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The Efficiency Cost of Asset Taxation in the U.S. after Accounting for Intangible Assets

Estelle P. Dauchy

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Estelle P. Dauchy¹
New Economic School
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Abstract

This paper comprehensively calculates corporate intangible assets by industry from 1998 to 2009, and evaluates the impact of expensing intangible assets on the cost of capital, the METR, and the welfare cost of inter-asset taxation, under current law and alternative tax policy including recent policy proposals. It also estimates the welfare cost of 'leveling the playing field'. I find that capitalizing intangible assets can reduce the METR by up to 28 percentage points in finance. The intangible-inclusive welfare cost of inter-asset taxation is twice as large as a conventional measure under current law, and can be much larger than the tax revenue loss of alternative policy. Leveling the playing field may reduce or increase the deadweight loss of inter-asset taxation. The results provide a valuable input for research estimating the impact of investment tax incentives.

¹ edauchy@nes.ru. New Economic School, Nakhimovsky Prospekt 47, Moscow, Russia 117418.
<http://www.nes.ru/en/home/>

I. Introduction

Two recessions in the last decade and increasing budget deficits have led governments to adopt short and long term fiscal policies aimed at stimulating business investment. Although there is a large literature on the impact of investment tax incentives, estimates of their impact on investment and the economy are increasingly hindered by the growing, yet difficult to measure, size of intangible assets (Nakamura, 2001; Corrado, Hulten, and Sichel, 2005, hereafter CHS). The question of how to account for intangible assets, both for financial and tax purposes is essential for future policy design. Economists traditionally calculate companies' cost of capital based only on physical assets. However, as shown in this paper, when intangible assets are included in the asset mix the variation across firms and industries is significantly altered, which in turns affects the effectiveness of tax incentives to stimulate investment, and their impact on GDP (Fullerton and Lyon, 1988; Robinson and Sansing, 2007).

The first important contribution of this paper is that it measures intangible assets in a comprehensive manner, for the US corporate sector, and by industry. Contrary to CHS (2005) who are the first to develop a comprehensive and detailed measure the aggregate size of intangible assets (at the asset level) as a share of the total economy, I focus on the corporate sector and disaggregate their method at the industry level for each year from 1998 through 2009. The second contribution is to estimate the distortions caused by the differential taxation of assets with or without including intangible assets in the investment mix, under current law and alternative policy. Therefore this paper draws from Fullerton and Lyon (1988), who also estimate the distortions of inter-asset taxation with and without capitalizing intangible assets at the industrial level. However, their

measure of intangible assets is limited in many ways. First, they only include intangible assets that are directly observable from corporate annual reports: research and development and advertising. These only represent 22 percent of total intangible assets and 11 percent of total investment assets. This omission significantly affects both the estimated deadweight loss of inter-asset taxation and its distribution across industries. Second, their measure covers the 1980's, when intangible assets were a much smaller proportion of total investment as compared to the last decade.² This paper re-estimates the deadweight loss of inter-asset taxation by using a comprehensive measure of intangible assets at the industry level. Moreover, this is done for current law and alternative policy, including changes in tax depreciation allowances—such as making permanent the temporary 50 percent tax depreciation allowance, full expensing, and aligning the tax treatment of equipment and structure assets. Last but not least, the results of this paper are very important for any future research that aims at estimating the impact of investment tax incentives based on firm level or industry data. It provides a detailed measure of the change in the cost of capital, marginal effective tax rates, investment and stock of intangible assets, by industry and from 1998 through 2010.

Since the early 2000's, the design of investment incentives has been unprecedented. First, most investment incentives have been temporary—although in effect these have been extended and increased. Second, they have increased inter-physical assets' distortions. In the last decade, Congress has twice passed temporary bonus depreciation of equipment assets and fiscal stimulus has extended their duration:

² Fullerton and Lyon (1988) account for research and development and advertising intangible assets, which represented less than a half of total intangible assets in 1988-90 and less than a third of all intangible assets in 1998-2000 (CHS, 2005). They report that corporate R&D and advertising was about 16 percent of total physical and intangible assets--excluding land and inventory--and 10 percent including land and inventory assets.

firms making new physical investment have benefited from additional tax depreciation allowances for many years, at a rate that has been more generous over time (from 30 percent in 2002 to 100 percent in 2010).³ The purpose of these fiscal incentives has been to spur corporate investment in the short-term by increasing the after tax rate of return on capital investment. However, we still know very little about the effectiveness of these policies. What we know however is that they distort investment decisions, such as the choice between short-lived equipment assets and longer-lived structure assets. Moreover, these fiscal incentives do not take into account that companies simultaneously invest in a more diversified asset mix including not only physical assets but also intangible assets, the latter being nowadays at least as large as physical assets. Intangible assets are generally fully expensed for both accounting and tax purposes.⁴ Therefore, most estimates of the impact of fiscal incentives on investment are likely to be biased due to

³ Bonus depreciation was introduced as a temporary measure in 2002, made retroactive to September 11, 2001. It allowed a 30 percent immediate write-off of qualifying investments (short-lived assets). It was then expanded to a 50 percent write-off in 2003, and expired at the end of 2004. In 2008, it was reintroduced at 50 percent as a temporary provision again under the 'Economic Stimulus Act of 2008', and extended in 2009 by the 'American Recovery and Reinvestment Act of 2009'. In 2010, 50 percent bonus depreciation was expanded under the 'Jobs Act of 2010', to qualifying property purchased and placed in service during the 2010 tax year. Bonus depreciation was expanded again to full expensing under the 'Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act' of 2010, which provides 100 percent depreciation bonus for capital investments placed in service after September 8, 2010 through December 31, 2011. For equipment placed in service after December 31, 2011 and through December 31, 2012, the bill provides for 50 percent depreciation bonus. It is worth noting that Bonus depreciation does not benefit firms with \$500,000 or less in investment, since Section 179 already allows full expensing for these firms. Contrary to Section 179, large businesses with more than \$2 million of capital equipment purchases fully qualify for bonus depreciation. Businesses with investment between \$500,000 and \$2.5 million may first use Section 179 first, followed by Bonus depreciation for the part uncovered by Section 179. Another important difference is that Bonus depreciation only applies to new investment, while Section 179 applies to both used and new investment. Therefore, Bonus depreciation is particularly attractive to large businesses and new investment.

⁴ Although most self-created intangible assets are expenses, many purchased intangible assets are amortized. For example, while the Internal Revenue Code (IRC) treats in-process R&D, know-how, and patents as expensed these assets can be amortized (over 15 years, or over the duration of the patent) if it is "exclusive", but expensed otherwise. IRC Sec. 197 provides a broader list of purchased intangible assets that may be capitalized and amortized if exclusive (e.g., trade secrets, computerized information, engineering design, trademarks).

measurement error (Chen and Dauchy, 2013).⁵ Hall recently wrote about economists who measure the return to physical capital as its marginal product based on a parametric model:

“If intangible capital is an important factor of production, the marginal product of physical capital will depend on the quantity of intangible capital. Hence, [...] test for physical capital is contaminated because it ignores intangible capital.” (Hall, 2001)

Intangible assets generally include assets that are not easily quantifiable such as research and development (R&D), investment in social capital, management and organizational skills, the value of branding, the quality of architectural design and artistic skills, all of which produce value to the firm that is likely to last many years. There is very little knowledge about the size of the stock of intangible capital because intangible assets are difficult to identify, quantify, and their economic life is a difficult task.

Estimating the intangible-inclusive deadweight loss of inter-asset taxation based on a comprehensive measure of the size of intangible assets is not an easy task. One needs to know many unobserved information such as the undistorted equilibrium level of capital assets, the undistorted cost of capital, the demand function of companies, and the depreciation pattern of assets. For this reason, few economists have attempted to perform

⁵ Chen and Dauchy (2013) construct a tax-adjusted q-model of investment and show that when firms' investment in both physical and intangible assets depreciate and accumulate over time, conventional models of physical investment mis-measure tax-adjusted q. They show that, under constant returns to scale, a correct measure of 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. They use their model to evaluate the impact of temporary tax incentives in the US since 1998 and find that the measurement error in the q-part significantly affects downward estimated coefficients on the tax parts for large firms. More papers have estimated the efficiency of temporary investment tax policies such as bonus depreciation to spur investment during the post-2001 recession (Desai and Goolsbee, 2004; House and Shapiro, 2008; Dauchy and Martinez, 2008).

⁵ Many papers have estimated the distortion of inter-asset taxation by industry, but parsimoniously based on subsets of intangible assets or for a subset of all corporations (e.g., Fullerton & Lyon, 1988; Roberson and Sansing, 2008).

this task.⁶ Nevertheless, because temporary fiscal policy has been used for many consecutive years, it is important for policy makers evaluate the relative welfare costs of tax policies, including accelerated depreciation of equipment assets under current law (MACRS), recent temporary tax incentives such as bonus depreciation for equipment assets and full expensing of investment assets, and to be aware of the extent to which the conventional exclusion of intangible assets from the investment mix affects the accuracy of these estimates.⁷ In this paper, I show that it is possible to evaluate a range for and compare the welfare costs of different tax policies. To do this, this paper comprehensively measures the size of intangible assets held by corporations in the US.⁸ Summers (1987) notes that the omission of intangible capital is likely to bias the determination of which policy would level the playing field, and points out that such tax reforms are misconceived because, under current law of accelerated depreciation, capital-intensive industries are penalized compared to intangible-intensive industries. In this paper, I also estimate the welfare cost of leveling the playing field between equipment and structures by allowing straight-line depreciation of all physical assets. I find that, contrary to predictions, replacing MACRS by straight-line depreciation of all physical assets would increase the deadweight loss of inter-asset taxation, because it would widen the gap between the tax treatment of fixed and intangible assets.

Many economists have found that intangible assets have taken a quickly increasing share of business investment (Nakamura, 2001; CHS, 2005). CHS (2005,

⁶ Many papers have estimated the distortion of inter-asset taxation by industry, but parsimoniously based on subsets of intangible assets or for a subset of all corporations (e.g., Fullerton & Lyon, 1988; Roberson and Sansing, 2008).

⁷ Permanent full expensing of new investment has been proposed as permanent policy by Rep. Paul Ryan, in his proposal to replace the corporate income tax by a consumption tax called "BCT". See Paul Ryan, "A Roadmap For America's Future (Version 2.0) - The Challenge and the Opportunity", January 2010. <http://www.roadmap.republicans.budget.house.gov/UploadedFiles/Roadmap2Final2.pdf>

⁸ The corporate sector is the population of businesses that are subject to the corporate tax.

2006) are the first that attempt to measure the size of intangible assets in the most comprehensive way for every intangible asset used by businesses, including scientific and non-scientific research and development, as well as firm-specific intellectual and economic assets, such as brand equity and organizational skills. They find that in ten years from 1988 to 1998, the relative size of intangible and physical assets for the US economy as a whole has increased from a ratio of 0.8 to more than unity.

In this paper, I use CHS's comprehensive definition of intangible assets to evaluate the size of corporate intangible assets over time and compare it with NIPA assets. I use data for 52 physical assets and 11 intangible assets, and provide details at the industry and asset levels, with a focus on corporate assets. This enables to calculate the corporate cost of capital under different tax policies, as well as the difference between the conventional cost of capital and the "intangible-inclusive" cost of capital. This also allows evaluating the relative deadweight loss of inter-asset taxation that would result from including or not including non-NIPA (non-depreciated for tax purposes) intangible assets as part of the mix of investment in corporate assets.

This paper is organized as follows. First, I review the recent literature that evaluates the welfare cost of intangible asset taxation, and the literature that measures the size of intangible assets. Then, I present the methodology used to measure the size of corporate intangible assets by industry over time, and relative to physical assets. The fourth section presents the model to calculate the conventional and the intangible-inclusive costs of capital and marginal effective tax rate, and to evaluate the welfare cost of inter-asset taxation. Section five presents the results. The last section summarizes and suggests directions for further research and future tax policy aimed at stimulating

investment.

II. Relevant Literature

This paper belongs to two strands of the literature. It fits the accounting and or finance literature because it measures intangible assets.⁹ It also naturally fits the economics literature interested in evaluating the impact of fiscal policy. Although no paper has comprehensively measured intangible assets specifically for the corporate sector or at the industry level in the US, a few papers have estimated comprehensive measures of business intangible assets for the aggregate US economy, or the sectorial level in other countries.¹⁰

In his Total System of Accounts (TISA), Eisner (1989) finds that in 1981, unaccounted intangible assets represented almost half of the total US stock of capital and land.¹¹ Nordhaus and Tobin (1972) had already noted the significant limitations of GDP as a measure of economic welfare, and developed a Measure of Economic Welfare (MEW) for the United States, based on consumption rather than production.

Based on a direct measure of intangible assets, and an indirect measure using

⁹ The economic literature on intangible assets has largely investigated the impact of including intangible assets on GDP growth, and finds that including intangible assets in national accounts increases labor productivity growth, significantly reduces total factor productivity, increases the role of capital deepening in labor productivity growth at the expense of labor income share (Corrado et al. 2009, Fukao et al., 2009).

¹⁰ Barnes (2010) applies Corrado et al. (2005, 2009)'s methodology to approximate the size of intangible assets relative to physical assets for the services and manufacturing sectors in Australia. He finds that in 2005-06, investment in intangible assets represent between 50 and 65 percent of physical assets, and that the stock of intangible assets has been growing since 1993. Edquist (2011) does the same exercise for Sweden and finds that both sectors invest intensively in intangible assets. Investment in manufacturing however has increased much faster than other sectors since 1995, doubling its size relative to physical assets by 2006. See also Clayton Borgo and Haskel (2008) for a broad sectorial analysis of the contribution of intangible assets to GDP growth in the UK.

¹¹ Eisner (1983) writes "In 1981, TISA's net national product (NNP) was 30 percent more than the BEA's NNP [...]. The differences between TISA and BEA measures of national products relate preponderantly to TISA's inclusion of nonmarket output. [...] TISA picks up a great deal of what may be viewed as capital formation that is not encompassed in the BEA definitions of gross and net private domestic investment. [...] Intangible capital thus came to almost half—47.7 percent—of the total stock of capital and land in 1981, while physical capital amounted to only 41.1 percent and land 11.3 percent." (pp. 49-51).

stock market valuations, Nakamura (2001) estimates the economy-wide size of intangible assets was about \$1 trillion in 2000, suggesting that the size of intangible assets was almost as large as that of physical assets. Hall (2001) finds that in an economy with no rent, the residual value of corporate stocks essentially depends on unobserved intangible assets that are self-created or used by the firm, although not recorded anywhere in its books. Using an adjustment cost model to infer the price of fixed capital, and comparing it to the value of securities, Hall (2001) finds that the market value of intangible assets has become larger than that of physical assets by the 1990s. Using BEA data on corporate profits and physical assets, McGrattan and Prescott (2001, 2005) find that the size of corporate profits is much larger than what can be explained with fixed capital assets. They assign the difference to intangible assets, representing 0.4 percent of GNP in 2000.¹²

CHS (2005) are also interested in measuring the economy-wide size of intangible assets, including all business sectors—incorporated or not. Contrary to Nakamura (2001), their purpose is to cover intangible assets as comprehensively as possible, based on publicly available data and on a comprehensive definition as found in Lev (2001). Their purpose is twofold. On the one hand they provide evidence that in the past decades intangible assets have increased at a much faster pace than physical assets (CHS, 2005). On the other hand, they estimate the impact of including intangible assets on economic growth accounting (CHS, 2006, 2009). They use data from various sources to

¹² The authors also find that at the peak of the 1990s boom, their measure of intangible assets reached 8 percent of GDP (see also Laitner and Stolyarov, 2011). This compares to 12.7 percent of GDP at the peak of the boom for non-residential physical assets. Megna and Mueller (1991) test if the fact that profit rate are dramatically different across industries can be explained by R&D and advertising. They find that adjusting for these intangible assets in capital stocks does not eliminate the wide dispersion across assets. They also show that R&D and advertising represent only about 20 of corporate investment in intangible assets. Gleason and Klock (2006) focus on the company data in the pharmaceutical industry and test the explanatory power of R&D and advertising on Tobin's Q, and find a significant impact.

approximate broad types of intangible assets including scientific and non-scientific R&D, economic competencies, and organizational skills. They find that from 1988 to 2000, the economy-wide size of investment in intangible assets has more than doubled to about \$1.2 trillion.

The methodology defined by CHS (2005) to measure the size of intangible assets has been later applied to other developed countries including Marrano and Haskel (2006) in England, Fukao and Miyagawa (2007) in Japan, Jalava et al (2007) in Finland, and Van Rooijen-Horsten et al (2008) in the Netherlands. This research consistently finds that the size of intangible assets is close or larger to that of physical assets, and represents a significant share of aggregate income.¹³

Fullerton and Lyon (1988) evaluate the deadweight loss of inter-asset taxation after accounting for some intangible assets. The authors focus on R&D expenses and advertising expenses, and the period covered is 1977-1983. Since then, business intangible assets have increased at a faster pace than GDP. Their selected measure of intangible assets represents 11 percent of the total stock of assets used by corporations in 1983. However, they do not include many other intangible assets, such as those identified by Lev (2001) and CHS (2005). Moreover, according to CHS (2005, 2009), scientific R&D and “branding” represented about 30 percent of total intangible assets.¹⁴

¹³ Based on CHS methodology, Marrano and Haskel (2006, 2009) find that in the United Kingdom in 2004, investment in intangible assets was 104 percent of existing business investment, and about 10 percent of GDP. Fukao et al. (2009) find that investment in intangible assets as a share of GDP in Japan has been increasing to about 7.5 percent of GDP in 2006. Jalava et al (2005) find that intangible investment was 9 percent of GDP in 2005 in Finland. Van Rooijen-Horsten et al (2008) find that in 2001-04 investment in intangible assets was 8 percent of GDP in the Netherlands.

¹⁴ Although CHS (2005)’s calculation is about investment while that of Fullerton and Lyon concerns stocks, CHS’s findings suggest that a large share of intangible assets are not included in Fullerton and Lyon (1988). In addition, Fullerton and Lyon do not have access to corporate R&D. Instead they use NSF data on total R&D and assume that R&D expenses are distributed between the corporate and the non-corporate sectors

Nevertheless, Fullerton and Lyon (1988)'s purpose is to estimate the impact of the repeal of the investment tax credit (ITC) and the Tax Reform Act of 1986. They find that the repeal of the ITC increased the intangible-inclusive cost of capital by 18 percent, as compared to 21 percent when intangible assets are excluded.¹⁵ They also find that capitalizing R&D and advertising increases the deadweight loss of inter-asset taxation after the TRA to about ten times its size with a conventional measure with no intangible assets.¹⁶

In the accounting literature, Robinson and Sansing (2008) use data on public corporations over 15 years to compare the tax preference of the immediate deduction of intangible assets to the debt-financing tax preference for physical assets. They find that the *economic* tax rate on investment is about 18 percent in the 1990s when the statutory tax rate was 35 percent, and that the difference between the two rates is equally due to the immediate write-off of intangible investment and the tax preference of debt financing (9 and 8 percentage points respectively).

III. Measuring corporate physical assets and intangible assets

A. Investment

Corporate investment in NIPA physical assets is obtained from the BEA's *Survey of Current Businesses*, and disaggregated between 52 equipment and structures assets using

according to other physical assets. Although this assumption is reasonable, it is also possible to directly obtain the size of corporate R&D expenses by industry from public tax files.

¹⁵ Conventional measures of the cost of capital generally include non-residential physical assets. Because the TRA of 1986 was aimed at being revenue neutral, its total effect on the cost of capital was to increase it by 4.7 percent (intangible-inclusive), compared to 5.3 percent (physical assets only).

¹⁶ For example, after the TRA in 1986, the authors find that the TRA 1986 reduced the deadweight loss of inter-asset taxation from by as much as 96 percent to \$0.4 billion (or 0.1 percent of GNP) before capitalizing R&D and advertising as assets. After capitalizing R&D and advertising these intangible assets, the TRA reduced the deadweight loss of inter-asset taxation by only 68 percent, leaving a much larger welfare cost of \$4.1 billion, (or 0.12 percent of GNP).

BEA's asset flow table in 1997. The disaggregation of intangible and physical assets between the corporate and the non-corporate sector is directly measured whenever possible, or based on annual investment by industry from the corporate sector (i.e. companies paying the corporate tax), obtained from the BEA. The distribution across industries is based on the BEA and the IRS, as described in appendix A1. As shown in the appendix, the methodology used in this paper to distribute investment and stocks of corporations (i.e. companies subject to corporate taxation) across industries closely reflect actual investment given available data, and even if BEA's Survey of Current Businesses covers a different set of companies than IRS's tax returns.¹⁷

Investment in corporate intangible assets by industry is measured comprehensively measured based on multiple data sources. The definition for intangible assets and the sources used to measure them are based on the CHS definition (2005,2009). In this paper, I measure total stocks and flows of corporate intangible assets based on the same definition as CHS (i.e., including both NIPA and non NIPA intangible assets). However, the impact of including intangible assets to the corporate asset mix on the tax-adjusted cost of capital and welfare is evaluated using current law (MACRS) as the baseline, under which NIPA intangible assets benefit from accelerated tax depreciation allowances.¹⁸ This paper focuses on corporate assets, where the corporate sector is defined as companies that are subject to the corporate tax.¹⁹

I identify three broad categories of intangible assets. In each following measure of

¹⁷ See appendix A1 for details.

¹⁸ MACRS provides accelerated depreciation of 5 years to computer software and mineral exploration (see appendix for details, and IRS Publication 946 at <http://www.irs.gov/publications/p946/index.html>).

¹⁹ Investment is assumed to be equity financed. Therefore the impact of including non-NIPA intangible assets in the evaluation of tax depreciation allowances, and welfare, must be appreciated in relation to its effect on corporate tax payment.

intangible assets, I favor conservative measures so that if the estimated impact on the cost of capital and on welfare is significant, I can be confident that it is a lower bound. In the following, I describe the main assumptions and definitions used in this paper, as well as important differences with previous research. Each category of corporate intangible assets that are not accounted in NIPA accounts, the sources for measuring them, and the breakdown by industry is described in more details in appendix (Table A2). Importantly, CHS find that not all intangible assets can be considered as investment. Therefore, this paper uses a similar methodology as CHS (2005, 2009) to proxy for the part of intangible assets that should be expensed.²⁰

The first category of intangible assets shown in the appendix includes computerized information that is not included in NIPA accounts. In this paper, computerized information combines this category with NIPA computer software. This category includes computerized databases and directories purchased by companies to publishers. Data are from the Services Annual Survey (SAS) for the annual revenue of List publishers by source, combined with input-output data from the Bureau of Economic Analysis (BEA) in order to measure the industry use of publishers.

The second category covers innovative property, which includes scientific and non-scientific R&D. For scientific R&D, because I am only interested in corporate R&D, I use SOI/IRS data on corporate R&D expenditures that qualify for the R&E tax credit. I recognize that the distribution of intangible assets across industries based on tax returns is very likely to be different from that based on BEA's *Survey of Current Businesses* for many reasons. However, I defend in the appendix that the methodology used in this paper closely reflect the actual distribution of corporate assets based on available data and

²⁰ See appendix A1 for details.

enables a careful, yet imperfect, analysis of the impact of taxation on welfare.²¹ Corporate non-scientific R&D includes copyrights and license costs, as well as other product development, designs, and other research expense not already accounted in scientific and non-scientific R&D. Copyright and license costs are the cost of developing new products by the motion picture industry and by other media industries including radio, television, sound recording, and book publishing. Other non-scientific R&D expenses include the cost of developing new financial products incurred by financial corporations, new architectural and engineering design purchased by corporations as inputs, and R&D expenses used by companies in the social sciences and the humanities as inputs.

The third category of intangible assets consists of workers and managers' economic competencies not already included in innovative activities, and either directly used internally or purchased by firms as professional services. This includes firm-specific human capital (i.e., internal and external costs of improving the skills of a company's workforce), organizational skills of managers and executives, and firm-specific brand equity (e.g., advertising).

From these sources, I obtain a comprehensive measure of investment in intangible

²¹ Corporate scientific R&D includes all qualified R&E reported by companies that file Form 6765. For example in year 2008, it includes the sum of total qualified R&E under section A (regular credit, or line 9 in Form 6765), section B (alternative incremental credit, or line 28 in Form 6765) and section C (alternative simplified credit, or line 53 in Form 6765). Although the actual tax credit allowed for only a portion of qualified expenditures, the data used in this paper include all qualified expenses reported for tax purposes, regardless of whether they generate a tax credit. The reported amount of qualified R&E expenditures is likely to underestimate the actual amount of total research expenditures for many reasons. First, some corporations with qualified R&D expenses may not claim the R&E tax credit even if they are entitled to it (although it is likely that most corporations with significant R&D expenses will claim it). Second, qualified R&E expenditures explicitly exclude some R&D expenditures that are likely to lead to innovation or improvement in current process and products. For example, R&E expenditures that do not qualify for the R&E tax credit include research conducted after the beginning of commercial production and research adapting an existing product or process to a particular customer's need. Qualified R&E expenses do not include other expenses that are likely to lead to innovation or improvement in current process and products, such as surveys and studies, research related to certain internal use computer software, and research in the social sciences and the humanities. Nevertheless, this paper separately account for these R&D items as part of the category of non-scientific R&D expenses.

assets by corporations from 1998 to 2009 and at the industry level.

As shown in table 1, from 1998 to 2009, investment in corporate intangible assets increased by 52.4 percent, or an annual growth rate of 4 percent, to \$1.03 trillions, while investment in corporate physical assets increased by 21.2 percent, or an annual growth rate of 2 percent, to \$1.06 trillions. The largest increase in occurred in finance and real estate industries, in which investment in intangible assets nearly doubled from 1998 to 2009.

<INSERT TABLE 1>

Figure 1 shows that the largest amount of investment in intangible assets is, by decreasing order of the amount of spending, in manufacturing, finance, information, and business services, which cover almost three fourth of total investment in intangible assets. However, the share of intangible assets that is performed by manufacturing has been decreasing over time from 34 percent in 1998 to 26 percent in 2009, while the share in finance has increased from 15 percent of total intangible investment in 1998 to 19 percent in 2009.

<INSERT FIGURE 1>

Figure 2 shows that the ratio of investment in corporate intangible assets to NIPA corporate physical assets has slightly increased over time from 0.8 in 1998 to 1 in 2009. This change has not been symmetric across industries. In four industries—construction, wholesale, finance, and real estate, the ratio of intangible to physical assets increased by more than 50 percent in 11 years. Although not shown in the figure, in finance and construction, the ratio of intangible to physical assets increased by a significant amount during the last year, mostly due to larger reductions in investment in physical assets than

in investment in intangible assets in 2009. The greatest increase was in real estate, also due to a large reduction of real estate investment in physical assets during the recent financial crisis.

<INSERT FIGURE 2>

For agriculture, utilities, mining, and transportation, the ratio of intangible to physical assets has remained close to zero throughout the period, and has hardly increased for transportation.²² Mining and utility are the only industries where investment in physical assets has actually increased faster than investment in intangible assets.

Figures 3a and 3b show that on average in 2009, more than 50 percent of intangible assets used by corporations included non-scientific R&D (30 percent), brand equity (26 percent), and organizational capital (20 percent). Scientific R&D, and human capital represented respectively 14 percent and 9 percent of total investment in intangible assets. Computerized information, which essentially includes clients and suppliers' directories, represents less than 1 percent of intangible investment by corporations.²³

<INSERT FIGURE 3a>

<INSERT FIGURE 3b>

In 2009, more than three fourth of total investment in non-scientific R&D occurred in finance and insurance and information, with almost half in finance and insurance. This is not surprising because, by definition, this category includes financial products' innovations, innovations in visual and audio media, and business designs. More

²² This is due to the fact that these industries' investment in intangible assets has not been as significant investment in physical assets.

²³ In this study, corporate R&D expenditures are based on qualified R&D expenditures, as defined by the IRS. In practice, qualified R&E represent about 62 to 65 percent of total R&E expenditures (Hall, 1994). Qualified R&E includes "research in the laboratory or for experimental purposes, undertaken for discovering information, technological in nature, application is intended to be useful in the development of a new or improved business component for the taxpayer, whether carried on by the taxpayer or on behalf of the taxpayer by a third party."

than two third of brand equity investment (mainly advertising and market research) occurs in manufacturing, trade, and information, including almost one third in manufacturing alone. The distribution of investment in brand equity has hardly changed over time, with the exception of manufacturing and information, which respectively experienced a reduction and an increase of their industry share of investment in brand equity.

Almost 70 percent of scientific R&D is used in manufacturing, with two third of it used in durable non-metallic goods. Scientific R&D is also used in information (12 percent of the total) and professional services (9 percent of the total). Although computerized information represents a small share of total intangible asset investment, more than 50 percent of it is used in manufacturing non-metallic durables and information, with an increasing use in the information industry.

Organizational capital, which mainly includes management skills, is used by all industries, with a slightly larger share in manufacturing durables such as primary metal and electronic equipment.

The growth of intangible assets from 1998 to 2009 has not benefited all assets proportionately. Surprisingly, of all intangible assets, scientific R&D is the one that experienced the smallest rate of growth, at about 2.3 percent per year on average. This is in spite of larger tax incentives for R&D investment than many other intangible assets. Most purchased R&D is not only fully expensed for tax purpose, but corporations can also claim a tax credit of up to 20 percent of qualified R&D expenditures.²⁴ Brand equity and organizational capital have also increased at a smaller rate than the average annual

²⁴ Although the internal Revenue Code generally treats in-process R&D as expensed, it can be amortized (over 15 years, or over the duration of the patent) if it is “exclusive”, but expensed otherwise (IRC Sec. 197).

growth rate of intangible assets (respectively 3 percent and 2.6 percent respectively for organizational capital and brand equity compared to an average growth rate of 4 percent for all intangible assets).

Two categories of intangible assets have increase much faster than any other intangible assets. The fastest growing category is human capital, at an average annual growth rate of more than 7 percent from 1998 to 2009 (human capital represents less than 10 percent of total intangible assets). The other group of intangible assets that has grown at a faster rate than average is non-scientific R&D, which grew by 5.5 percent annually over the period.

B. Asset stocks

The economic rate of depreciation by asset is taken from Fraumeni (1998) and the BEA (2003) for NIPA physical assets. Few studies have estimated the depreciation rate of intangible assets, probably because of the difficulty to measure them and to assess the use of these assets by different industries. To measure the stock of intangible assets for the whole economy, I use a range of economic rates of depreciation based on previous literature (CHS, 2009, Fullerton and Lyon, 1988, Nadiri and Prucha, 1993; Hall, 2007).²⁵

For computerized information, I use the same economic depreciation as software (0.33). For other non-NIPA intangible assets, I use a rate of economic depreciation of 0.2 for innovative property, 0.4 for firm-specific human capital, and 0.6 for brand equity.²⁶

²⁵ The rates of economic depreciation of physical and intangible assets used in this study and the detailed calculation of the tax depreciation allowances by asset are presented in appendix table A3.

²⁶ Fullerton and Lyon (1988), who focus on R&D and advertising, use smaller (exponential) economic depreciation rates of respectively 0.15 and 0.33. Using data on the manufacturing industry, Nadiri and Prucha (1993) estimate the rate of economic depreciation for R&D as close to 0.12 percent. Pakes and Shankerman (1978) use data on patents to estimate the rate of economic depreciations of knowledge capital in European countries. They find a central estimate of 0.25. They also find that in some European countries, the rate of decay of patents has been decreasing over time (Pakes and Shankerman, 1986).

Estimating the stock of intangible capital is necessary in order to calculate the welfare cost of inter-asset taxation. I use the perpetual inventory method, which has been extensively used by the OECD to estimate the stock of physical assets as well as other literature that has estimated the quantity of business intangible assets (Hall, 2001; Nakamura, 2001). The distribution of the stock of capital in 2009 by asset groups and industry is shown in table 2.

<INSERT TABLE 2>

The conservative choice of the economic rate depreciation of intangible assets presented in this paper implies that the stock of intangible assets was more than eight times smaller than that of physical assets in 2009. Nevertheless, table 2 shows that the stock of intangible assets has more than tripled from \$0.55 trillion in 1998 to \$1.74 trillion in 2009, when the stock of physical assets was nearly \$12.7 trillion, or about 1.7 times its value in 1998. More than 50 percent of the stock of intangible assets is concentrated in manufacturing durables (primary metal and electronics), information, and finance. Finance is the most intangible intensive industry, where the stock of intangible assets is almost half of this industry's stock of total assets. Other intangible intensive industries are business services, information, and wholesale (where the stocks of intangible assets represent respectively 28 percent, 24 percent, and 22 percent of these industries' assets).

IV. Distortions of inter-asset taxation

The first purpose of this section is to measure the conventional cost of capital and compare it to the cost of capital resulting from including intangible assets in the mix of assets (or intangible-inclusive cost of capital). To the extent that tax depreciation is

different from economic depreciation and that there is no market failure in the investment decision both of these costs of capital are distorted. However, this paper shows that the intangible-inclusive cost of capital is closer to the true distorted cost of capital. In the following, I present a partial equilibrium model of a representative company's optimal choice of asset investment. I also present the assumptions used to evaluate the deadweight loss of inter-asset taxation. The model does not distinguish between types of assets (i.e., intangible or not). Nevertheless, it is used to evaluate the distortions of inter-asset taxation before and after capitalizing for intangible assets.

Following Fullerton and Henderson (1989), I assume that the representative company's investment decision is done in successive steps. The first step involves the choice between capital and labor, where capital is a composite of assets. In the second step, the representative company chooses the mix of capital assets. I only consider the second step, assuming that these decisions are independent from each other.

The production function is homogenous of degree one. The demand function for the composite capital input can be represented by the following CES function.

$$(1) \quad K_i = \left[\sum_{a=1}^N \alpha_{ia} K_{ia}^{\sigma-1/\sigma} \right]^{\sigma/\sigma-1},$$

where K_i is the stock of composite capital in industry i , K_{ia} is the stock of capital asset a in industry i . This stock of composite capital includes both fixed and intangible assets.

The constant elasticity of substitution between assets is σ .

The pretax cost of each capital asset a is based on Jorgenson's formula for the cost of capital, given by

$$(2) \quad \rho_a = (r - \pi + \delta_a) / (1 - \tau) (1 + \tau z_a) - \delta_a,$$

where ρ_a is the *net of economic depreciation* pretax cost of capital asset a assumed equal

across industries, δ_a is the rate of economic depreciation of asset, z_a is the present discounted value of tax depreciation allowances for asset a , τ is the corporate tax rate, r is the corporate sector discount rate, and π is the inflation rate. For intangible assets, z_a is equal to one and the net of economic depreciation cost of capital is simply reduced to the real rate of return on capital $r - \pi$. The pretax cost of capital by assets is the pretax rate of return that the company could obtain if it invested the fund elsewhere for the same risk level. The representative company minimizes the total cost of investment represented by

$\sum_{a=1}^N \rho_{ia} K_{ia}$ subject to the constraint in equation (1). The first order condition gives the

following inverse demand functions for each asset, per unit of the composite capital K_i

$$(3) \quad \rho_{ia} = \left(\alpha_{ia} (K_i \rho_i) / K_{ia} [\sum_{k=1}^N \alpha_{ik} (\rho_k)^{1-\sigma}] \right)^{1/\sigma}.$$

The composite pretax cost of capital is given by

$$(4) \quad \rho_i = (\sum_{a=1}^N \alpha_{ia}^\sigma \rho_{ia}^{1-\sigma})^{1/1-\sigma}.$$

It is possible to solve for α_{ia} by combining equation (3) for each asset. This gives:

$$(5) \quad \alpha_{ia} = K_{ia} (\rho_a)^\sigma / \sum_{a=1}^N K_{ia} (\rho_a)^\sigma.$$

We also know from equations (4) and (5) that under all reallocations of assets within industry i , the following equality must hold

$$(6) \quad \rho_{ia}^\sigma K_{ia} = \alpha_{ia}^\sigma K_i \rho_i^\sigma.$$

This equality ensures a constant value of the stock of composite capital under all reallocations of assets.

The welfare cost of inter-asset taxation in industry i is represented by

$$(7) \quad W_i = \sum_{a=1}^N \left| \int_{K_{ia}^*}^{\bar{K}_{ia}} \rho_{ia}(K_{ia}) - \bar{\rho}_i dK_{ia} \right|,$$

where $\bar{\rho}_i$ is the uniform cost capital that ensures the same amount of aggregate stock of capital assets as under current law. By abuse of language, I call this equilibrium cost of capital the *undistorted* cost of capital in industry i .²⁷ At equilibrium, this *undistorted* cost is equal across assets and industries, and can simply be written as $\bar{\rho}_i = \bar{\rho}$ for all i . The *undistorted* stock of capital, \bar{K}_{ia} , represents the amount of capital asset a that would prevail at cost $\bar{\rho}$. K_{ia}^* is the distorted amount of capital asset a under current law.

Combining (3) and (4), equation (7) can be solved as

$$(8) \quad W_i = \left| \sum_{a=1}^N \alpha_{ia} K_i \rho_i^\sigma \ln \left(\bar{K}_{ia} / K_{ia}^* \right) - \bar{\rho} (\bar{K}_{ia} - K_{ia}) \right|.$$

We can use (6) and substitute $\frac{\rho_{ia}^{*\sigma} K_{ia}^*}{\rho_i^\sigma}$ for \bar{K}_{ia} in equation (8) to rewrite the welfare cost of inter-asset taxation as

$$(9) \quad W_i = \left| \sum_{a=1}^N \rho_i^{*\sigma} K_{ia}^* \ln \left(\rho_{ia}^* / \rho_{ia} \right)^\sigma + 1 - \left(\rho_i / \rho_{ia}^* \right)^\sigma \right|.$$

No study has estimated the elasticity of substitution across intangible assets. For physical assets, only few studies exist, and they generally do not estimate the elasticity of substitution between the 38 assets listed in NIPA accounts. I follow papers that calibrate general equilibrium models in order to measure the distortion of inter-asset taxation and use a central value of one (Fullerton, 1991; Fullerton and Henderson, 1989; Gravelle, 1982).²⁸

²⁷The *undistorted* cost of capital is calculated as the weighted average cost of capital at the distorted equilibrium (i.e., under current law), weighted by the observed stock of capital across assets. Because this cost of capital still differs from the after-tax rate of return, the size of the capital stock—but not its allocation across assets—is still distorted.

²⁸For sensitivity analysis, I also estimate various values around this central value. However, as a simple Taylor approximation indicates, the deadweight loss of inter-asset taxation should be roughly proportional to the elasticity; therefore it is unlikely that exact calculations would yield a greatly different pattern. Results based on an elasticity of substitution around the central value of one are not presented, but are

V. Results

In this paper, I recognize that most previous studies that estimate the impact of investment incentives use a cost of capital that is overstated, because most corporations use a significant amount of tax-free intangible assets.²⁹ The importance of this measurement error can be large. For example, let's assume that the conventional pretax cost of capital does not change from one year to the next, amounts to 4 percent, and that a company equally invests in physical (taxable) and intangible (tax free) assets. If the ratio of intangible assets to physical assets doubles, the intangible-inclusive cost of capital decreases by 50 percent during the year, while the conventional measure remains constant. As seen in Dauchy and Chen (2013), this measurement error can generate large biases in estimates of the tax elasticity of investment.

In this paper, I calculate the cost of capital over time and under different tax policy, including current law (MACRS), a permanent 50 percent bonus depreciation, and full expensing of equipment assets.³⁰ The conventional cost of capital is compared to the intangible-inclusive cost of capital for each industry.

Figure 4 shows that the conventional cost of capital, under current law, was 4.48 percent in 2009. Under a 50 percent bonus depreciation provision—which was in effect that year—the conventional cost of capital was 3.8 percent, or 15 percent lower than under current law. Including intangible assets under current law reduces the cost of capital to 3.75 percent. The intangible-inclusive cost of capital under bonus depreciation

available on demand. For a comprehensive review of estimates of the elasticity of substitution, see Klump et al. (2011).

²⁹ Similarly, Hall (2001) recognizes that estimating the return to physical assets based on the market value of firms and the stock of physical assets is incorrect because it omits intangible assets, which are not recorded by companies.

³⁰ The calculator used in this paper to calculate the cost of capital, the METR, and the deadweight loss of inter-asset taxation assumes a constant value over time of the inflation rate and the risk-free rate of return. However, the calculator can be adjusted for actual values.

is 3.4 percent, or 9 percent smaller than under current law. These differences show that the conventional method of calculating the cost of capital can lead to measurement error, which in turn may affect estimates of investment models, such as q-model of investment.³¹

<INSERT FIGURE 4>

Not surprisingly, the difference between the intangible-inclusive cost of capital and the conventional cost of capital is larger in industries that invest a significant share of their total investment in intangible assets (Table 3). In the financial industry, the intangible-inclusive cost of capital is almost 30 percent smaller than the conventional cost of capital. Large differences between the intangible-inclusive and conventional costs of capital also occur in manufacturing, trade, information, and services.

<INSERT TABLE 3>

Another interesting result is that if equipment assets were provided a 50 percent bonus depreciation or full expensing, the difference between the conventional and the intangible-inclusive cost of capital would be much smaller.³² For example, figure 4 also shows that on average across industries, while the ratio of the conventional cost of capital and the intangible-inclusive cost of capital is 1.2 under current law, the same ratio would

³¹ Because of data limitation, previous studies estimate the elasticity of the investment ratio in physical assets with respect to the cost of composite investment, or the firm's q-ratio adjusted for tax preferences (Cummins et al., 2002). Typical empirical specifications regress the investment ratio on average q, depreciation allowances, and firm-specific characteristics such as proxy for liquidity constraints (Edgerton, 2010). However, these specifications are likely to be mis-specified because they ignore intangible assets in corporate investment decisions. Chen and Dauchy (2013) show that under constant returns to scale, physical investment is determined by the after-tax cost of investment and can be expressed as a function of the tax-adjusted marginal value of physical assets (tax-adjusted q). They show that when tax changes are temporary, such as under bonus depreciation, the tax-adjusted q can be approximated from observed market value, tax depreciation allowances, and the share of physical assets. They estimate a tax-adjusted q-model with intangible assets and find that the impact of the equipment and structure tax terms are generally significant and larger than conventional estimates.

³² Temporary investment tax incentives between 1998 and 2011, such as bonus depreciation and full expensing have been given to assets with recovery periods of 20 years or less.

drop to 1.12 under 50 percent bonus depreciation, and to 1.05 under full expensing. A further look at table 3 in conjunction with table 1 reveals that in industries that are both intangible-intensive and where investment in physical assets includes a disproportional share of equipment relative to structures, full expensing would almost completely remove the measurement error in the conventional cost of capital. For example in 2009, 77 percent of investment was made in intangible assets, and the remaining investment in physical assets was intensive in equipment (table 1).³³ Table 3 shows that in this industry the measurement error in the cost of capital that results from excluding intangible assets decreases sharply from 1.1 under current law to 0.22 under full expensing (compared to a reduction of 0.61 under current law to 0.11 under full expensing on average for all industries). However in intangible-intensive industries that are more intensive in structures than average, such as personal services and retail, expensing would only partially offset the measurement error in the conventional cost of capital.

The marginal effective tax rate (METR) is the ratio of the difference between the pretax cost of capital and the after-tax of capital over the pretax cost of capital. Figure 5 shows that under current law in 2009, the corporate METR was 30.6 percent, and has slightly increased since 1998. However, using the intangible-inclusive cost of capital, the METR was half smaller, at 15.6 percent. As shown in table 4, in finance and insurance, which was the most intangible-intensive industry in 2009, the intangible-inclusive METR was 8.25 percent under current law, almost 80 percent smaller than the one based on the conventional cost of capital.

<INSERT FIGURE 5>

³³ The ratio of equipment to structures investment in finance and insurance in 2009 was 5.2, compared to an average of 2.1 (Table 1). Intangible-intensive industries with a high ratio of equipment to structures include manufacturing, wholesale, finance and insurance, business services, and information

<INSERT TABLE 4>

To evaluate the deadweight loss of inter-asset taxation, we still need to know the *undistorted* cost of capital (i.e. the uniform cost of capital that would ensure the same aggregate stock of capital as under current law). With no difference in tax preferences across assets, the pretax rate of return would be the same for all assets. I assume that the final burden of inter-asset taxation falls on productive inputs. Based on the model presented in part 4, with an *undistorted* cost of capital equal to the asset-weighted average of the distorted cost of capital, the difference between the pretax and the after-tax rate of return to investment would be the same under the *undistorted* and the distorted equilibrium, ensuring the same amount of aggregate capital under both equilibrium.³⁴ Under this assumption, the *undistorted* cost of capital is 4.4 percent with a conventional measure of the cost of capital, and 4.2 percent with an intangible-inclusive measure of the cost of capital.

As mentioned in part 3, although this paper comprehensively measures intangible assets, each measure of intangible assets is conservative. I believe that the following estimates of the deadweight loss of inter-asset taxation are lower bounds to actual deadweight losses.³⁵

Figures 6 and 7 show that in 2009, the deadweight loss of inter-asset taxation with conventional calculations of the cost of capital was \$23.7 billion--or 0.19 percent of gross value added--under current law. Including intangible assets in the investment mix

³⁴ This assumption is also used in Fullerton and Lyon (1988). Moreover, if all assets were taxed based on economic depreciation, the pretax cost of capital would simplify to the pretax rate of return, and be equal across assets and industries. Under MACRS, the capital-weighted average cost of capital used in this paper (4.4 percent) is very close to the pretax rate of return (4.6 percent, or $\frac{r}{(1-\sigma)}$).

³⁵ Although he does not provide method to estimate the size of corporate investment in intangible assets, Nakamura (2001) suggests that at least a third of corporate assets are intangible assets.

increases the deadweight loss of inter-asset taxation to \$39.8 billion under current law (0.33 percent of gross value added).

<INSERT FIGURE 6>

<INSERT FIGURE 7>

For purposes of comparison only, it is useful to compare the deadweight loss of inter-asset taxation under current law to what it would be under alternative policy, although this requires ignoring the behavioral effect of tax policy on investment. Nevertheless, this paper estimates a static deadweight loss of inter-asset taxation under bonus depreciation and full expensing of equipment assets for the following reasons. First, this illustrates that aligning the cost of equipment assets to that of intangible assets may not significantly attenuate the deadweight loss of inter-asset taxation in industries that are both intensive in intangible assets and in structures (relative to US average), such as business services and retail. Second, bonus depreciation was in effect in many years during the period analyzed in this paper, and was extended to full expensing in 2010. Although this policy is temporary, recent debates have considered making it permanent, although its impact on the long-term stock of capital assets is unclear.³⁶

One could also consider a hypothetical revenue-neutral reform that eliminates all distortions due to tax depreciation of physical assets by equalizing their effective tax rates. As noted by Summers (1987), such reform appears to completely eliminate the distortion

³⁶ While MACRS is the policy that prevails under current law (i.e., it is permanent), bonus depreciation and expensing are temporary, even if bonus depreciation has been extended many years since 2001. Nevertheless, the cost of capital used in the calculation of the deadweight loss of inter-asset taxation under bonus depreciation and expensing is assumed to be permanent, to provide an illustration of the impact that such permanent policy would have on welfare across industries. Nevertheless, the author recognizes that the true deadweight loss of inter-asset taxation under this permanent policy would be different because of behavioral changes investment choices (affecting the aggregate stock of capital in the long run). Full expensing of investment has also been considered as part of a comprehensive corporate tax reform (Rep. Paul Ryan proposal in 2010, see footnote 5).

of inter-asset taxation only if physical assets are considered, but clearly fails to achieve this objective if intangible assets are capitalized. For this reason, I also estimate the deadweight loss of inter-asset taxation under a policy that would level the playing field between equipment and structures by treating all physical assets the same way for tax purposes. Specifically, I estimate the deadweight loss of inter-asset taxation from providing straight-line depreciation to all physical assets, equipment or structures. This informs whether such a policy would reduce the overall distortion of inter-asset taxation (as compared to MACRS) and, if it does, the potential size of the reduction in the deadweight loss of inter-asset taxation. Moreover, as noted by Summers (1987) the omission of intangible capital prevents an accurate determination of which reform actually levels the playing field. The data set collected in this paper allows an assessment of the extent to which this concern is justified.

Figures 6 and 7 also show that under bonus depreciation, the deadweight loss of inter-asset taxation with conventional calculations of the cost of capital would be \$55 billion--or 0.45 percent of gross value added. This is twice the size of the deadweight loss of inter-asset taxation under current law. Including intangible assets in the investment mix increases the deadweight loss of inter-asset taxation to \$63 billion under current law (0.52 percent of gross value added). Compared to current law, full expensing triples the deadweight loss of inter-asset taxation. Also, including intangible assets in the investment mix further increases the deadweight loss of inter-asset taxation under full expensing to about \$83 billion, or 0.68 percent of gross value added.

Figures 6 and 7 also show that the difference between MACRS and straight-line depreciation of all physical assets (i.e., an example of leveling the playing field across

physical assets) is small. For example, in 2009, and without intangible assets from the investment mix, substituting straight-line depreciation for MACRS would reduce the deadweight loss of inter-asset taxation by \$0.8 billion (or 0.006 percent of gross value added). Nevertheless, interestingly, when intangible assets are included in the mix of assets, substituting straight-line depreciation for MACRS would *increase* the deadweight loss of inter-asset taxation by \$0.9 billion. Although negligible, this increase is contrary to current policy predictions of the effect of leveling the playing field.

Figure 8 shows that the deadweight loss of inter-asset taxation is proportionally larger in industries that use a disproportionate share of the stock of US intangible assets. In 2009, almost half of the total deadweight loss of inter-asset taxation under current law occurred in manufacturing, utilities, and information. It was also significant in industries that use a large share of the total US stock of physical assets such as personal services and manufacturing.

<INSERT FIGURE 8>

Furthermore, excluding intangible assets from the mix of assets under current law leads to a large downward measurement error of the deadweight loss of inter-asset taxation, as compared to capitalizing for intangible assets. For example, figure 9 shows that, in 2009, the intangible-inclusive deadweight loss of inter-asset taxation was more than six times larger than the conventional deadweight loss of inter-asset taxation in finance and insurance, and more than three times larger than the conventional deadweight loss of inter-asset taxation in business services. However, the ratio of the intangible-inclusive to the conventional deadweight losses significantly decreases in most industries under bonus depreciation and under full expensing, because the tax treatment of

equipment assets would be aligned to that of intangible assets. However, in dollar values, the intangible-inclusive size of the deadweight loss of inter-asset taxation under policies that accentuate the differential treatment between equipment and structures (such as bonus depreciation and full expensing) is much larger than under current law. Also, the ratio of the intangible-inclusive deadweight loss of inter-asset taxation under straight-line depreciation over the conventional (i.e., excluding intangible assets) deadweight loss of inter-asset taxation under straight-line depreciation is larger than the same ratio under current law (i.e. under MACRS). This suggests that when intangible assets are not capitalized, the option of leveling the playing field across physical assets by providing straight-line depreciation of all assets for tax purposes would be erroneously estimated as reducing the deadweight loss of inter-asset taxation (as shown in figure 6).

<INSERT FIGURE 9>

Figure 10 shows that the deadweight loss of inter-asset taxation may represent a large share of industrial value added in some industries. For example under current law in 2009, the deadweight loss of inter-asset taxation was 1.4 percent of industrial value added in utility, and almost 1 percent in mining. These industries are particularly intensive in long-lived structure assets.

<INSERT FIGURE 10>

Figures 11 and 12 show that the conventional deadweight loss of inter-asset taxation (i.e., excluding intangible assets from the mix of assets) under current law has increased by 70 percent from 1998 to 2009, or an average annual growth rate of 5 percent. Under current law the intangible-inclusive deadweight loss of inter-asset taxation has more than doubled in the same period, at an average annual growth rate of 7 percent. As a

percent of gross value added, the conventional deadweight loss of inter-asset taxation under current law has only slightly increased over time. However, because investment in intangible assets has increased faster than investment in physical assets, the intangible-inclusive deadweight loss of inter-asset taxation as a percent of gross value added has gained almost ten percentage points from 1998 to 2009.

<INSERT FIGURE 11>

<INSERT FIGURE 12>

VI. Concluding Remarks

Many economists recognize that the exclusion of many intangible assets from companies' composite investment is likely to affect estimated returns to investment. In this paper, I show that this is also true for previous measures of the cost of capital, of the marginal effective tax rate, and therefore of distortions of inter-asset taxation that are derived from it.

This paper comprehensively evaluates the size of intangible assets used by corporations in many industries, from 1998 to 2009. Based on a model in which companies invest in a composite asset, it is possible to evaluate the difference between conventional measures of the cost of capital—which exclude intangible assets in the investment mix--and measures of the cost of capital that includes intangible assets in the mix of assets. This intangible-inclusive cost of capital can then be used to evaluate the welfare cost of inter-asset taxation before and after capitalizing for intangible assets. This paper evaluates the extent of the measurement error that necessarily affects conventional cost of capital, by industry and over time. Given the active use, in the past decade, of temporary investment tax incentives, this paper also compares the accelerated tax depreciation of equipment assets under current law with other tax policies that have been

used since 2000, such as bonus depreciation, enacted 5 times since 2001, and full expensing which the ‘Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act’ of 2010 made effective to large businesses for the 2011 fiscal year. I also estimate the welfare cost of a revenue-neutral option that levels the playing field by allowing all physical assets straight-line depreciation instead of current law MACRS. This policy option is particularly informative since recent policy debates have discussed tax reforms that would increase the tax base and reduce the corporate tax rate.

Almost half of corporate investment in the United States is in intangible assets and has increased at a faster pace than aggregate investment since 1998, at an average of 4 percent per year. Therefore, capitalizing intangible assets significantly affects the cost of capital under current law and other policy. Under current law, the intangible-inclusive cost of capital is 13 percent smaller than the conventional cost of capital, which excludes intangible assets. The measurement error from excluding intangible assets from the cost of capital decreases with tax policy that aligns the tax treatment of equipment assets to that of intangible assets. Under full expensing of equipment, there is almost no difference overall between the intangible-inclusive and the conventional cost of capital, although there is a large variation across industries. Capitalizing intangible assets would reduce the marginal effective tax rate (METR) on new investment by half from its conventional measure to about 16 percent, again with variation across industries. The METR is as much as four times smaller than the conventional METR in the finance and insurance industry.

Even if intangible assets are by nature short-lived, the intangible assets’ intensity of companies subject to the corporate tax (i.e., the ratio of intangible asset stock to the

stock of composite assets) has rapidly increased in all industries. Capitalizing intangible assets under current law would almost double the welfare cost of inter-asset taxation. The deadweight loss (DWL) of inter-asset taxation could be as large as 0.33 percent of GDP under current law, up to 0.68 percent of GDP under full expensing. To evaluate the economic significance of this result, one can compare the loss in tax revenue under bonus depreciation in 2009, estimated as about \$47 billion by the Joint Committee on Taxation (JCT), to the DWL of inter-asset taxation under bonus depreciation, which this paper evaluates at \$63 billion in 2009 after capitalizing for intangible assets, or 30 percent larger than the revenue loss estimated by the JCT. Therefore, the conventional exclusion of intangible assets in the calculation of the welfare cost of taxation can be large, and offset a significant share of the predicted impact of investment tax incentives.

Nevertheless, the measurement error that arises from not capitalizing intangible assets would almost disappear under full expensing, and would significantly decrease under bonus depreciation, and even if the deadweight loss of inter-asset taxation under these policies is large because long-lived structures assets not qualify for tax incentives (accelerated depreciation or full expensing). This result should be kept in mind in future policy design. To the extent that intangible assets are difficult to measure and capitalize, one way to limit the impact of the measurement error from excluding intangible assets on the cost of capital and on measures of distortions of inter-asset taxation is to align the tax treatment of other physical assets to that of intangible assets.

Another very interesting result for current policy debates on corporate tax reform is the finding that when intangible assets are accounted in the mix of assets, leveling the playing field across physical assets (such as straight-line depreciation for all physical

assets) would not necessarily reduce the deadweight loss of inter-asset taxation. This is contrary to current predictions, and is due to the fact that this base-broadening option would increase even more the gap in the tax treatment of physical assets and intangible assets.

Last but not least, one of the greatest contributions of this paper is that it constructs a detailed calculator of the size of most intangible assets used by corporations over time, by industry and by assets. Therefore this paper provides the basis for future research interested in estimating the impact of investment tax incentives that affects the cost of capital. Obviously, with the proactive fiscal policy in which Congress has been engaged since the 2001 recession, and which has taken various forms, there will be a flow of such research in at least the next few years. For example, Chen and Dauchy (2013) estimate the impact of investment incentive from a q-model of investment that allows for intangible assets capitalization and further show that most previous research that has investigated the distortions created by investment tax incentives is contaminated by the fact that many unobserved intangible assets used by firms generate long-term revenue.

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Table 1: Investment in NIPA assets and non-NIPA intangible assets, by industries and type of assets, 1998 and 2009 (in \$billion)

	Total investment	Tangibles		Intangibles	Assets by type (percent of total corporate investment)	
		Total	Equ./ Str.		Total tangibles	Total intangibles
				Total tangibles	Total Intangibles	
1998						
Agriculture	32.0	31.2	8.4	0.8	97.6%	2.38%
Mining	38.4	34.9	0.9	3.5	91.0%	9.01%
Utilities	48.7	46.2	1.3	2.5	94.8%	5.19%
Construction	65.9	44.4	37.6	21.5	67.4%	32.6%
Manufacturing	395.3	169.5	6.9	225.8	40.7%	59.3%
Wholesale	64.9	27.5	6.4	37.4	42.3%	57.7%
Retail	101.9	49.5	1.2	52.4	48.5%	51.5%
Transportation	89.0	80.2	6.0	8.8	93.4%	6.56%
Information	181.4	89.2	5.2	92.2	49.2%	50.8%
Finance and insurance	147.9	50.1	4.2	97.8	33.9%	66.1%
Real estate, rental, leasing	49.3	40.1	5.4	9.2	81.4%	18.6%
Business Services	127.7	63.0	10.2	64.7	45.0%	55.0%
Personal Services	201.7	145.3	1.1	56.5	69.6%	30.4%
S Totals	1544.1	871.0	3.2	673.1	56.4%	43.6%
2009						
Agriculture	32.6	31.7	4.7	0.9	97.4%	2.63%
Mining	96.5	91.4	0.4	5.1	94.7%	5.26%
Utilities	90.8	87.6	0.6	3.2	96.5%	3.52%
Construction	58.1	31.6	18.8	26.4	54.5%	45.5%
Manufacturing	459.3	191.0	4.8	268.3	39.3%	60.7%
Wholesale	85.6	26.3	6.4	59.3	30.7%	69.3%
Retail	113.0	47.1	1.1	66.0	41.6%	58.4%
Transportation	100.1	86.6	2.8	13.6	88.8%	11.2%
Information	243.3	97.1	3.8	146.1	39.9%	60.1%
Finance and insurance	254.4	58.2	5.2	196.3	22.9%	77.1%
Real estate, rental, leasing	45.7	27.9	3.0	17.8	61.1%	38.9%

Table 2: Stock of NIPA assets and non-NIPA intangible assets, by industries and type of assets, 1998 and 2009 (in \$billion)

	Total investment	Tangibles	Intangibles	Assets by type (percent of total corporate investment)	
				Total tangibles	Total intangibles
1998					
Agriculture	301	301	0.60	99.8%	0.20%
Mining	350	347	2.80	99.2%	0.80%
Utilities	777	775	2.06	99.7%	0.27%
Construction	221	204	17.2	92.2%	7.8%
Manufacturing	1,420	1,237	182	86.0%	14.0%
Wholesale	191	162	29.0	84.8%	15.2%
Retail	553	514	38.8	93.0%	7.0%
Transportation	765	757	7.4	98.6%	1.39%
Information	656	577	78.8	88.0%	12.0%
Finance and insurance	356	272	83.9	76.4%	23.6%
Real estate, rental, leasing	301	293	7.3	97.6%	2.4%
Business Services	328	276	52.1	80.6%	19.4%
Personal Services	1,546	1,501	44.5	96.6%	3.4%
S Totals	7,765	7,218	547	93.0%	7.0%
2009					
Agriculture	439	437	1.14	99.7%	0.26%
Mining	911	902	8.73	99.0%	0.96%
Utilities	1,431	1,426	5.35	99.6%	0.37%
Construction	348	305	42.5	87.8%	12.2%
Manufacturing	2,306	1,845	461	80.7%	19.3%
Wholesale	348	272	76.5	78.0%	22.0%
Retail	1,051	980	70.7	93.3%	6.7%
Transportation	1,198	1,179	19.6	96.6%	3.4%
Information	1,266	965	301	76.2%	23.8%
Finance and insurance	921	505	416	54.8%	45.2%
Real estate, rental, leasing	477	452	24.5	94.9%	5.1%
Business Services	643	478	164	72.0%	28.0%
Personal Services	3,064	2,912	151.2	94.8%	5.2%
S Totals	14,403	12,660	1,743	87.9%	12.1%

Table 3: Cost of capital before and after capitalizing for intangibles, by industries and tax policy, 2009 1/

	No intangibles			With intangibles		
	MACRS	BD50%	Expensing	MACRS	BD50%	Expensing
Agriculture	4.25%	3.63%	3.06%	4.22%	3.61%	3.06%
Manufacturing	4.52%	3.71%	3.40%	4.38%	3.65%	3.36%
Utilities	4.23%	3.55%	3.23%	4.16%	3.52%	3.22%
Construction	4.10%	3.54%	3.02%	3.74%	3.36%	3.01%
Manufacturing	4.43%	3.61%	3.03%	3.58%	3.25%	3.01%
Wholesale	4.39%	3.81%	3.23%	3.59%	3.34%	3.10%
Retail	4.54%	4.16%	3.78%	3.75%	3.56%	3.38%
Transportation	4.24%	3.63%	3.09%	4.16%	3.59%	3.08%
Information	4.19%	3.63%	3.13%	3.59%	3.31%	3.06%
Finance and insurance	4.66%	3.99%	3.33%	3.56%	3.34%	3.11%
Real estate, rental, leasing	4.22%	3.71%	3.20%	4.00%	3.58%	3.16%
Business Services	4.56%	3.87%	3.18%	3.70%	3.39%	3.08%
Personal Services	4.58%	4.04%	3.69%	4.10%	3.72%	3.47%
S Totals	4.39%	3.76%	3.25%	3.79%	3.43%	3.14%

Cost of capital net of depreciation allowances, calculated as the weighted average of the cost of capital of each assets. Economic depreciation of tangible assets based on Fraumeni (1997) and House and Shapiro (2008).

Table 4: METR before and after capitalizing for intangibles, by industries and tax policy, 2009

	No intangibles			With intangibles		
	MACRS	BD50%	Expensing	MACRS	BD50%	Expensing
Agriculture	31.44%	18.75%	2.76%	30.61%	18.26%	2.69%
Manufacturing	33.45%	20.38%	15.02%	31.69%	19.30%	14.23%
Utilities	24.48%	14.70%	8.71%	23.62%	14.18%	8.40%
Construction	28.52%	17.06%	0.49%	15.54%	9.29%	0.27%
Manufacturing	26.95%	16.40%	0.74%	10.64%	6.48%	0.29%
Wholesale	33.18%	21.91%	4.91%	10.20%	6.73%	1.51%
Retail	34.45%	27.44%	16.85%	14.35%	11.43%	7.02%
Transportation	29.47%	17.92%	2.84%	26.22%	15.95%	2.48%
Information	28.57%	17.50%	3.57%	11.41%	6.99%	1.43%
Finance and insurance	36.09%	24.32%	5.83%	8.25%	5.56%	1.33%
Real estate, rental, leasing	30.92%	20.77%	5.91%	18.90%	12.70%	3.61%
Business Services	35.08%	22.53%	3.07%	13.21%	8.45%	1.08%
Personal Services	32.99%	26.91%	17.72%	19.88%	16.15%	10.51%
S Totals	30.65%	20.30%	7.35%	15.57%	10.32%	3.74%

Figure 1: Distribution of investment in intangible assets by industry, 1998 and 2009 (percent of total intangible investment)

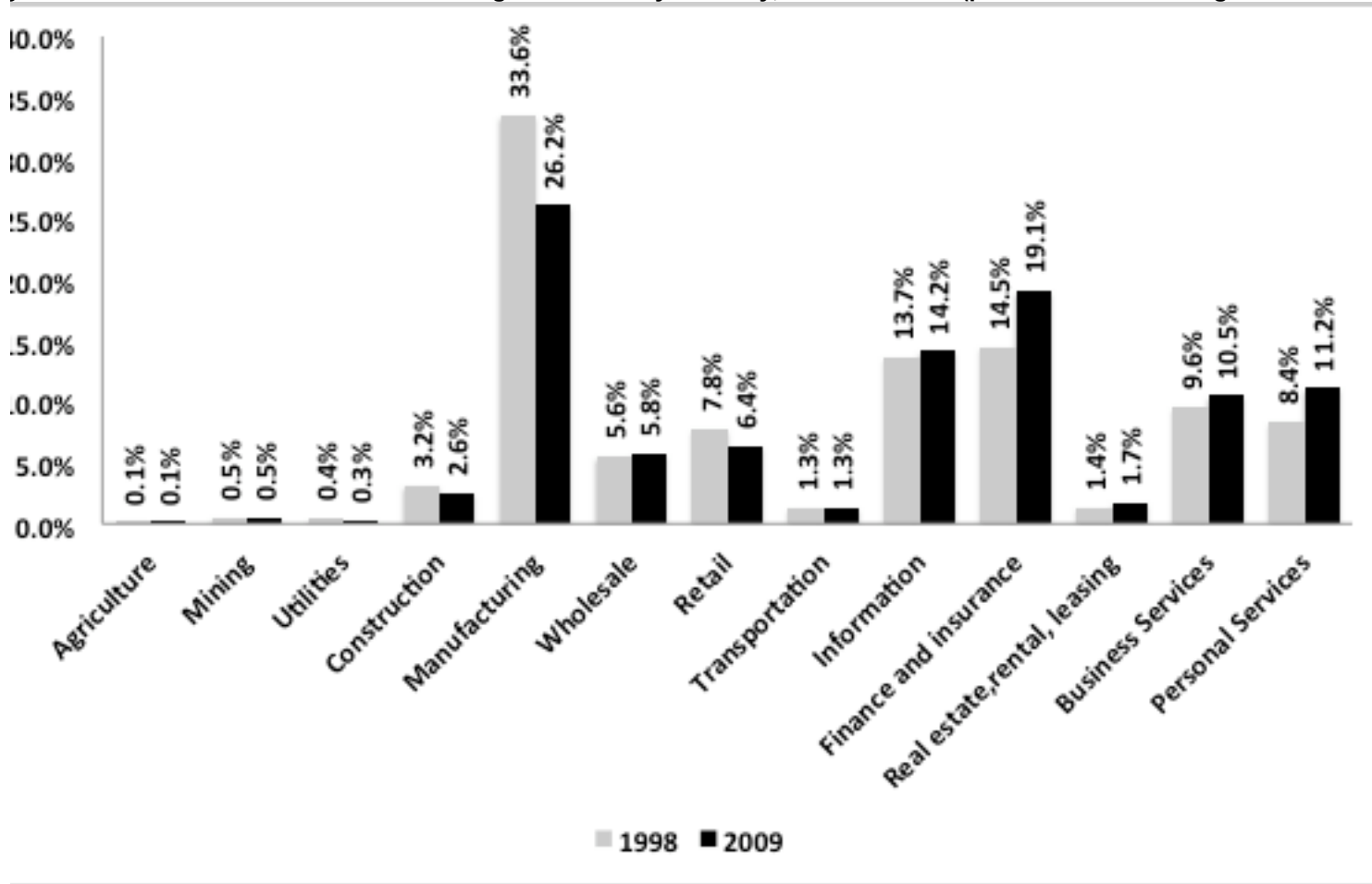


Figure 2: Ratio of non-NIPA intangibles to NIPA assets, by industry, 1998 to 2009

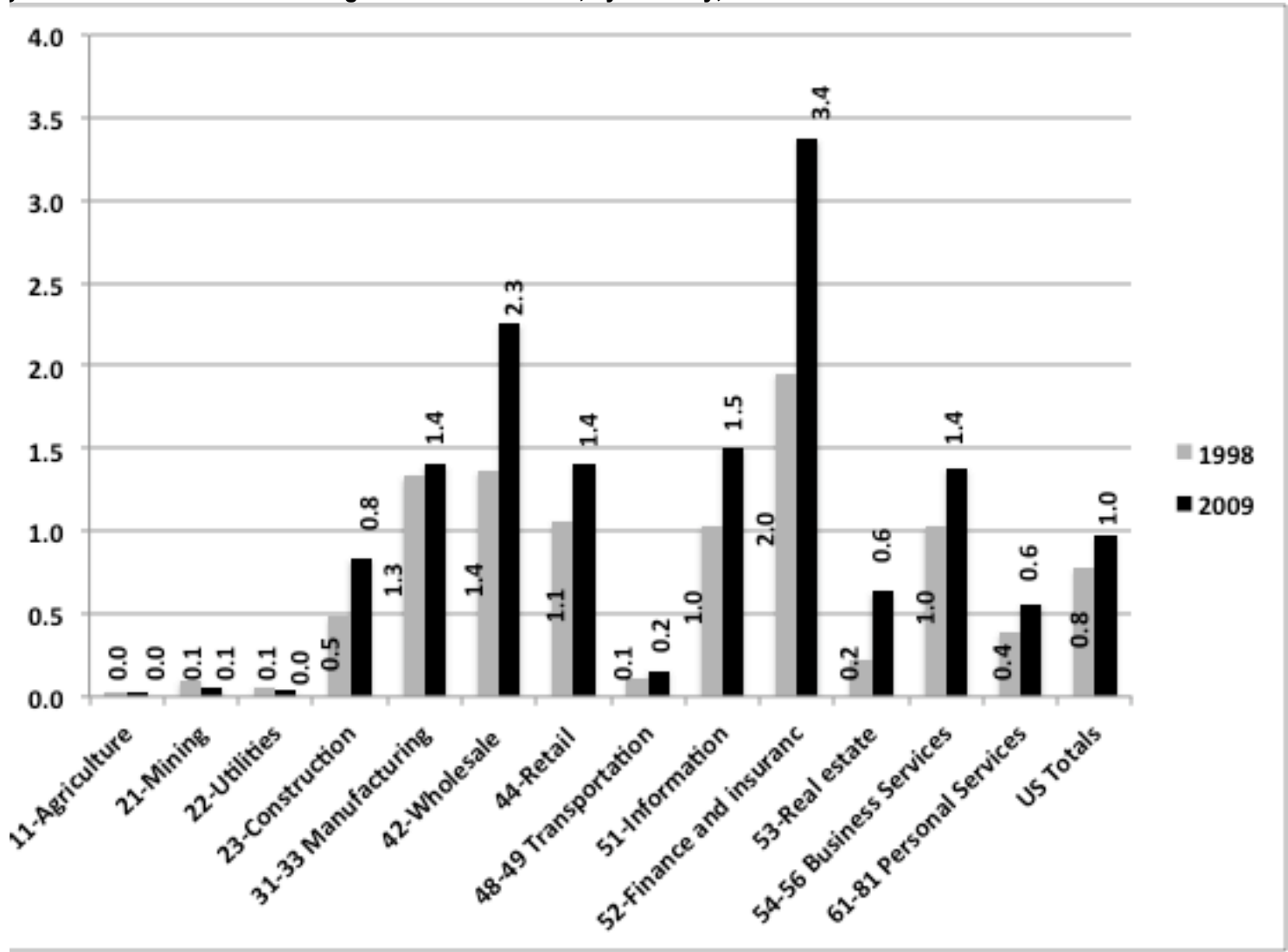


Figure 3a: Investment in intangible assets, by industries and type of assets, 2009 (in % of all intangibles)

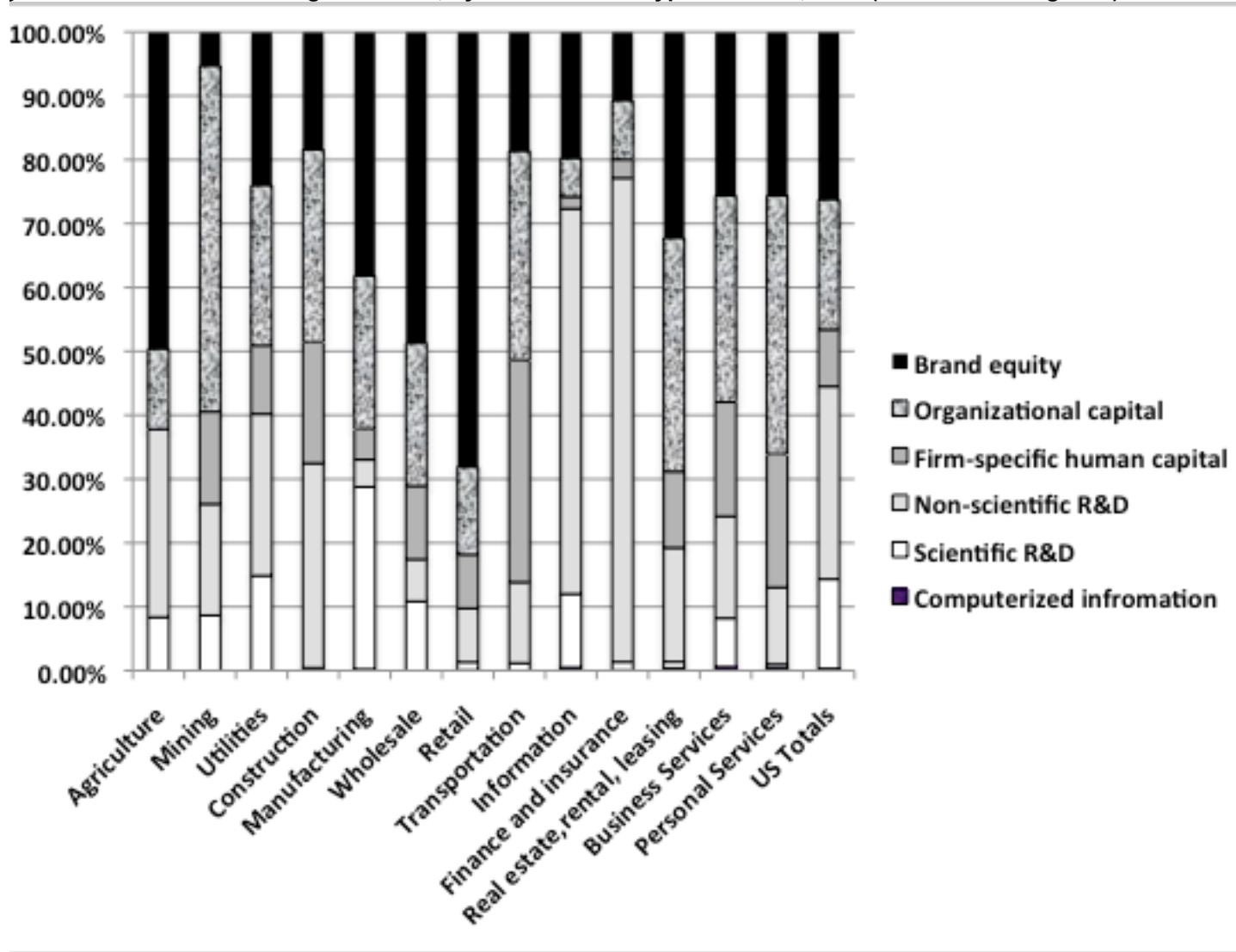


Figure 3b: Investment in intangible assets, by industries and type of assets, 1998 (in % of all intangibles)

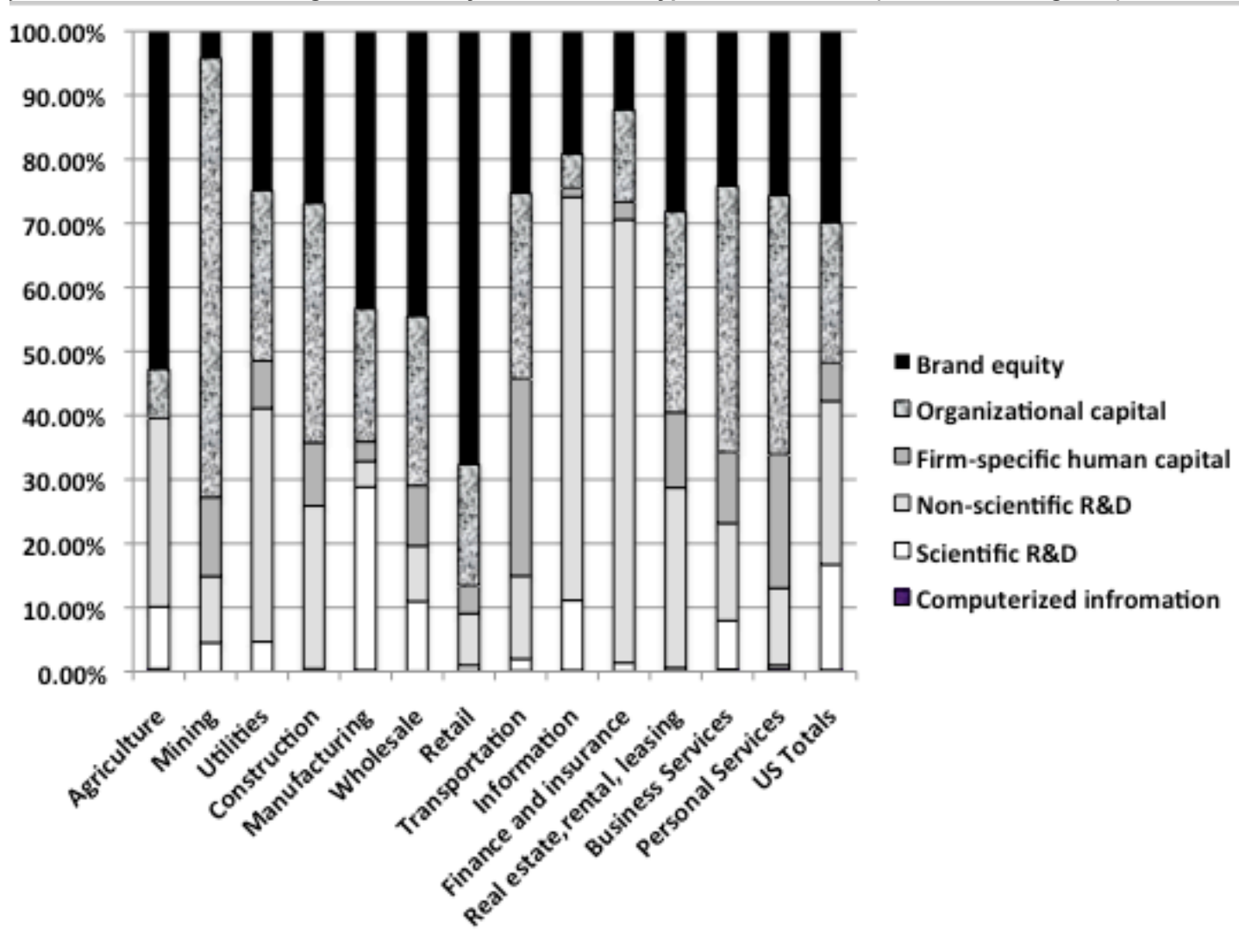
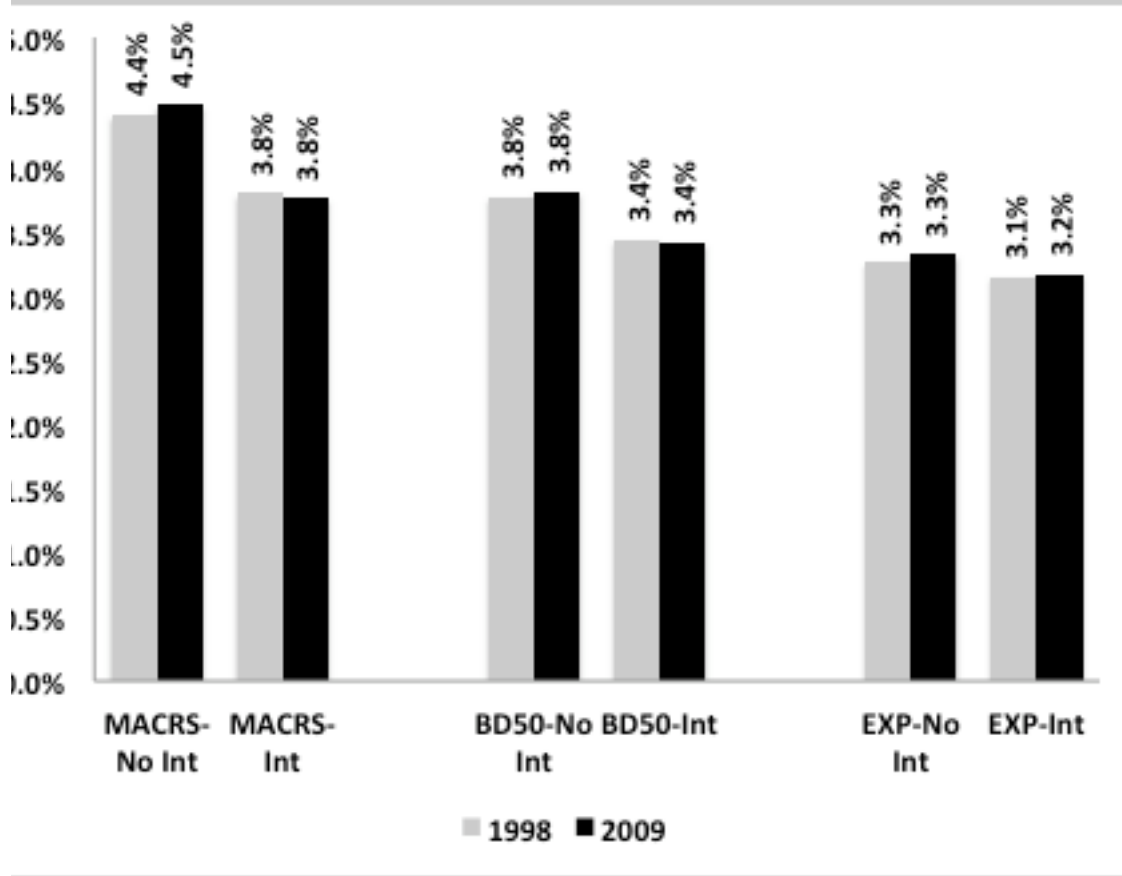


Figure 4: Cost of capital before and after capitalizing for non-NIPA intangible assets, by industries and tax policy, 1998 and 2009 1/



Cost of capital net of depreciation allowances, calculated as the weighted average of the cost of capital of each assets. Economic depreciation of tangible assets is based on Auerman (1997) and House and Shapiro (2008).

Figure 5: METR before and after capitalizing for non-NIPA intangible assets, by industries and tax policy, 1998 and 2009

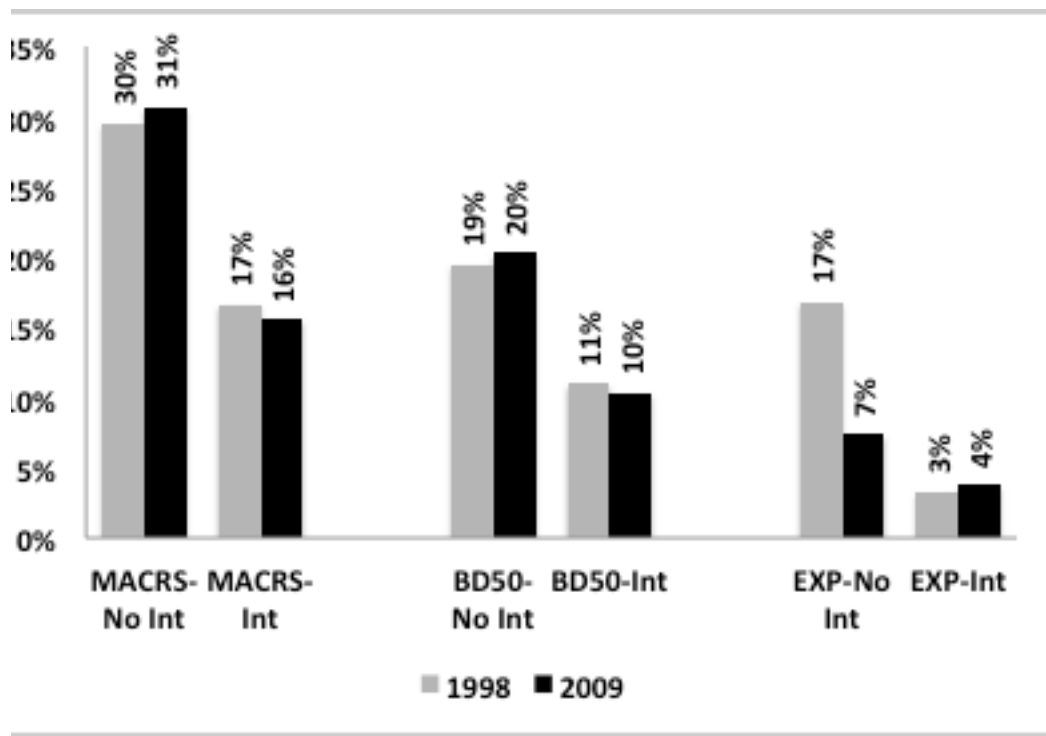
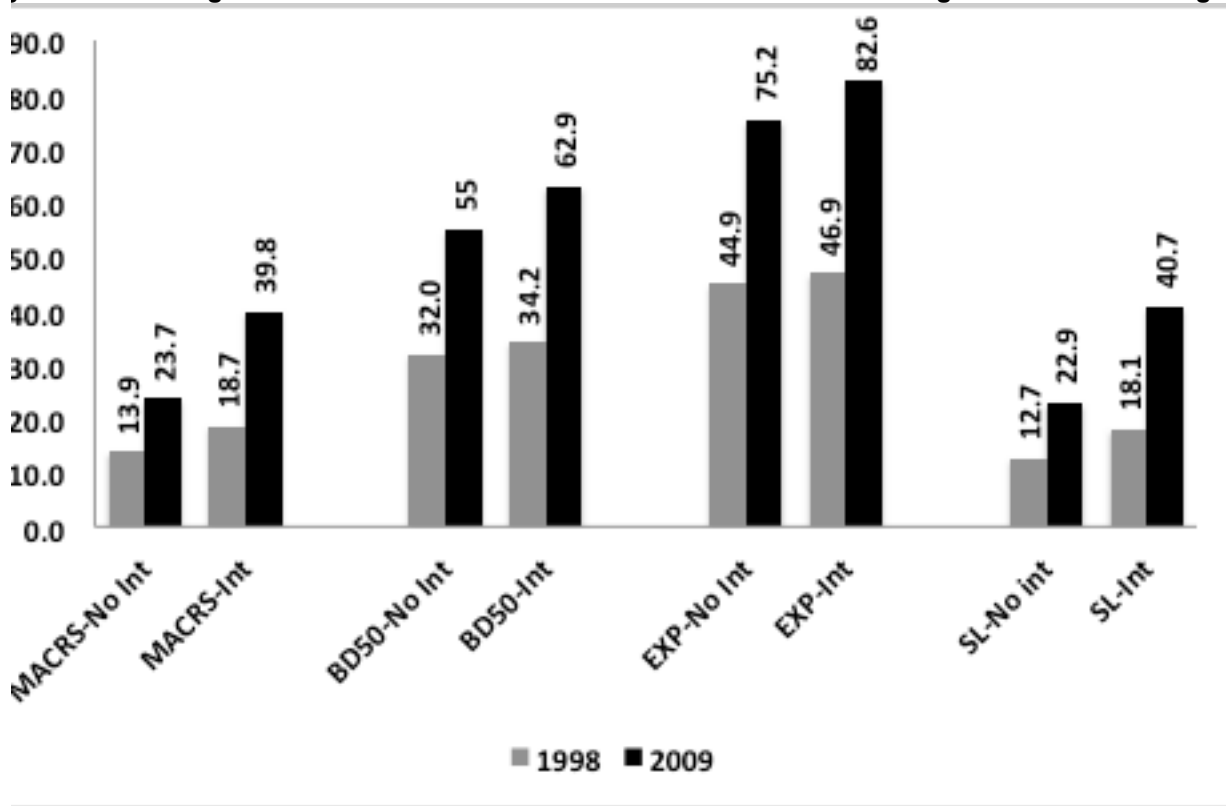
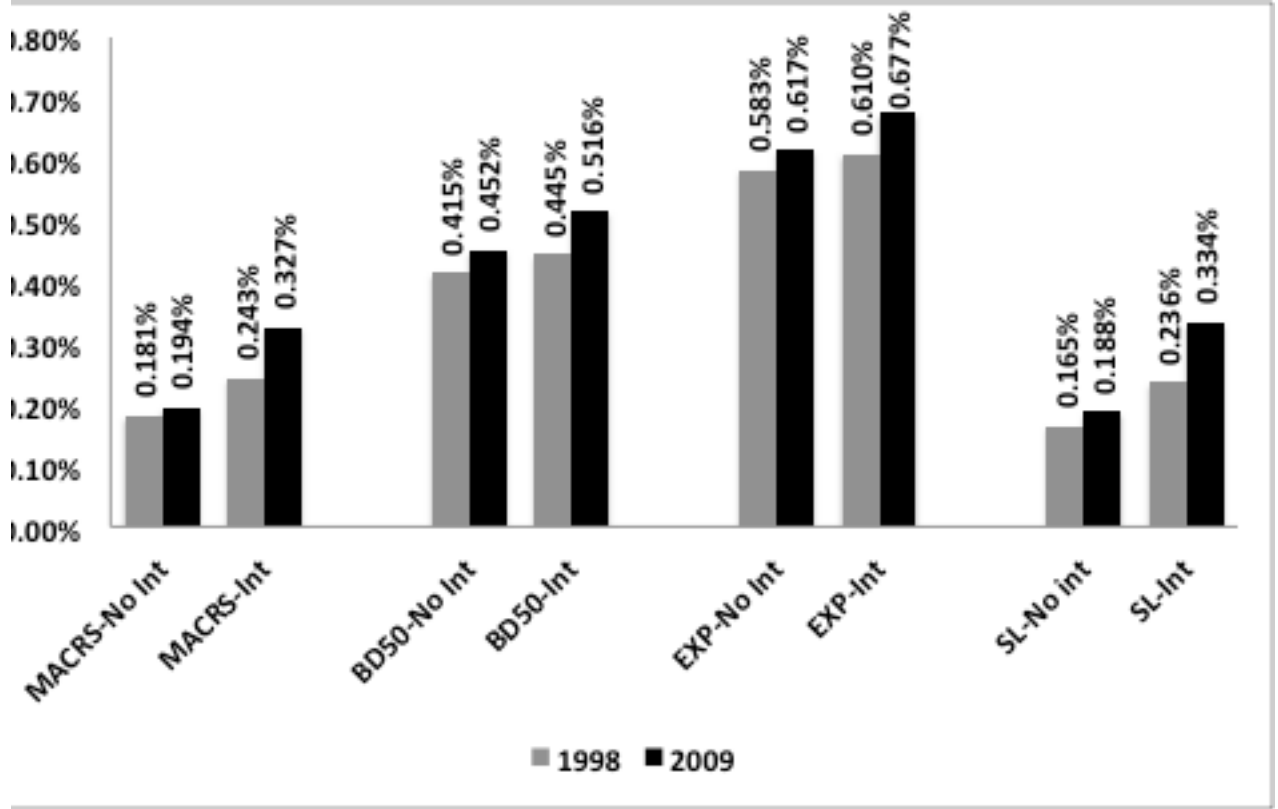


Figure 6: Deadweight loss of inter-asset taxation before and after accounting for non-NIPA intangible assets, by tax policy, 1998 and 2009 (\$ billion) 1/



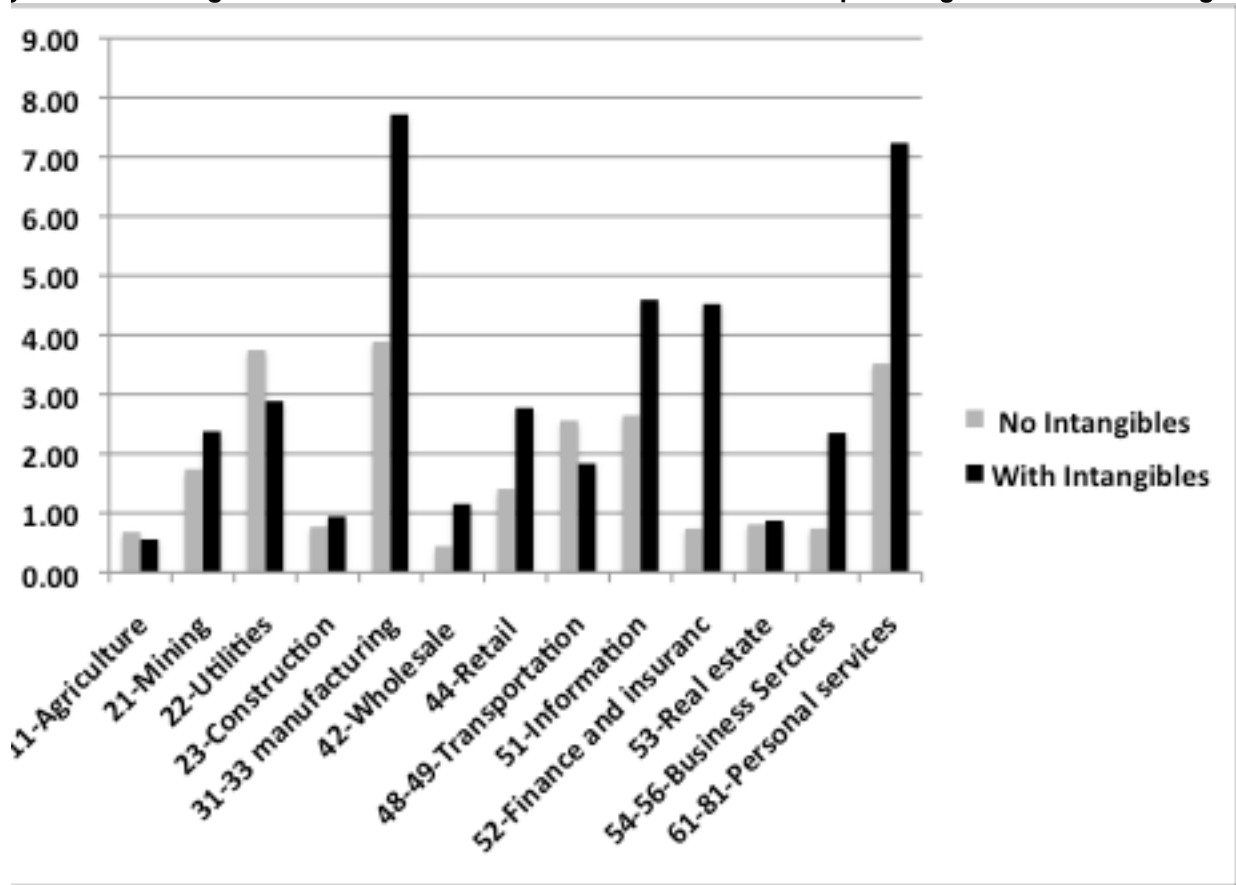
The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets. Four tax policy options are presented without (-No Int) and with (-Int) intangible assets: current law (or MACRS), 50% first-year bonus depreciation (BD50), expensing (EXP), and straight-line depreciation of all fixed assets (SL).

Figure 7: Deadweight loss of inter-asset taxation before and after accounting for non-NIPA intangible assets, by tax policy, 1998 and 2009 (% of GDP) 1/



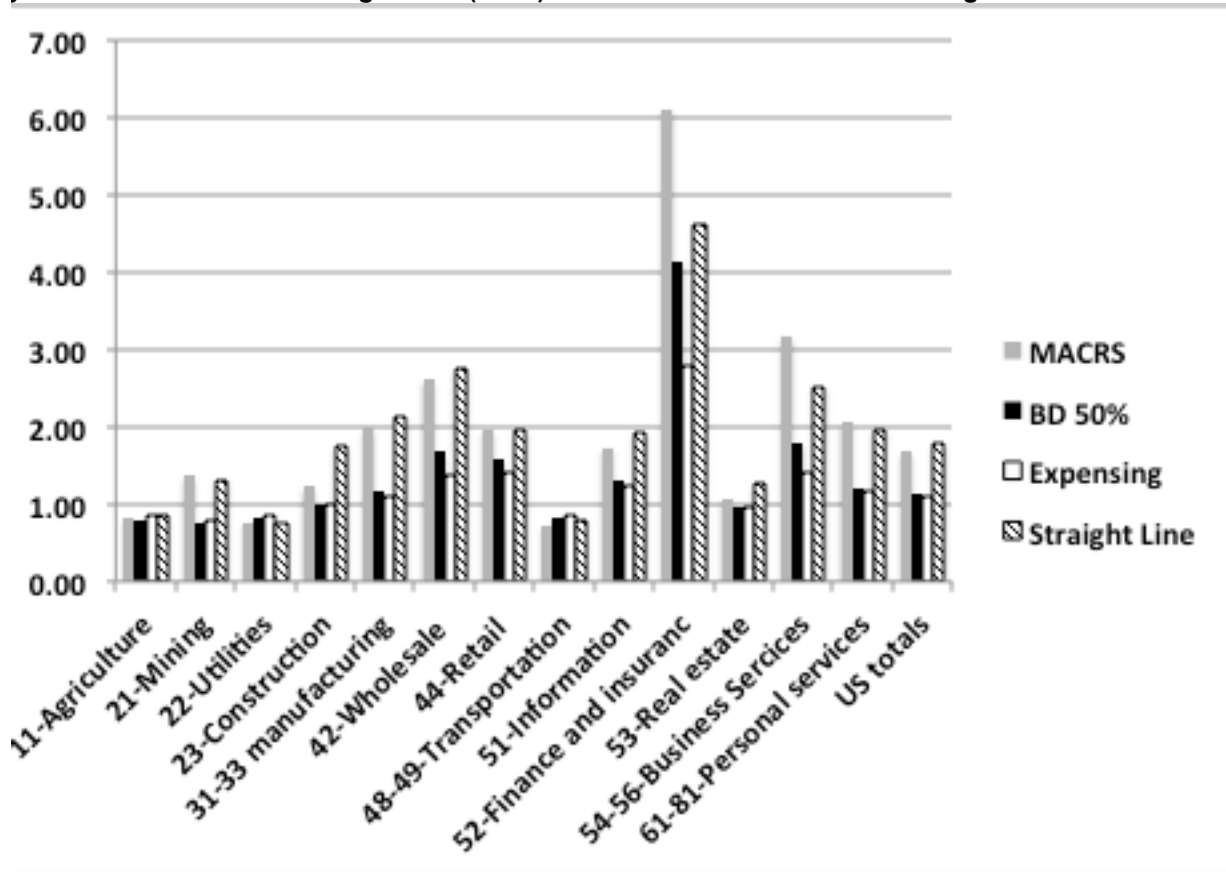
The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets. Four tax policy options are presented without (-No Int) and with (-Int) intangible assets: current law (or MACRS), 50% first-year bonus depreciation (BD50), expensing (EXP), and straight-line depreciation of all fixed assets (SL).

Figure 8: Deadweight loss of inter-asset taxation before and after capitalizing for non-NIPA intangible assets, by industry and under current law in 2009 (\$ billion) 1/



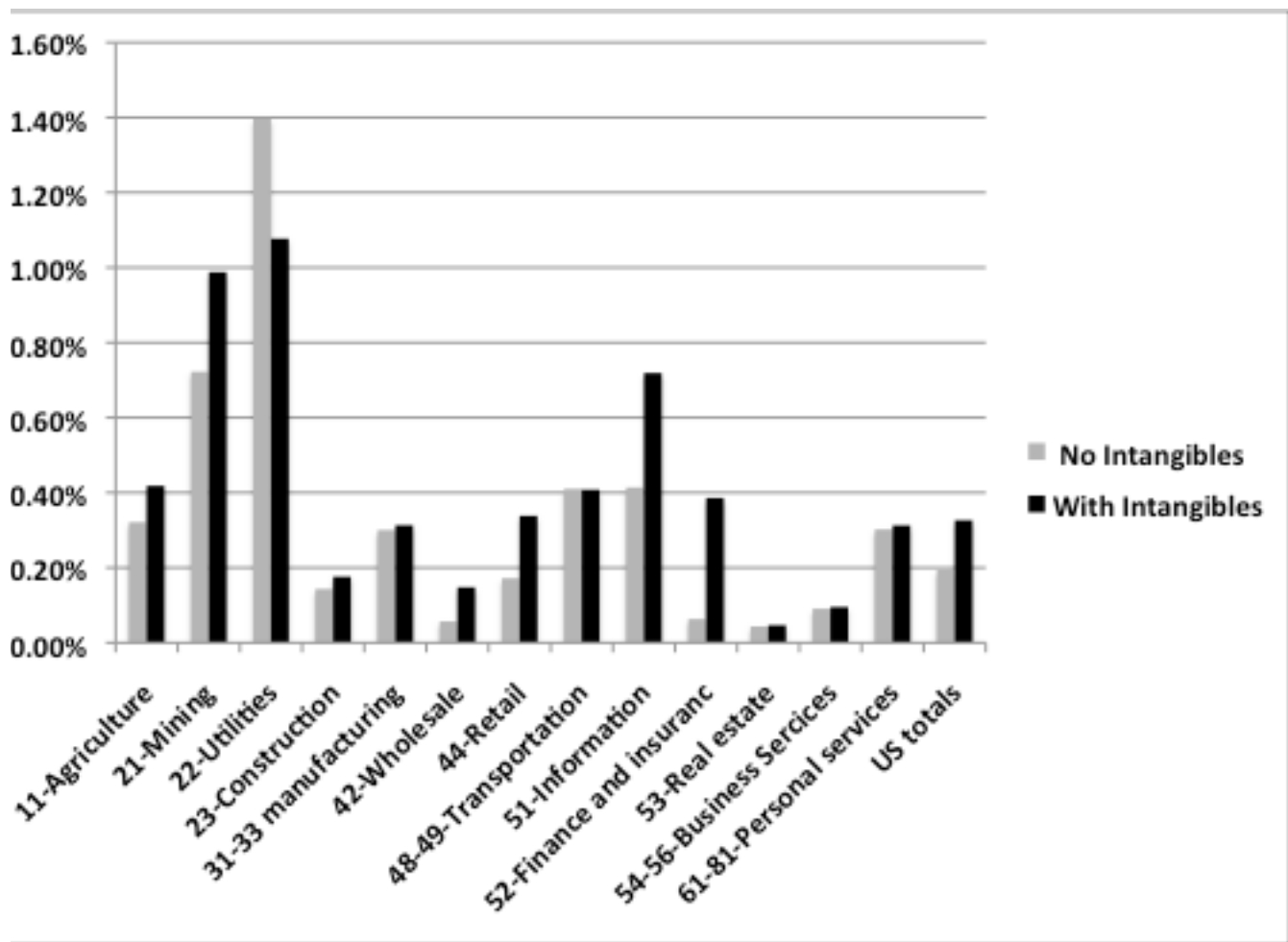
The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets.

Figure 9: Ratio of the deadweight loss (DWL) of inter-asset taxation with intangibles over DWL without intangibles, by industry and tax policy in 2009 1/



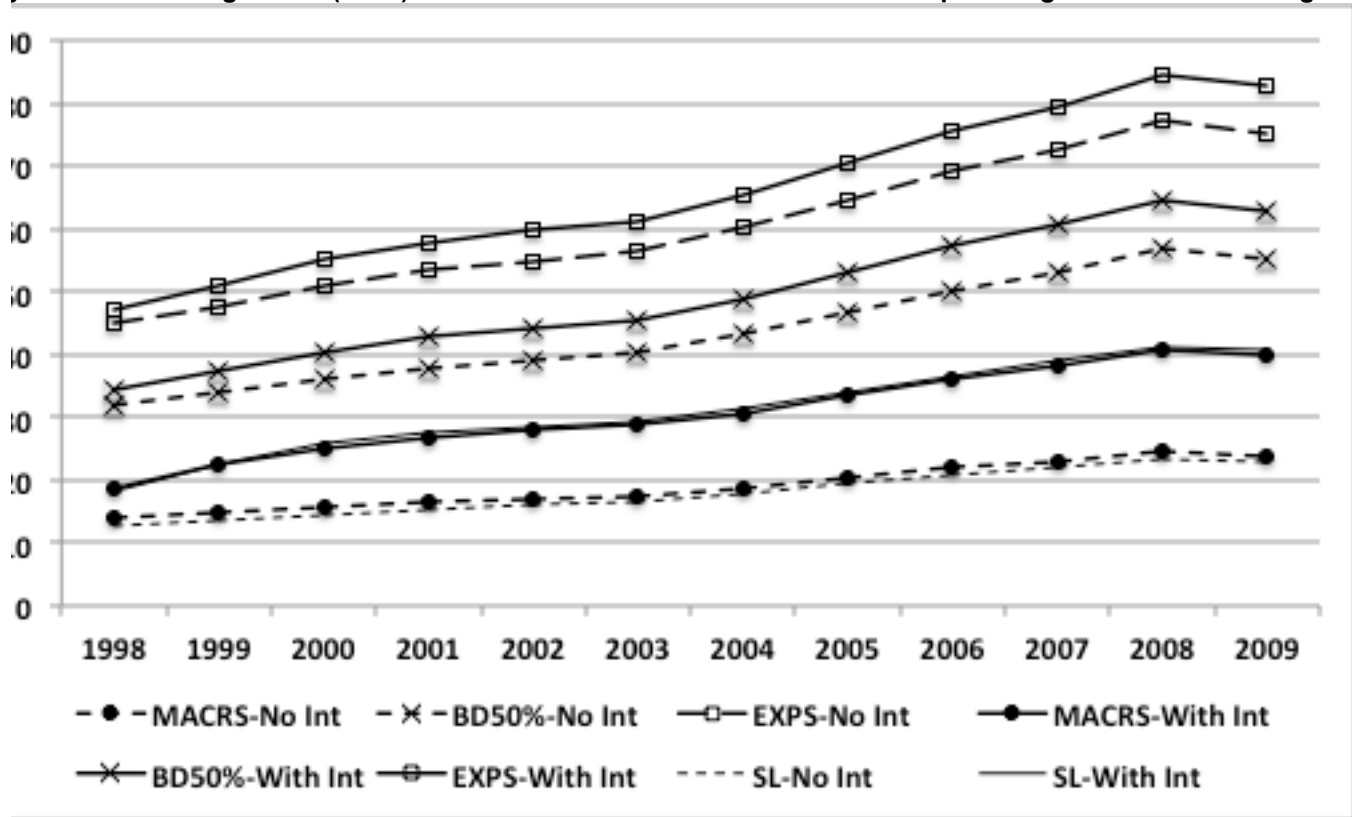
The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets. Four tax policy options are presented without (-No Int) and with (-Int) intangible assets: current law (or MACRS), 50% first-year bonus depreciation (BD50), expensing (EXP), and straight-line depreciation of all fixed assets (SL).

Figure 10: Deadweight loss of inter-asset taxation before and after capitalizing for non-NIPA intangible assets, by industry and under current law in 2009 (% of GDP)



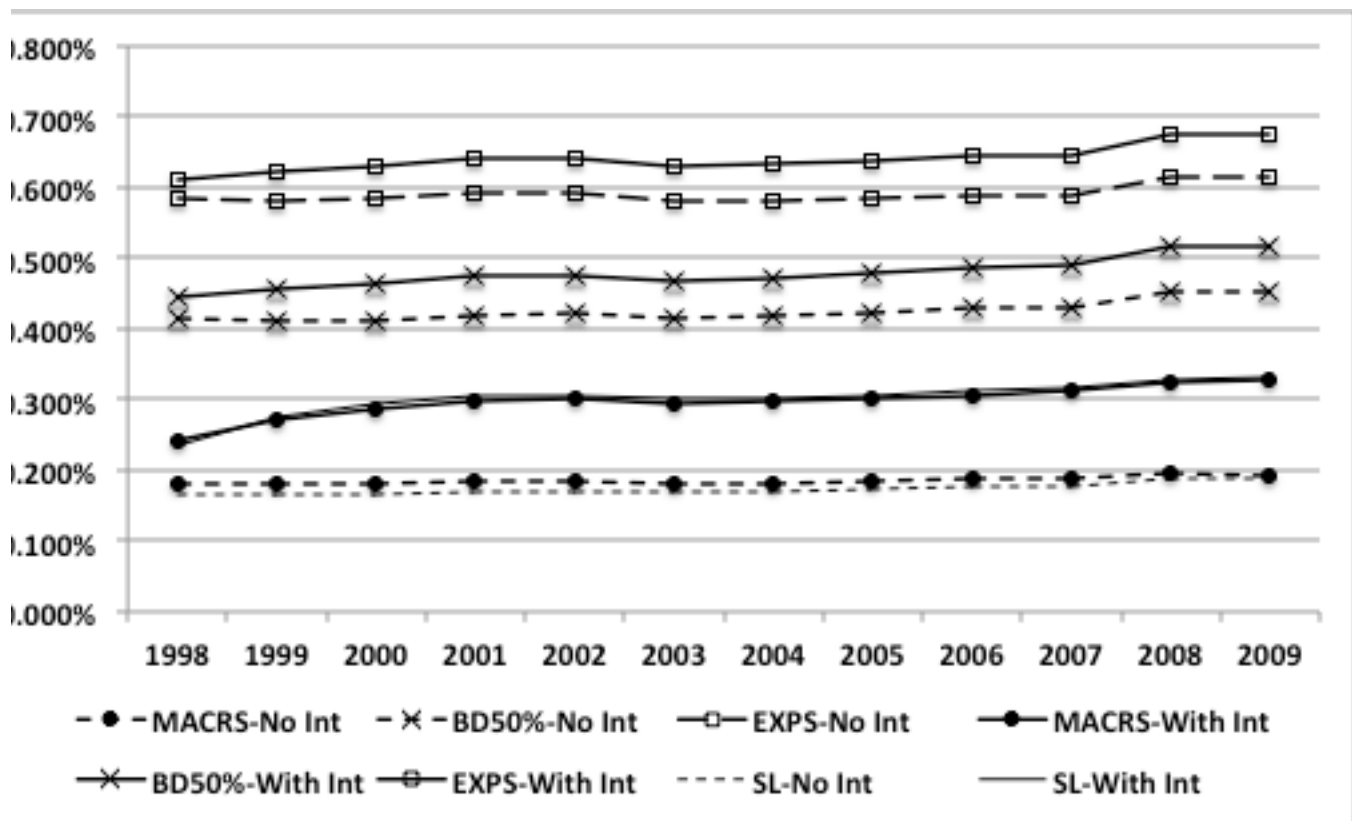
The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets.

Figure 11: Deadweight loss (DWL) of inter-asset taxation before and after capitalizing for non-NIPA intangible assets, by tax policy, 1998 to 2009 (\$ billion) 1/



The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets. Four tax policy options are presented without (-No Int) and with (-Int) intangible assets: current law (or MACRS), 50% first-year bonus depreciation (BD50), expensing (EXP), and straight-line depreciation of all fixed assets (SL).

Figure 12: Deadweight loss (DWL) of inter-asset taxation before and after capitalizing for non-NIPA intangible assets, by tax policy, 1998 to 2009 (% of GDP) 1/



The undistorted cost of capital is the capital weighted average of the cost of capital under current law, with or without accounting for non-NIPA intangible assets.

APPENDIX

Appendix A: Methodology for Measuring the Stocks and Flows of Intangible and Physical Assets

A1- Intangible Assets

This paper measures intangible assets in a comprehensive way using the methodology developed by Corrado et al. (2005, 2009) for the United States, and increasingly used for other countries since then (Edquist, 2011; Marano and Haskel, 2006, 2009; Fukao et al., 2009; Jalava et al., 2007; Van Rooijen-Horsten, 2008). However, while all these papers have been interested in measuring the impact of aggregate intangible assets on productivity growth, none of them have attempted to disaggregate this measure to the corporate sector. In this paper I only focus on companies that file form 1120 for tax purposes, and therefore are classified by the Internal Revenue Service as corporations paying the corporate tax. CHS methodology uses various sources to cover intangible assets, including the Bureau of Economic Analysis (BEA)'s *Survey of Current Businesses* for intangibles that are accounted in national NIPA accounts as physical assets (e.g., computer software). All sources for non-NIPA intangible assets are presented in Table A2.

At this point, it is worth mentioning that NIPA measures of aggregate investment and revenues are based on data collected from either “establishments” or “companies.” In the *Industry* section of *A Guide to the NIPA's*, the BEA states that¹

Establishments are classified into an SIC industry on the basis of their

¹ Bureau of Economic Analysis, available at http://www.bea.gov/scb/account_articles/national/0398niw/maintext.htm

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, for tax purposes, corporate tax filings are prepared by the parent company, and generally allocated to industries on a company basis. Therefore, 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. For our purposes of accurately calculating depreciation allowances and 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—are separate entities filing taxes separately from their parent or their own subsidiaries. By contrast, branches are not separated from their parent, and non-corporate businesses (such as partnerships) do not pay the corporate tax. In this paper, I start by separating investment between the corporate and the non-corporate sector. Then I distribute corporations across

industries based on NIPA accounts by assuming that intangible assets have the same distribution across sectors than equipment and software assets. The latter is 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, I use data from the IRS/SOI. This is the case for two intangible assets: research and development or R&D spending and advertising.

Nevertheless, I recognize that the distribution of investment across industries is still subject to misclassification. Nevertheless, I believe that this paper limits the industry llocation error across as much as possible. In table A1 below I present a simple comparison of the impact of measuring intangible investments from the corporate part of the BEA's *Survey of Current Businesses* as compared to IRS/SOI Tax Filings in the case of R&D, for which I can compare R&D spending from tax filings to corporate expenditures in R&D from the corporate sector of the BEA. The table shows that although the distribution of R&D expenditures across industries is not precisely the same when BEA/NSF accounts are used as when IRS tax filings are used, the relative importance of industries is preserved. For example, in both the IRS and the BEA's distribution, the share of R&D spending is the largest for the manufacturing industry, followed by information and finance.

[Insert table A1 here]

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.

Investment in physical assets (also referred to as tangible, or fixed assets) is also obtained from the BEA's NIPA accounts.

We measure of intangible assets by types of assets from 1998 through 2009,

based on a methodology developed by CHS (2005) for aggregate intangible assets and extended to the industry level. The data collection is, to our knowledge, the most comprehensive to this date for this time period. .

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

Similarly to CHS (2005), 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. None of these assets (except for software) is included in NIPA accounts. Instead they are directly expensed for accounting purposes, generally because they are difficult to measure.

Table A2 describes in detail data sources used to measure various types of intangible assets, and the methodology used to measure the part of these assets that creates 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 of table A2 lists the non-NIPA intangible asset. The second column lists the data sources. The third column defines the asset. While some intangible assets could be directly measured for the corporate sector only, for other intangible assets, the disaggregation between the corporate and the non-corporate sectors is based on NIPA investment and stocks share 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 in each industry (see appendix A2 on physical assets).

[Insert Table A2 Here]

To obtain the stock of intangible assets, we use the data obtained for investment in intangible assets and assumes that these assets depreciate according to the perpetual inventory method (PIM). The PIM is also used by NIPA accounts to age the stock of physical assets, and is explained in detail in Meinen et al. (1998). The net stock of any asset in year t and in year t prices is defined as:

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

where d is the recovery period of the asset, I_t is the amount invested in the asset in current dollars, $P_{t-i,t}^I$ 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

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

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

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 A3 shows the assumed values of economic depreciation of various assets. For intangible assets, we follow previous literature (CHS, 2005; Fraumeni, 1997).

[Insert Table A3 Here]

BEA tables:

- BEA value added table: “GDPbyInd_VA_NAICS_1998-2009.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 1998-2009.

A2- Physical Assets

To isolate investments and stocks of physical and intangible assets by industry, assets, and over time, we essentially use BEA's Physical Asset tables (listed below). First, 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 and investment in equipment and structures for each year. Second, for each year, we distribute the corporate amounts of investment and stocks in these broad asset types—obtained from step one--across detailed asset types, using BEA tables 2.1 and 2.7, which provide detailed stocks and flows of private physical assets for 75 detailed asset types. Third, for each year and each asset, we distribute these detailed corporate asset investment amounts (stock and flows) across industries, using the 1997 BEA's capital flow data, based on the *Survey of Current Businesses*. This implies that the total distribution across assets of investment and stocks of corporate stock physical assets varies not only over time (step two), but also across industries (step 3). We obtain one matrix for each year showing the distribution of corporate stock (respectively investment) across detailed physical assets and two-digit industries: 9 matrices (one for each year from 1998 to 2009) 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 ($t=1998-2009$). $A1$ 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 ($t=1998-2009$).

BEA tables:

- 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 2009, 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 2009) 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 N_i) at time t ($t=1998-2009$), 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 N_i) at time t ($t=1998-2009$).

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

Appendix B: Tax Parts

We follow Cummins, Hasset, and Hubbard (1994) and House and Shapiro (2008) to construct the tax parts. Many changes in the treatment of depreciable assets have been passed in the last decade: in 2002 to 2004. All of these changes were temporary investment tax incentives with different effects for different asset types. The depreciation allowances allowed in 1998-2009 only applied to short-lived investment assets, which is defined as equipment and structure assets with a recovery period of 20 years or less.

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 of the applicable policy:

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

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 shows PV of depreciation allowances of each asset and under the alternative policies in place during 1998-2009 period. The table below shows the number of days when a given policy has been applicable in a given year.

Calendar year	MACRS	BD 30%	BD 50%	Expensing
1998 - 2001	365 or 366			
2002		365		
2003		125	240	
2004			366	
2005 – 2007	365			
2008-2009			365 or 366	
2010			251	114

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. The Economic Stimulus Act of 2008 and American Recovery and Reinvestment Act of 2009 provided a 50 percent depreciation allowance of qualified fixed assets. The ‘Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act’ of 2010, which provides 100 percent depreciation bonus for capital investments placed in service after September 8, 2010 through December 31, 2011. Qualified assets are equipment and structures with a recovery period of 20 years or less.

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 allowance 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.

In this paper, since we are interesting 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

$$w_{i,a,t} = \frac{mf_{i,a,t}}{\sum_{k=1}^{A1} mf_{i,k,t}}$$

Table A6 shows summary statistics of depreciation allowances of each industry during 1998-2009. The tax term of each group of assets is $TaxTerm_{i,t} = (1 - DA_{i,t} * \tau / (1 - \tau))$, where τ is the statutory top corporate tax rate, consistently 35 percent over the period considered.

[Insert Table A6 Here]

When intangible assets are not included in total investment, the average PV of depreciation allowances for \$1 of investment over all industries in 1998-2009 was \$0.68 for the equipment and software part and \$0.11 for the structures part. When

intangible assets are included in total investment, the PV of depreciation allowances for \$1 of investment is \$0.38 for the equipment and software part, \$0.06 for the structures part, and \$0.44 for the intangible assets part. The PV of depreciation allowances for the intangible assets part is largest in industries that are intangible intensive: food and apparel manufacturing, finance and insurance, and business management services.

Appendix C- Macroeconomic Variables

The real growth rate of GDP is obtained from the 2011 Economic Report of the President (ERP, table 1: “Current-Dollar and Real Gross Domestic Product, 2005 Price). Price indices (PPI and CPI) are obtained from tables 64 and 68 or the ERP. The unemployment rate is from table 42 of the ERP.

The 10-year federal funds rate is taken from Board of Governors of the Federal Reserve System, table H.15 (seasonally adjusted)