1	31.7
Food, beverage, tobacco, textile, apparel, leather (31)	1,945	52.1	27.3	20.5	0.3	0.4	3.1	1.5
Wood, paper, printing, petroleum, chemical (32) 1/	5,383	56.0	27.7	16.3	0.5	0.8	1.6	6.6
Metal, machinery, computer, electronic (33) 2/	8,757	49.7	29.0	21.3	0.2	0.3	0.6	1.2
Wholesale (42)	2,336	44.6	33.7	21.7	0.1	0.2	0.5	0.6
Retail (44, 45)	6,583	18.4	73.6	8.1	0.4	0.9	1.1	1.3
Transportation, Couriers and Warehousing (48, 49)	8,453	55.2	43.3	1.5	0.1	0.8	0.1	4.6
Information (51)	8,477	39.6	38.4	22.0	3.3	2.3	13.1	84.0
Finance and insurance (52)	5,304	21.7	39.0	39.3	0.2	0.5	0.2	0.7
Real estate, rental & leasing (53)	3,387	43.6	51.9	4.5	0.1	0.3	0.4	0.4
Professional & technical services (54)	2,331	49.7	26.6	23.7	0.4	1.8	0.5	7.8
Management of companies & enterprises (55)	557.84	28.3	31.0	40.8	0.4	0.7	1.3	1.4
Administrative & waste services (56)	1,281	51.8	33.5	14.6	1.3	5.4	4.4	4.3
Educational services (61)	1,921	14.7	76.5	8.8	1.1	2.0	2.8	5.8
Health care & social assistance (62)	6,999	27.9	68.1	4.0	0.3	3.7	0.4	7.6
Arts, entertainment, & recreation (71)	1,374	14.0	81.8	4.1	0.1	0.3	0.2	2.8
Accommodation and food services (72)	5,593	14.6	81.7	3.7	0.6	4.0	0.7	20.2
Other services, excluding public administration (81)	2,967	16.5	79.8	3.7	0.1	0.9	0.2	4.5
US Totals	**92,628**	**36.2**	**52.3**	**11.4**	**0.3**	**2.1**	**0.4**	**8.8**

Notes: 1/ Includes plastics, rubber, nonmetallic minerals manufacturing; 2/ includes electrical equipment, transportation equipment, furniture, miscellaneous manufacturing

Table A6. Selected Statistics for Sample Firms, All Firms (1999 - 2006)

	All N=45,064		Top 3500 N=35,732		Top 1500 N=23,753		Top 500 N=10,691	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ETT_{jt}								
1999	1.161	0.072	1.162	0.071	1.161	0.070	1.160	1.160
2000	1.160	0.072	1.161	0.071	1.161	0.071	1.159	1.159
2001*	1.160	0.071	1.161	0.071	1.161	0.071	1.159	1.159
2002	1.141	0.075	1.142	0.075	1.142	0.075	1.140	1.140
2003	1.137	0.077	1.138	0.076	1.138	0.076	1.136	1.136
2004	1.135	0.078	1.135	0.078	1.135	0.077	1.134	1.134
2005	1.164	0.074	1.164	0.074	1.163	0.073	1.161	1.161
2006	1.167	0.077	1.167	0.076	1.165	0.075	1.162	1.162
STT_{jt}								
1999	1.489	0.045	1.488	0.046	1.489	0.045	1.490	1.490
2000	1.489	0.045	1.488	0.046	1.488	0.045	1.490	1.490
2001	1.489	0.046	1.488	0.046	1.488	0.046	1.489	1.489
2002	1.484	0.055	1.484	0.055	1.484	0.055	1.484	1.484
2003	1.482	0.057	1.483	0.056	1.483	0.056	1.483	1.483
2004	1.481	0.058	1.482	0.058	1.482	0.056	1.483	1.483
2005	1.485	0.051	1.485	0.050	1.486	0.049	1.488	1.488
2006	1.483	0.054	1.483	0.053	1.485	0.051	1.486	1.486
I_{ijt}/K_{ijt-1}								
1999	0.258	0.481	0.257	0.472	0.241	0.444	0.217	0.217
2000	0.337	0.586	0.320	0.551	0.286	0.500	0.258	0.258
2001	0.184	0.239	0.188	0.233	0.181	0.223	0.170	0.170
2002	0.133	0.171	0.134	0.163	0.132	0.156	0.129	0.129
2003	0.130	0.175	0.128	0.166	0.123	0.160	0.115	0.115
2004	0.184	0.325	0.172	0.297	0.160	0.268	0.151	0.151
2005	0.204	0.344	0.193	0.320	0.178	0.284	0.162	0.162
2006	0.230	0.389	0.221	0.369	0.204	0.333	0.199	0.199

Notes: *Although bonus depreciation applied to investment starting in Q4 of 2001, the reduction in the tax price of equipment assets is not reflected in our sample because if dissolves with earlier quarters of the calendar year (which are used for financial statement purposes).

Table A7 Selected Statistics for Sample Firms, Intangible Intensive Firms, From 1999 To 2006

	All N=45,064		Top 3500 N=35,732		Top 1500 N=23,753		Top 500 N=10,691	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ETT_{jt}								
1999	1.138	0.000	1.138	0.000	1.138	0.000	1.138	1.138
2000	1.129	0.013	1.130	0.012	1.130	0.011	1.131	1.131
2001	1.129	0.013	1.130	0.012	1.130	0.012	1.131	1.131
2002	1.108	0.012	1.109	0.011	1.109	0.011	1.110	1.110
2003	1.103	0.012	1.103	0.012	1.104	0.011	1.104	1.104
2004	1.100	0.012	1.101	0.012	1.101	0.011	1.102	1.102
2005	1.129	0.013	1.130	0.012	1.130	0.012	1.131	1.131
2006	1.129	0.013	1.129	0.013	1.130	0.012	1.131	1.131
STT_{jt}								
1999								
2000	1.510	0.000	1.510	0.000	1.510	0.000	1.510	1.510
2001	1.506	0.012	1.506	0.011	1.506	0.011	1.506	1.506
2002	1.506	0.012	1.506	0.011	1.506	0.011	1.506	1.506
2003	1.504	0.015	1.504	0.015	1.504	0.014	1.504	1.504
2004	1.504	0.015	1.504	0.015	1.504	0.015	1.504	1.504
2005	1.504	0.015	1.504	0.015	1.504	0.015	1.504	1.504
2006	1.506	0.011	1.506	0.011	1.506	0.011	1.506	1.506
I_{ijt}/K_{ijt-1}	1.506	0.011	1.506	0.011	1.506	0.011	1.506	1.506
1999								
2000								
2001	0.165	0.297	0.158	0.304	0.141	0.161	0.137	0.137
2002	0.408	0.663	0.384	0.624	0.347	0.581	0.306	0.306
2003	0.187	0.240	0.191	0.233	0.186	0.224	0.179	0.179
2004	0.119	0.148	0.120	0.138	0.119	0.131	0.120	0.120
2005	0.109	0.136	0.108	0.124	0.104	0.118	0.098	0.098
2006	0.157	0.284	0.147	0.250	0.138	0.227	0.134	0.134

Table A8 Selected Statistics for Sample Firms, Physical Intensive Firms, From 1999 To 2006

	All N=45,064		Top 3500 N=35,732		Top 1500 N=23,753		Top 500 N=10,691	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ETT_{jt}								
1999	1.204	0.094	1.203	0.093	1.202	0.092	1.198	1.198
2000	1.206	0.094	1.204	0.093	1.203	0.092	1.197	1.197
2001	1.205	0.094	1.204	0.093	1.203	0.092	1.198	1.198
2002	1.186	0.099	1.186	0.098	1.186	0.098	1.181	1.181
2003	1.226	0.099	1.224	0.098	1.224	0.099	1.220	1.220
2004	1.225	0.100	1.222	0.100	1.221	0.100	1.219	1.219
2005	1.247	0.093	1.245	0.093	1.243	0.094	1.238	1.238
2006	1.250	0.093	1.248	0.094	1.245	0.095	1.240	1.240
STT_{jt}								
1999								
2000	1.465	0.061	1.465	0.061	1.465	0.061	1.467	1.467
2001	1.463	0.062	1.464	0.061	1.465	0.061	1.467	1.467
2002	1.463	0.062	1.464	0.062	1.464	0.062	1.466	1.466
2003	1.456	0.075	1.457	0.074	1.457	0.074	1.458	1.458
2004	1.423	0.078	1.425	0.077	1.425	0.077	1.425	1.425
2005	1.420	0.079	1.422	0.078	1.424	0.077	1.423	1.423
2006	1.430	0.066	1.432	0.065	1.435	0.064	1.436	1.436
I_{ijt}/K_{ijt-1}	1.426	0.067	1.428	0.066	1.432	0.066	1.433	1.433
1999								
2000								
2001	0.218	0.398	0.208	0.351	0.192	0.331	0.180	0.180
2002	0.233	0.429	0.232	0.414	0.204	0.348	0.191	0.191
2003	0.181	0.238	0.184	0.232	0.174	0.222	0.159	0.159
2004	0.154	0.196	0.153	0.188	0.149	0.182	0.141	0.141
2005	0.168	0.216	0.162	0.204	0.158	0.202	0.145	0.145
2006	0.241	0.389	0.228	0.367	0.212	0.335	0.197	0.197

TABLE A9. VARIABLES DEFINITIONS

I_{ijt}/K_{ijt-1}	$= \mathit{capx128}_{ijt} / \mathit{ppeveb187}_{ijt}$ = Investment rate;
q_{ijt}	$= MVA_{ijt} / BVA_{ijt}$ = Physical-only average q;
q^*_{ijt}	$= MVA_{ijt} / BVA_{ijt} * S^m_{jt}$ = Average q adjusting for intangibles in BVA;
q^{*m}_{ijt}	$= MVA_{ijt} / BVA_{ijt} * S^m_{jt} * q\_factor_{jt}$ = Intangible-adjusted marginal q (based on author's model);
MVA_{ijt}	$= \mathit{at6}_{ijt} + (\mathit{csho25}_{ijt} * \mathit{prcc199}_{ijt}) - \mathit{ceq60}_{ijt} - \mathit{txdb74}_{ijt}$= market value of assets;
BVA_{ijt}	$= \mathit{ppeveb187}_{ijt}$ = book value of assets;
BVA^{alt}_{ijt}	$= \mathit{at6}_{ijt}$ = book value of assets (used in the alternative measure of physical-only q);
q_factor_{jt}	$= 1 / \{[S^m_{jt} + \eta_{jt} (1 - S^m_{jt})](1 - \tau)\psi\}$;
η_{jt}	$= [1 - k^u_{jt} - \tau z^u_{jt} + (1 - \tau)\psi(I^u_{jt}/K^u_{jt})]/ [1 - k^m_{jt} - \tau z^m_{jt} + (1 - \tau)\psi(I^m_{jt}/K^m_{jt})]$;
CF_{ijt}/K_{ijt-1}	$= (\mathit{ib18}_{ijt} + \mathit{dp14}_{ijt})/ \mathit{ppeveb187}_{ijt}$ = Ratio of cash flow to capital stock;
Lev_{ijt}	$= \mathit{dltt9}_{ijt} / \mathit{ceq607}_{ijt}$ = Leverage ratio= Value of long-term debt to equity;
ETT_{jt} and	
STT_{jt}	$= (1 - \tau z^m_{jt}) / (1 - \tau)$ = Equipment and structures tax term.

Sources: Compustat and authors' calculations. Observations are at the firm level (subscript i) or industry level (subscript j). Compustat variables are listed as item and item #, where ppeveb (or item 187) = Property, plant and equipment (Ending balance, Schedule V); capx= Capital expenditures; at=Total assets; csho=Common shares outstanding; prcc=Annual price at closing; ceq=Total common and ordinary equity; txdb=Deferred taxes (Balance sheet); ib=Income before extraordinary items; dp=Depreciation and amortization; dltt9=Total long-term debt. All final variables constructed from Compustat are further winsorized at 2 percent at the top and bottom.