THE RISE IN GROSS PRIVATE INVESTMENT

IN INTANGIBLE ASSETS SINCE 1978

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Abstract

This paper argues that the rate of intangible investment – investment in the development and marketing of new products – accelerated in the wake of the electronics revolution in the 1970s. The paper presents preliminary direct and indirect empirical evidence that US private firms currently invest at least $500 billion, and perhaps more than $1 trillion annually, in intangibles. This rate of investment is roughly the same size as US gross investment in nonresidential tangible assets. This estimate also suggests that the capital stock of intangibles in the US may have an equilibrium market value of $5 trillion.

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THE RISE IN GROSS PRIVATE INVESTMENT

IN INTANGIBLE ASSETS SINCE 1978

This paper, part of a project on the empirical importance of creative destruction, attempts a preliminary estimate of the US investment in intangible assets. I argue that the rate of investment in intangibles, and its economic value, accelerated significantly beginning around 1980. I estimate that US private gross investment in intangibles was in 2002 at least $500 billion. My preferred estimate is closer to $1 trillion.

For historical reasons, much of this US investment in intangibles still remains uncounted. Both in US generally accepted accounting principles, and in US national income accounting dating at least back to Kuznets, investment in intangibles has been expensed, that is, treated as an intermediate input consumed in producing current output rather than as investment that produces a long-lived asset.[1]

In 1999, the national income accountants at the Bureau of Economic Analysis (BEA) began the process of counting intangibles as investment by including software in its measures of business investment. Gross business investment in software is already over $180 billion, so US measured gross domestic product is nearly 2 percent higher than it would be if intangibles weren't counted at all.

An intangibles investment rate of $1 trillion suggests that US businesses are investing nearly as much in intangibles as they are in plant and equipment (business investment in fixed nonresidential plant and equipment in 2000 was $1.1 trillion). It also suggests that a third of the value of US corporate assets are intangibles, an estimate I document in part three. That means that the economics of creative destruction -- also known less colorfully as endogenous growth -- are rapidly becoming as important as the economics of the invisible hand (Nakamura, 2000.) These estimates are of the same general magnitude as those in Hall (1999) and McGrattan and Prescott (2001).

What are intangibles? In this paper, I will define intangible investment as *private* expenditures on assets that are intangible and necessary to the creation and sale of new or improved products and processes. These include designs, software, blueprints, ideas, artistic expressions, recipes, and the like. They also include the testing and marketing of new products that are a necessary sunk cost of their first sale to customers. It is the private expense to create private rights to sell new products. If US businesses are employing substantial resources to create these rights, it should be possible to discern the impact of these investments in various facets of the economy. If not, then perhaps the omission is unimportant.

Each of my estimates for intangible investment is based on incomplete data, but all of them point to an estimate that is at least half a trillion dollars, and quite likely twice that amount. My methodology is to attempt to capture estimates from three separate aspects of intangible investing: expenditures (how much users pay for investments), labor inputs (what workers' occupations are and how much they are being paid), and corporate operating margins (as viewed through their tax accounts and their public financial reports).

Specifically, the first estimate is based on the expenditures of the investors: the National Science Foundation's data on industrial expenditures on research and development, the US BEA's estimates of software investment, and McCann-Erickson's

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[1] For a discussion of the intellectual history of output classification, see Hill (1999).

estimates of expenditures on advertising media. These together were 6 percent the size of US GDP in 2000.

The second estimate is based on inputs that are identifiable as contributing to the production of intangibles. I use occupational statistics to determine the proportion of labor income going to workers whose occupations are creative – engineers, scientists, writers, artists, etc. These are estimated below to represent 9.9 percent of payrolls in 2000, using data from the Bureau of Labor Statistics' Current Population Statistics on full-time workers and the median pay they receive.

The third estimate is from the corporate income side, based on operating margins. If firms are spending a substantial amount on intangibles, and have been doing so for some years, the successes of this expenditure should permit firms on average to increase markups. This can be estimated using corporate expense statements, as a shift of expenditures away from direct production costs that Compustat and the US Treasury's Statistics of Income label "cost of goods sold," to research and development, and administrative, marketing and general expenses. These series show that cost of goods sold, relative to revenues, fell about 10 percentage points after 1980.

All these estimates suggest strongly, if imprecisely, that at least 6 percent to 10 percent of US GDP is spent annually on intangibles, and possibly substantially more. It turns out that it is possible to use an *indirect* method to arrive at a surprisingly precise lower bound on the gross investment in intangibles. The ratio of consumption to true gross domestic product, including both tangible and intangible investment, should be relatively stable. If so, then the rise in the ratio of consumption to *measured* gross domestic product will provide a relatively precise estimate of the increase in unmeasured intangible investment. This ratio suggests that unmeasured intangible investment was $910 billion in 2000, with a 5 percent confidence interval of plus or minus $200 billion. Adding in the $179 billion in software investment that was measured in that year, we arrive at a lower bound estimate of US gross investment in intangibles of $1.1 trillion. This estimate is a lower bound in that it measures the increase in investment in intangibles after 1977.

If we are investing $1 trillion a year in intangibles, and if the obsolescence rate for intangibles is no more than 16 percent annually, then the long-run equilibrium value of intangibles is $6 trillion. Although we have not reached the long-run equilibrium, we can use the expenditure paths derived above to show that the current equilibrium value is most likely over $5 trillion. In the bear market valuation of US domestic equities at the end of the first quarter of 2001, the market valuation of all US stocks was roughly $13 trillion. Thus, intangibles could represent a third or more of the market value of US domestic corporations.

Why has this change suddenly swept over the US economy? Because of the electronics revolution of the 1970s, which raised the return to investing in intangibles. A series of papers, including one by Jeremy Greenwood and Boyan Jovanovic (1999), have argued that the US stock market equity decline in the mid-1970s, and its subsequent rise beginning in the 1980s, were both consequences of the electronics revolution. One aspect of the electronics revolution is presented below: I argue that it made intangible investment much more remunerative. In particular, what electronics have done is reduce the cost of reaching and staying in touch with customers, making it easier and more profitable to bring new products to market. I use theory developed by Chandler (1980,

1994) and Stein (1997) to argue that innovators became able to reap a larger share of the rewards of innovation in the wake of the electronics revolution.

Let me stress that national income accountants are well aware of the growing role of intangibles and have already begun to take steps toward measuring investment in intangibles; this effort to capture intangibles has been led by statisticians at the OECD (1998). One of the justifications for the new industrial classification system, NAICS, is getting a better handle on industries, such as the arts, that depend heavily on intangible asset formation. And as I have mentioned, in the 1999 revision to the US national accounts the BEA added the first intangible investment, investment in software, to its measure of US gross domestic product.

I begin with the theory and evidence for the dramatic changes of the 1970s before turning to my empirical estimates.

Part One: The coming of the New Economy: The impact of electronics on customer bases in the 1970s

As Alfred Chandler (1980, 1994) documented, corporations that led their industries in the late 19th century and early 20th century continued to dominate their industries into the 1960s and 1970s. He argued that the large industrial enterprise established a factory base that took advantage of economies of scale and large throughput to become the core producer of a mass market product. Because of the unique efficiencies offered by economies of scale in mass production, this giant corporation could reap substantial per unit profits. This large profit stream in turn required and made affordable a large sales force, to ensure that each in the parade of myriad products found its way to a customer, and that the corporation's share of the proceeds from every customer found its way back to the corporate treasury. In addition, running the factory, deterring potential rivals, coordinating deliveries with sales, accounting for each dollar of sales and expenditures, and discovering new ways to reduce cost and improve the product required a huge bureaucracy of white-collar workers at regional and headquarters offices.

The corporation's investment in its sales force and its white-collar staff formed an immense barrier to entry for a potential rival in the corporation's market. A corporation whose market power rested solely on its investment in a large plant would be vulnerable to a change in technology. A new entrant with a more efficient technology could outmode the corporation's existing plant. But if a substantial investment in a sales and clerical staff was necessary to sell a large volume of products efficiently, the most efficient use a potential entrant could make of a new innovation would be to sell it to the incumbent – and so any innovator would have to share the value of the R&D with the incumbent.[2]

Chandler documents that the great corporations of the late 19th and early 20th centuries were extraordinarily stable and were still the dominant corporations from 1950 to 1980. This also meant that during this period the incentive to develop new products and bring them rapidly to market was muted. But beginning in the 1970s, there was a profound change in the ability of the large corporation to defend its turf.

[2] The incumbent is a monopsonist vis-a-vis the innovator, who is a monopolist. This is a bargaining game between players with unequal resources, and the incumbent should be able to reap much of the surplus from the innovation. This was the pattern in the 1960s and earlier (Scherer, 1984)

A formalization of Chandler's theory that helps us understand the decline in the great corporation has been set forth by Jeremy Stein (1997). Stein describes an industry in which intangible investments in quality innovations are associated with additional investments in a sales network. Investing in the sales network takes time, possibly due to learning-by-doing, and causes the cost of sales to fall over time. This reduced cost of distribution constitutes a barrier to entry, which becomes higher as the incumbent becomes more entrenched. Stein shows that if a new technology is sufficiently better to enable an entrant to oust the incumbent, the new incumbent will, in the short run, be more vulnerable than the old incumbent for the period before the new sales force is built up. Thus entry encourages further entry, as it creates a window of opportunity in which entry barriers are lower, and a wave of creative destruction can erupt. The model can readily be used to show the impact of a permanent decline in the cost of investing in sales and communication infrastructure.

What happened in the 1970s was that electronic technology in that decade – in particular the elimination of computational economies of scale and its resulting decentralization through the PC revolution and the multitasking mainframe with CRT workstations – revolutionized sales and clerical technology and outmoded the sales and communication infrastructure of the great corporation.[3] As I have documented elsewhere (Nakamura, 2001), the sales and clerical staff, which had grown at least as fast as other managerial and professional staff from 1900 to 1975, began to shrink as a proportion of the workforce beginning in 1980. The relative decline in sales and clerical staff is a key indicator of the obsolescence of the corporate investment in sales and communication.

In brief, the rate of return to innovation rose as the cost of accounting information associated with the distribution of products plummeted. This led to a wave of innovation that dramatically increased product variety available to consumers. I have documented (Nakamura 1999a) the rise in variety and innovation in products sold at grocery stores, which accelerated dramatically as scanners came into widespread use in the late 1970s and early 1980s. Bils and Klenow (2001) document a similar phenomenon across a wide variety of consumer products in a process that appears to accelerate in the late 1970s.

In the process, corporations became far more vulnerable to innovation than they had been. As Greenwood and Jovanovic (1999) show, there was a substantial crash in corporate valuation that occurred in the mid-1970s, which they ascribe to the computer revolution. My interpretation, that computers outmoded sales and communication investments, attempts to put more detail on their argument. If my interpretation is correct, there ought to be a tendency for stock market valuations of firms to become more volatile because investing in innovations is very risky, as Scherer and Harhoff (2000) have documented. A relatively few innovations typically account for much of the profitability of industries that is due to intangibles. Thus if innovation becomes more valuable, and can be more readily brought to market by new entrants, the stock market valuations of individual firms should become more volatile.

Beginning in the 1980s, the market valuation of individual firms, as documented by Campbell et al. (2001), became more idiosyncratically volatile. While this effect may also be explained, as they tentatively argue, by firms becoming deconglomerated and more focused in their product lines (so that firms' idiosyncratic variations are less

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[3] Prior to the development of the large scale integrated circuit in the 1970s, mainframe computers exhibited

internally hedged) and by the institutionalization of equity ownership (tending to concentrate and sharpen the impacts of differences in opinion), both these arguments are complementary to the view that corporate value became riskier because of the increased importance and economic force of innovative activity and intangible assets. It is worth noting that they also find that the total market volatility (over the period 1962 to 1997) if anything decreased.

An interesting parallel development is that also beginning in the late 1970s, the rate of dividend payment by firms began to fall. As Fama and French (2000) show, in 1978, 66.6 percent of publicly traded nonfinancial nonutility firms paid dividends. In 1999, only 20.8 percent of such firms paid dividends. Firms that have never paid dividends tend to be less profitable, have more growth opportunities, invest at a higher rate, do more R&D, and have higher ratios of market value to book value than firms that pay dividends. (They are also much smaller, so that, in fact, the ratio of total dividends paid to GDP has risen for US firms.) To put it briefly, these nondividend-paying firms are firms that have made and are making large investments in intangible assets. Because these investments are risky and illiquid, the firms making them tend to face relatively high outside financing costs and, thus, should rationally be more reluctant to issue dividends.[4] The rise of these firms with their substantial investments in intangibles thus favored capital gains relative to dividends.

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large economies of scale, following a power law in costs.

[4] Moreover, firms investing in intangibles and expensing them are investing with pre-tax dollars. Corporate shareholders optimally prefer the firm to continue rolling over their dividends into capital gains as long as the internal rate of return for the firm is above the reservation (risk-adjusted) rate of return available outside the firm.

There are, of course, other rationales for firms not to pay dividends, such as their double taxation, and the various tax advantages of capital gains. (However, it is not the case that firms that don't pay dividends have shifted to share buybacks; rather Fama and French show that share buybacks are done by firms that also pay dividends.)

To summarize, I have argued that the electronics revolution in the 1970s caused existing corporate customer bases to become less valuable, innovative activity more profitable, corporate valuation riskier, dividends less important, and capital gains larger.

Part Two: Estimates of gross private investment in intangible assets

In this section I discuss sources of data and estimates of gross private investment in intangible assets. Generally speaking, what I am interested in is two-fold: one, what would be added to U.S. gross domestic product if we were to account for intangible investment in a manner that paralleled the treatment of tangible assets, and two, how would this affect our estimation of the equilibrium stock market value of private business.

Direct estimates of expenditures on intangibles. According to National Science Foundation estimates, in 2002, US corporations spent $193 billion of their own funds on *research and development*. This represented 3.5 percent of the gross domestic product of nonfinancial corporations, and 1.9 percent of total gross domestic product (Table 1). In 1978, R&D expenditures were 1.8 percent of nonfinancial corporate GDP and 1 percent of aggregate GDP. For a more detailed and nuanced discussion of how research and development can fit into the national accounts, see Fraumeni and Okubo (2002).

It is important for two reasons to use nominal data in this comparison. First, the proportion of economic resources devoted to investment is best measured in terms of the opportunity cost. This implies using an aggregate deflator like a wage deflator (Keynes, 1936) or the GDP deflator, or a comparison with other nominal magnitudes, such as the ratio between intangible expenditures and GDP, which is the measure I have chosen.[5] Second, the value of the financial asset created in equilibrium by a given investment is determined by the nominal investment, not its real quantity.

In 2002, according to the BEA, private businesses invested $183 billion in *software*, 1.7 percent of GDP, compared to 0.3 percent in 1978. In 2000, 33 percent of business software investment was prepackaged software, 31 percent was custom software, and 36 percent was software made for internal use (own account). For own account software, and for some custom software, the intellectual asset is bundled with the investment. But for prepackaged software, the investment is made by the purchaser, but the intellectual property rights to the software remain with the seller.

Note that both the buyer and the seller then have intangible assets. The intangible asset retained by the seller can be seen in the market value of Microsoft, almost all of which is due to the copyrights and patents Microsoft owns. Microsoft's intangible investments – and those of other producers of prepackaged software – are considered research and development. In 1996, prepackaged software makers performed $6.7 billion in research and development according to NSF data. Thus to separately count software and software research and development as distinct assets in this segment does not involve double counting.

Advertising expenditures, according to McCann-Erickson, were $237 billion, or 2.3 percent of GDP, in 2002, compared to 1.9 percent in 1978. These statistics are media

[5] I argue in Nakamura (1997, 1999a) that price mismeasurement increased in the 1980s and 1990s.

expenditures that capture the market for advertising agencies, for the most part, and do not include, for example, the sales forces of pharmaceutical companies or fees paid to public relations firms and athletes, marketing expenses that have been rising faster than agency fees. On the other hand, a large proportion of advertising expenditures are associated with immediate sales strategies (efforts to reduce inventory or to price discriminate) rather than new product information.

It may be remarked that a substantial part of advertising expenditure is a payment to media that serves to subsidize consumer entertainment. Network television, for example, is predominantly paid for by this means. As a consequence, much of the expenditure on television and radio broadcasting does not appear as a final product in the national income accounts, only as an intermediate expenditure that is part of the sales cost of other consumer products. The value of TV broadcasts to the consumer, to the extent that they have zero price, does not enter into personal consumption expenditure as a consequence. Thus there is no double counting in regarding this advertising expense as an investment in intangibles.

Expenditures on research and development, software, and advertising do not exhaust, by any means, firms' expenditures to create and introduce new products. For example, most financial corporations do not report as "research and development expenses" their expenditures to develop new products. Yet financial corporations have been making a large and growing investment in financial innovations, including swaps, derivatives, electronic payment systems, ATMs, and credit and debit cards. They have also invested large sums in customer databases, and in customer relationships associated with these new instruments.

Almost no data are collected on the expenditures on intangibles by financial corporations. However, noninterest expenditures of financial corporations have been rising rapidly. For example, for commercial banks, noninterest expenditures were $222 billion in 2001, 2.2 percent of GDP, up from 1.5 percent of GDP in 1978. Noninterest expenditures include innovations and marketing expenses by commercial banks, but they also include expenditures for tellers and bank branches. The market value of financial institutions has recently averaged over 20 percent of the market value of nonfinancial corporations, compared to around 11 percent in 1978. If financial corporations spend one-fifth as much on research and development as nonfinancial corporations report spending, this would add another $50 billion to R&D. Commercial banks alone have added over $50 billion in noninterest expenditures in this same period. And that neglects the innovative expenditures of mutual funds, insurance companies, real estate firms, other depositories, or investment banks.

Additional investments in intangibles are made by writers, artists, and entertainers. None of these are recorded as part of research and development. For example, in 1997, according to the US economic census, publishing, motion picture, and sound recording industries had a total revenue of $221 billion. Associated with this stream of revenues are investments in creativity, and in finding, developing, and publicizing artists and their work (Caves, 2000). While some of this revenue stream results in personal consumption expenditures (motion picture theater tickets) or in advertising intangibles (media buys by advertisers), additional cultural intangible assets are created. The backlists, paperback rights, and foreign rights of book publishers, the film libraries, video rights, and TV, hotel, and inflight licensing rights of the major studios, and the song catalogs of music publishers and recording houses constitute intangible assets that represent a substantial investment. Much of these rights are not represented in the corporate equity of publishing and entertainment corporations, as they are retained by individuals, partnerships, and unlisted corporations.

If we sum the data for advertising, software, and research and development in 2000, we get a total of $613 billion, or 5.9 percent of 2002 GDP. As shown in Figure 1, all three grow faster, as a proportion of GDP, after 1978. If we add on $50 billion for financial corporations and $50 billion for publishing, motion pictures, and sound recording, we would obtain a total of $713 billion in 2000, a figure I believe to be quite conservative. It does not include administrative and direct training costs of adopting new software, and it does not include the bulk of expenditures on research and development by individuals and unincorporated businesses.[6]

Can we construct a time series over an extended period of time? One that does not seem too fanciful would be to take the BEA's estimates for software and the NSF's estimates for corporate R&D and double them, to make up for omissions, and add the expenditures for advertising. The results, in Figure 2, give us a picture of gross intangible investments that were fairly stable as a proportion of GDP in the 19 years from 1959 to 1978, rising gently from 3.8 percent to 4.4 percent (.03 percentage point annually), then rising quite briskly thereafter, to 9.5 percent in the 24 years to 2000 (0.2 percentage point annually).

[6] New product development by start-ups sponsored by angels or venture capital becomes part of corporate equity value when the company is taken public, turning past investments by individuals and unincorporated businesses in intangibles into corporate assets.

Evidence on wages and salaries in occupations associated with creativity. Professional specialty workers in the US economy have been growing as a proportion of the total. A large part of this group is workers who are typically associated with creativity and with innovation: engineers, architects, natural scientists, mathematicians and computer scientists, artists, writers, and entertainers. As a fraction of the workforce, this group has been expanding rapidly. Table 2, which mixes data from the Census of Population and the Current Population Survey, shows that the proportion of workers in these creative professions rose from 3.8 percent in 1980 to 5.8 percent in 2000. In 2000 the Bureau of Labor Statistics changed the categories under which occupations are collected when it implemented the Standard Occupational Classification system. Data for the most nearly comparable categories for 2000 to 2002 are shown separately on the bottom of table 2.

We can also use data from the Current Population Survey to estimate the proportion of total US wages and salaries these workers represent. Detailed data on median weekly earnings of full-time employees are published annually in Employment and Earnings; total earnings can be estimated by multiplying the median weekly earnings by the number of full-time workers in each category. If we do this, we can estimate that in 2000, creative professionals were paid 9.9 percent of US wages and salaries, as their median earnings were, on average, 1.6 times the median for the entire workforce (Table 3). In contrast, 17 years earlier, in 1983, creative professionals were paid 7.5 percent of US wages and salaries. If creative workers represent nearly 10 percent of wages and salaries, it would appear that estimating that 10 percent of US output for intangibles is low and that 15 percent might not be out of the question.

During the same period, service professionals – legal, social service and health, and education professionals – grew from 10.3 percent to 13.1 percent of payrolls, and executives and managerial professionals grew from 16.1 percent to 21.4 percent of payrolls. Some increasing part of these workers is also working to help create, test, and market intangible assets. For example, college teachers write textbooks, do research, set up web sites, and, increasingly, start companies to capitalize on their intangible investments. Doctors, in rapidly increasing numbers, perform research for drug companies and develop diagnostic, surgical, and therapeutic tools. For example, according to the Association of University Technology Managers Licensing Survey, universities and hospitals in the US earned nearly $800 million in licensing fees in the academic year 1998-99.

The median pay statistics suggest that payments to creative workers rose roughly a third from 1983 to 2000, as a proportion of the total. This is a distinctly slower pace of growth than for the direct estimate of gross investment in intangibles, which rose by about four-fifths in proportion to gross domestic product in the same period.

One reason that we might see a slower pace of growth in the payroll data is that the measure we use to capture average wages is the median, rather than the mean. Inequality has likely been rising in these categories, as it has in other wage measures, during this period. This may cause the mean to rise more rapidly than the median (although it will do so for the total as well). More important, these data do not capture wage supplements, in particular, stock options. Stock options have been disproportionately used in payment to executives and creative professionals and in industries where intangible investment is important. In a similar vein, incomes of individuals like Tiger Woods, Bill Gates, or Stephen King may not be adequately captured in these data. Third, as the incentive for intangible investment has increased, the proportion of workers and the proportion of work done that represents intangible investment has no doubt risen. For example, an architect or an engineer can more readily reuse past drawings and diagrams because these are now digitally recorded on computers; this turns past effort into a durable, intangible investment. If less of engineers' time is taken up doing routine work that simply repeats designs of the past, more of their hours may be used to create new products and, as a result, may show up as "research and development."

Another view of this is provided in Figure 3. Here I have organized the estimated wages and salaries of occupational groups into three categories: One is production workers, that is, those who produce goods and services, including service professionals such as doctors and teachers. The second is sales and clerical workers, and the third is managers and creative professionals. From 1983 to 2000, total wages and salaries of production workers and clerical and sales workers have grown just about in parallel, 5.1 percent annually and 5.2 percent annually, respectively. During that same period, wages and salaries of managers and creative professionals have risen at an annual rate of 7.3 percent.

Put another way, for every dollar spent on production workers and clerical and sales workers in 1983, 38 cents was being spent on managers and creative professionals. In 2000, 54 cents per dollar was being spent on managers and creative professionals. If we can attribute the increase in this ratio to intangible investment, then intangibles would account for 11 percent of employment expenditures.

Cost of goods sold. If there has been an accelerated expenditure on intangibles arising in research and development, marketing, and administrative expenses, and these expenditures have resulted in corporations' gaining market power in the form of unique assets such as copyrights, patents, and brand names, then margins should be rising. As I have argued elsewhere (Nakamura, 1999b), the rise in margins may not show up fully as an increase in profitability because the intangible expense itself will also be rising, thus canceling out some of the improvement in profits.

What we should observe is that direct operating costs should decline substantially as a proportion of revenues, and expenses should shift toward research and development, marketing, and administrative expenses. We have documented the shift toward the latter. Do we also see the former?

A standard measure of operating costs is cost of goods sold; this is materials costs, leasing costs, and production payroll costs. For all corporations, cost of sales and operations rose from $4.2 trillion in 1980, according to the US Treasury's Statistics on Income (based on corporate taxes) to $11.1 trillion in 2000. As a proportion of receipts, this is a decline from 66.1 percent to 53.5 percent (Table 4). Taking manufacturers alone, cost of sales and operations rose from $1.7 trillion to $3.6 trillion, a decline from 71 percent to 63.5 percent. For manufacturing corporations, I have assembled similar data from Compustat on cost of goods sold, from 1980 to 2001. In these data I have held the corporations fixed to see whether this phenomenon has arisen from new corporations or within existing corporations (although mergers muddy this distinction quite a bit still.) The Compustat data are widely used by researchers, so this series may be more well understood, even though it is less comprehensive. In this data, cost of goods were 76.8

percent of sales in 1980 and 68.6 percent in 2001, In Figure 4, I have graphed the three series of ratios of cost of goods sold (or cost of sales and operations) to revenue, setting 1980 equal to 1 for comparability. As can be seen, the three series all show the same steep decline in the 1980s and a slower rate of decline in the 1990s. Overall, the change is in line with our other estimates: over 10 percent of cost of goods sold.

This measure is subject to many problems, since it includes double counting.[7] Moreover, corporations may change the way they separate cost of sales from administrative and other expenses, depending on how they define their product. For example, several large corporations, including General Electric, have redefined themselves as service corporations or conglomerates, and no longer publish cost of goods sold on the same basis. Businesses that receive contract or royalty payments for creative activities like design or invention will tend to include many creative expenses as part of "cost of operations." But shifts in expenses have been so large that with all of these problems, cost of goods should fall substantially as a proportion of corporate receipts, and that is what we observe. Indeed, a decline in cost of goods sold of about 10 percent of revenues is about what we should expect if intangible investment has reached 10 percent of output: by 2000, we were approaching that amount.

A relatively precise indirect estimate of gross investment in intangibles. Investment in intangibles can be viewed as an alternative to investing in tangibles, in that it enables us to derive more utility from production for our variable inputs, the same effect a higher capital stock might achieve. If this is so, it is a natural conclusion of endogenous growth theory that the ratio of consumption to measured input should rise when investment in intangibles becomes more fruitful. If there has been a sudden acceleration in the rate of intangible investment, as I argue, then it is plausible that this should show up in a rise in the ratio of consumption to gross domestic product, if we do not fully include investment in intangibles in our measure of gross domestic product. The puzzle of the rise in consumption vis a vis income has been raised in Parker (1999).

Another way to think of this is to suppose the contrary. One of the more robust predictions of modern *exogenous* growth theory is that consumption should be a relatively stable share of gross domestic product, and gross investment in intangibles should be unimportant, because exogenous growth theory sees growth as occurring without investment in innovation. This conclusion can be drawn from a growth model that assumes a constant savings rate, as Solow (1956) does or an optimal growth path as Ramsey (1928) does. The main requirement is that the depreciation rate remain steady.

The rise in the ratio of consumption to gross domestic product is, of course, closely related to the decline in the personal savings rate. But the conclusion that consumption should be stable relative to gross domestic product is more robust in theory and empirically than the conclusion that the measured personal savings rate should remain steady (Friedman, 1957), as under Ricardian equivalence intertemporal changes in taxes, for example, will affect the measured personal savings rate, although they do not affect the ratio of consumption to GDP.[8] Moreover, the standard deviation of the latter is more stable for the period 1953 to 1978; the standard deviation of the savings rate is 1.0

[7] Vertical integration will tend to lower double counting. Also, energy costs are repeatedly counted in cost of sales, so the decline in energy costs during this period would also tend to lower cost of sales.

[8] The decline in the personal savings rate in the 1990s has been explained by Peach and Steindel (2000) and Nakamura (1999b) as being due to realized capital gains and associated taxes, as capital gains are not included in measured disposable income.

percent, compared to the ratio of personal consumption expenditures to gross domestic product, 0.6 percent, using quarterly data. Indeed, the theories of growth that can be used to determine general equilibrium values of corporate capital stock typically have as a testable sub-hypothesis that the ratio of consumption to GDP is constant.

To summarize, if an important amount of investment in intangibles began to occur in the 1980s, as our direct measures have suggested, then the ratio of consumption to gross domestic product should have risen, since the gross investment in intangibles was not captured.

If we assume that the gross savings rate is constant over time, as is compatible with some theories of growth, then we can go further and say that changes in the ratio reflect changes in unmeasured gross domestic product. If we can further argue, as I have, that the source of mismeasurement is investment in intangibles, then the proportion by which the consumption-gross domestic product ratio has risen is the increase of the gross investment in intangibles as a proportion of measured gross domestic product. If the ratio has risen by 9.1 percent, as we shall show, then the increase in gross investment in intangibles is 9.1 percent of gross domestic product.

Another advantage of this measure is that it is for the most part a ratio of directly observed quantities, except, of course, for the omission of gross intangible investment from the denominator. The components of both are estimated from the same side of the national income statement, the expenditures side. And the largest imputed quantity in expenditures, the imputation for household consumption of owner-occupied housing services, is slow-moving and appears in both the numerator and the denominator, so mismeasurement effects will be second order. A final advantage is that it can be measured in a way that is insensitive to deflation issues, as both the numerator and the denominator can be deflated with the GDP deflator, which is the same as using their nominal ratios.

Figure 5 shows that from the early 1950s through the late 1970s, the ratio of consumption to GDP was indeed stable. During this period, the average ratio of personal consumption expenditures to gross domestic product in the United States was 62.2 percent, with a standard deviation (measured on an annual basis) of 0.67 percentage point.[9] Thus the central tendency is quite precisely estimated. Throughout the period, the ratio never goes higher than 63.1 percent or lower than 61.0 percent. It is perhaps worth noting that during this period the ratio is modestly countercyclical, rising in recessions, as the permanent income hypothesis would suggest.[10]

If consumers treat gross intangible investment as they would gross tangible investment, the increase in the ratio of consumption to gross national product should be an estimate of the ratio of increased unmeasured intangible investment to output. Indeed, by 2000 the ratio had risen by 9.1 percent of its base level, suggesting that gross domestic product was understated by $910 billion. If we can judge by the stability of the ratio from 1951 to 1981, a 95 percent confidence interval around the 2000 estimate would go from approximately $700 billion to $1.1 trillion. Adding this to measured intangibles of $230 billion, we get a rough estimate of $1.1 trillion.

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[9] The standard deviation was actually higher, 0.77 percentage point, measured quarterly. Thus we do not obtain more precise information about this ratio by moving to more frequent data.

[10] Another way to reduce noise is to exclude durable goods. But doing so increases the standard deviation, because the series becomes more countercyclical. The ratio of nondurables plus services consumption to GDP moves a somewhat larger proportion from its 1951 to 1981 base than does the measure actually used.

Moreover, if we believe that gross investment in intangibles has grown relatively smoothly as a proportion of gross domestic product, it would appear that the ratio of consumption to true gross domestic product has remained relatively constant (Figure 5). If we begin a new time trend in 1978, and regress the ratio on time, the regression line for the ratio rises 0.25 percentage point a year, from 62.7 percent in 1978 to 68.1 percent in 2000. The latter number is 9.5 percent above its base level of 62.2 percent and, thus, suggests an even higher investment in 2000. Of greater interest is the fact that the standard error of the regression is 0.60 percent – the standard deviation of the residuals is smaller than during the period from 1951 to 1981. That is, the ratio of consumption to gross domestic product is not moving at all erratically, but moving upward as steadily as it had been steadily constant. If there is an irrational bubble in consumption, it is immense and it is not of very recent origin – it has been building steadily for two decades!

An alternative way to document the relationship between consumption and intangible output is to use regression analysis. The underlying thesis is that data on research and development, software, and advertising proxy for a total quantity of gross private intangible investment. If this investment were included in GDP, then the ratio of consumption to GDP would be unchanged rather than rising from 1978 forward.
The first point to be made is that if we take the three intangibles and similarly "detrend" them by dividing by GDP, the contemporaneous correlations are very high. As Table 5 shows, the contemporaneous correlations among consumption, research and development and software are very high, all over 0.93. This multicollinearity means that regression coefficients and their tests may not be very meaningful.

I have regressed consumption on research and development, software, and advertising, after first dividing each by GDP, over the period from 1959 to 2002. The results (in Table 6) suggest that the rise in the consumption to GDP ratio can plausibly numerically be explained by the three intangible investments.

The high degree of correlation among the right hand side terms suggests that aggregation may be useful. I combined the three investments by multiplying research and development and software by two and adding advertising, into a variable I call intangible investment (the outcome is not sensitive to the weighting). I then performed a vector auto regression with annual data from 1961 to 2002, with a Cholesky ordering of consumption (called CONSY) and then intangible investment (INTY).

We see bivariate Granger causality in Table 7, interpretable as saying that the lagged terms on both sides are statistically significant. In Figure 6A, it is evident that over a period of several years, much of the change in the ratio of consumption to income is explained by prior movements in the ratio of intangible investments to income.[11] Variance decomposition indicates that 71 percent of variance of the ratio of consumption to income can be explained after a period of 10 years.

These data imply that if properly measured intangible investment is on the order of twice the sum of research and development and software, plus advertising, then the puzzle concerning the rise of nominal consumption to gross domestic product can be solved by widening the definition of output to encompass gross private investment in intangibles.

Part Three. Endogenous growth theory, endogenous investment, and stock market valuation

One way of interpreting q theory is that it argues that market value of corporations is equal in free entry equilibrium to the value of past net investments in physical capital. In the following section, we extend this theory to intangible assets, via a model of quality ladders, to estimate the stock market value of intangibles using data on gross investments. The model of Grossman and Helpman (1991) is ideal for this. The simplest version of this model works this way: there are many types of goods and services in the economy, but they have the same rate of technical progress per generation, called λ, and the same average rate of obsolescence, called ι, determined endogenously. What determines the rate of obsolescence are the time rate of preference, ρ, and the price of producing technological progress, a_I.

In any model of this type, if we can estimate the rate of obsolescence, ι, and the rate of gross investment in technology, $a_I \iota$, then we can determine the steady state stock market value of intangibles, a_I.

Now it is unlikely that we are in a steady state, but the calculation will tell us whether the valuations that we have for the market are sustainable (on the extreme assumption that there is no organizational capital). I assume that the gross rate of investment in intangibles is 10 percent of GDP, or $1 trillion. I further assume that the rate of obsolescence is 16 percent, a conservative reading of the literature on research and development (see, for example, Nissim and Thomas, 2000, and Chambers et al., 1998).

[11] The contemporaneous correlation of the dependent variables is .95 but the residuals are uncorrelated, so the ordering is not important.

Then in steady state, the equilibrium stock market value of intangibles will be $6 trillion. The reasoning is straightforward. In steady state, the rate of obsolescence of intangible assets must equal the rate of their creation. The rate of creation is one-tenth of GDP, and that means that the stock market must lose, through obsolescence, exactly one-tenth of GDP each year. If the stock market is losing 16 percent of its intangibles to obsolescence every year, in steady state the stock market value of intangibles must be 0.6 times GDP, or $6 trillion. Thus it would appear that if *tangibles* by themselves justify a $10 trillion stock market, as appears to be the case from Flow of Funds data, our current rate of gross investment in *intangibles* would justify, in steady state, a $16 trillion stock market.

The value of the stock market. Suppose there are no intangible investments, which is the basic assumption of exogenous growth theory. If markets are competitive, the current value of tangible investments net of debt will, in long-run equilibrium, equal the market value of equities, by the same reasoning just presented for intangibles.

Figure 7 shows the net worth of US *nonfinancial* corporations, scaled by US gross domestic product, and the market value of their corporate equities, using data from the US flow of funds accounts, showing end-of year ratios from 1952 to 2000. It also shows the market value of all domestic corporate equities, financial and nonfinancial. The net worth of financial corporations is difficult to estimate, and the flow of funds accounts do not report a total net worth for this group. As shown, there are two periods -- the mid-1960s and the mid-1990s -- in which the stock market was approximately at its long-run equilibrium value under this version of q theory.

According to this theory of the stock market, the net worth of nonfinancial corporations is a smaller proportion of GDP today than it was during the three decades from 1960 to 1990. In this view, stock market investors have been grossly misled since at least 1995 about the value of their holdings. At the end of the first quarter of 2001, the market value of nonfinancial corporations (using the S&P Industrials as a guide) had probably fallen to about $11 trillion. According to *exogenous* growth theory, the stock market has still to fall another 25 percent.

Figure 8 shows the net worth of all US corporations, financial and nonfinancial, scaled by gross domestic product, under the assumption of *endogenous* growth theory. I assume here the electronics revolution wiped out all existing intangible assets in 1978 and that effective investment in intangibles began to occur in 1978. I assume that effective investment in intangibles has increased steadily, in line with the estimates developed in the rest of this paper, to about $1 trillion annually.

Specifically, I use the expenditure estimates shown in Figure 1 and assume that obsolescence takes place at an annual rate of 16 percent. (Alternatively, we could use the estimates from assuming a constant consumption-gross domestic product ratio, and results would not be appreciably different: the value of the stock market would be just $100 billion lower.) Under the endogenous growth theory set forth in this section, this should be a conservative estimate of corporate equity, since it does not include organizational capital. Counting intangibles, stock market valuations began to catch up with reality only in 1996, and since then, at least by past standards, the stock market has been near equilibrium. The last data point marked is year-end 2002. In this view, the bear market of 2001-02 drove the value of the stock market significantly below its long-run equilibrium value.

Part Four: Conclusion.

I have argued in this paper that data on corporate expenses, occupational wages and salaries, personal consumption expenditures, and stock market valuations are more consistent with the notion that US gross investment in intangibles in 2002 was nearer $1 trillion than zero. Indeed, the data are surprisingly consistent with a US gross investment in intangibles that is at least $1.1 trillion.

The pace of change of the US economy is likely to continue to be rapid, even if the pace of growth of gross investment in intangibles is not as fast in the future as it has been in the past 20 years. This will likely keep stock market equity valuations rising at a strong clip.

References:

Abel, Andrew B., "R&D and the Market Value of the Firm: A Note," in Zvi Griliches, ed., *R&D, Patents and Productivity*, University of Chicago Press, Chicago, 261-269, 1984.

Aghion, Philippe and Peter Howitt, "A Model of Growth Through Creative Destruction," *Econometrica*, Vol. 60, No. 2: 323-51, 1992.

Association of University Technology Managers, *AUTM Licensing Survey, FY 1999 Survey Summary*. http://www.autm.net/surveys/99/survey99A.pdf

Bils, Mark and Peter Klenow, "The Acceleration in Variety Growth," *American Economic Review* 91: 274-280, May 2001.

Campbell, John Y., Martin Lettau, Burton G. Malkiel, and Yexaio Xu, "Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk," *Journal of Finance* 56: 1-43, 2001.

Caves, Richard, *Creative Industries: Contracts Between Art and Commerce*. Harvard University Press, Cambridge MA, 2000.

Chambers, Dennis, Ross Jennings, and Robert B. Thompson, "Evidence on the Usefulness of Capitalizing and Amortizing Research and Development Costs," mimeo, University of Texas, January 1998.

Chandler, Alfred D., *The Visible Hand: The Managerial Revolution in American Business*. Belknap Press, Cambridge MA, 1980.

Chandler, Alfred D., *Scale and Scope: The Dynamics of Industrial Capitalism*. Belknap Press, Cambridge MA, reprint edition, 1994.

Fama, Eugene F., and Kenneth French, "Disappearing Dividends: Changing Firm Characteristics or Lower Propensity to Pay?" CRSP Working Paper No. 509, June 2000.

Fraumeni, Barbara, and Sumiye Okubo, "R&D Satellite Accounts and Returns to Private R&D," BEA Working Paper, 2002.

Friedman, Milton, *A Theory of the Consumption Function*. Princeton University Press, Princeton NJ, 1957.

Greenwood, Jeremy, and Boyan Jovanovic, "The IT Revolution and the Stock Market," *AER Papers and Proceedings*, May 1999.

Greenwood, Jeremy and Mehmet Yorukoglu, "1974," *Carnegie-Rochester Conference Series on Public Policy*, 46: 49-95, June 1997.

Grossman, Gene M., and Elhanan Helpman, "Quality Ladders in the Theory of Growth," *Review of Economic Studies* 58: 43-61, 1991.

Hall, Robert E., "The Stock Market and Capital Accumulation," NBER Working Paper 7180, June 1999.

Hill, Peter. "Tangibles, Intangibles, and Services: A New Taxonomy for the Classification of Output," *Canadian Journal of Economics*, April 1999, 426-446.

Jovanovic, Boyan, and Peter Rousseau, “Vintage Organizational Capital,” NYU Working Paper, 2001.

Keynes, John Maynard, *The General Theory of Employment, Interest, and Money*. Harcourt Brace, NY, 1936.

Lev, Baruch, and Theodore Sougiannis, “The Capitalization, Amortization, and Value Relevance of R&D,” *Journal of Accounting and Economics* 21: 107-138, 1996.

McCann-Erickson World Group, *Bob Coen’s Insider’s Report*. December 2000.

http://www.mccann.com/html/coenreport.html

McGrattan, Ellen R., and Edward C. Prescott, “Is the Stock Market Overvalued?” NBER Working Paper No. 8077, January 2001.

Nakamura, Leonard. “Is the US Economy Really Growing to Slowly? Maybe We’re Measuring Growth Wrong,” Federal Reserve Bank of Philadelphia *Business Review*, March/April 1997.

Nakamura, Leonard, “The Measurement of Retail Output and the Retail Revolution,” *Canadian Journal of Economics* April 1999a, 408-425.

Nakamura, Leonard. “Intangibles: What Put the *New* in the New Economy?” Federal Reserve Bank of Philadelphia *Business Review*, July/August 1999b.

Nakamura, Leonard. “Economics and the New Economy: The Invisible Hand Meets Creative Destruction,” Federal Reserve Bank of Philadelphia *Business Review*, July/August 2000.

Nakamura, Leonard, “Education and Training in an Era of Creative Destruction,” Federal Reserve Bank of Philadelphia Working Paper 00-13/R, 2001.

National Science Foundation, *National Patterns of R&D Resources: 2000 Data Update*, 2000.

http://www.nsf.gov/sbe/srs/nsf01309/pdf/tabd.pdf

Nissim, Doron, and Jacob Thomas, “R&D Costs and Accounting Profits,” University of Haifa, Zimmerman Foundation Discussion Paper ZF-01-01, April 2000.

OECD Secretariat, “Treatment of the Components of Intangible Investment in the 1993 System of National Accounts,” mimeo, 1998.

Parker, Jonathan, “Spendthrift in America? On Two Decades of Decline in the U.S. Savings Rate,” in Ben Bernanke and Julio Rotemberg eds, *NBER Macroeconomics Annual, 1999*, MIT Press, 317-70, 1999.

Peach, Richard, and Charles Steindel, “A Nation of Spendthrifts? An Analysis of Trends in Personal and Gross Saving,” Federal Reserve Bank of New York *Current Issues in Economics and Finance* 6, September 2000.

Ramsey, Frank P., “A Mathematical Theory of Savings,” *The Economic Journal* 38: 543-59, 1928.

Romer, Paul, “New Goods, Old Theory, and the Welfare Costs of Trade Restrictions,” *Journal of Development Economics* 43: 5-38, 1994.

Scherer, Frederic M., *Innovation and Growth*. MIT Press, Cambridge MA, 1984.

Scherer, Frederic M., and Dietmar Harhoff, “Technology Policy for a World of Skew-distributed Outcomes,” *Research Policy* 29, 559-566, 2000.

Schumpeter, Joseph, *Capitalism, Socialism, and Democracy*. Harper, New York, 1942.

Solow, Robert M., "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70: 65-94, 1956.

Stein, Jeremy C., "Waves of Creative Destruction: Firm-Specific Learning-by-Doing and the Dynamics of Innovation," *Review of Economic Studies* 64, 265-288, 1997.

U.S. Bureau of Economic Analysis. Private Nonresidential Fixed Investment in Software (seasonally adjusted).

U.S. Department of Labor, Bureau of Labor Statistics, *Employment & Earnings*, Household Data, Annual Averages.

Figure 1
3 Types of Investments in Intangibles Accelerate after 1978

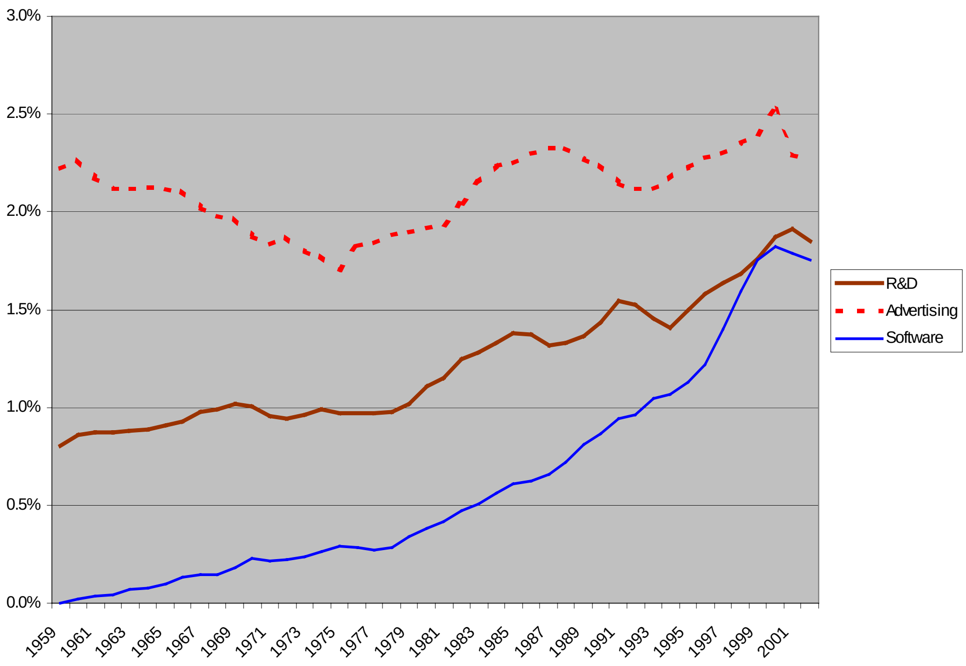


Figure 2
Alternative total measures of intangibles rise after 1978

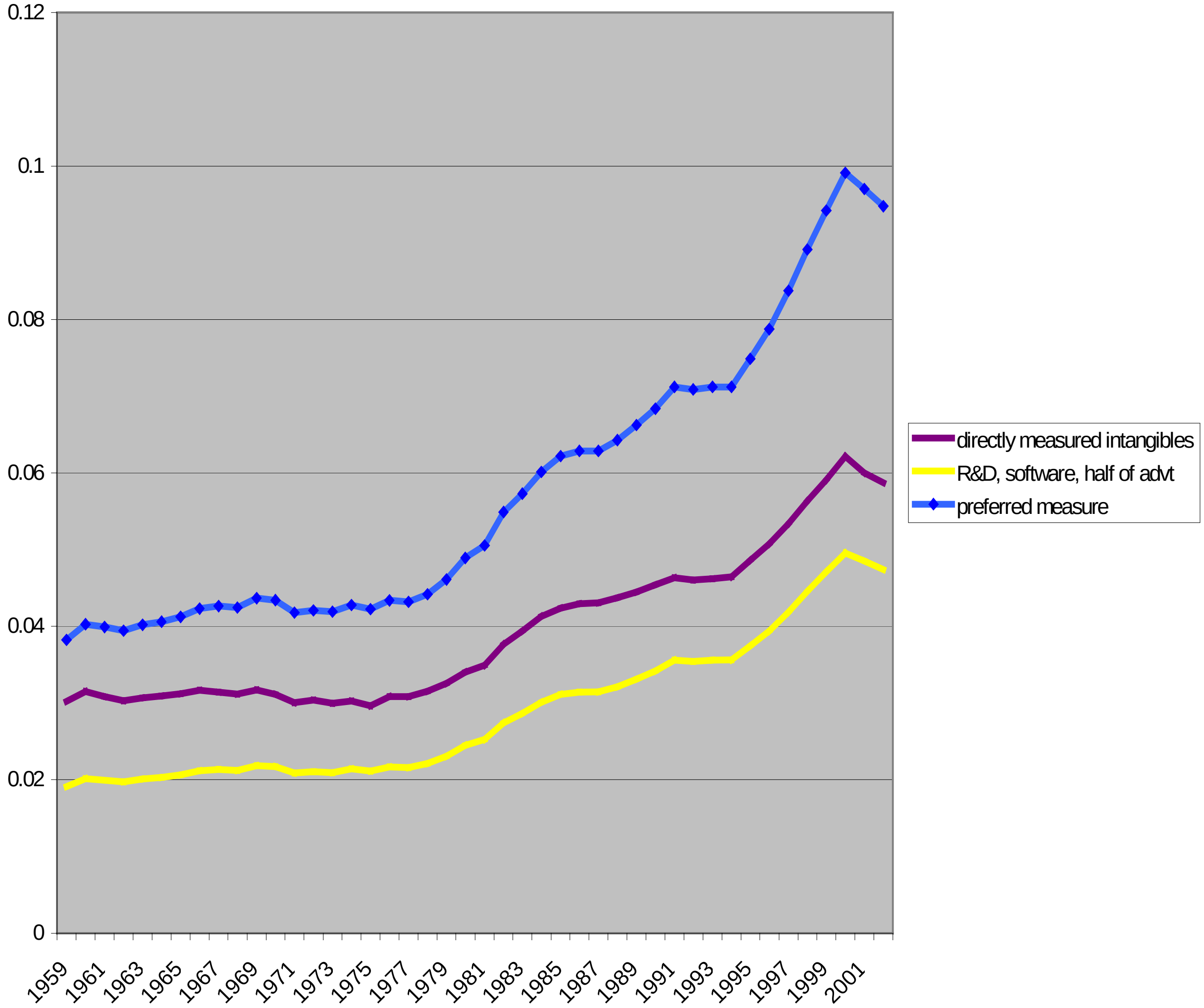


Figure 3. Aggregate wages and salaries, full time workers

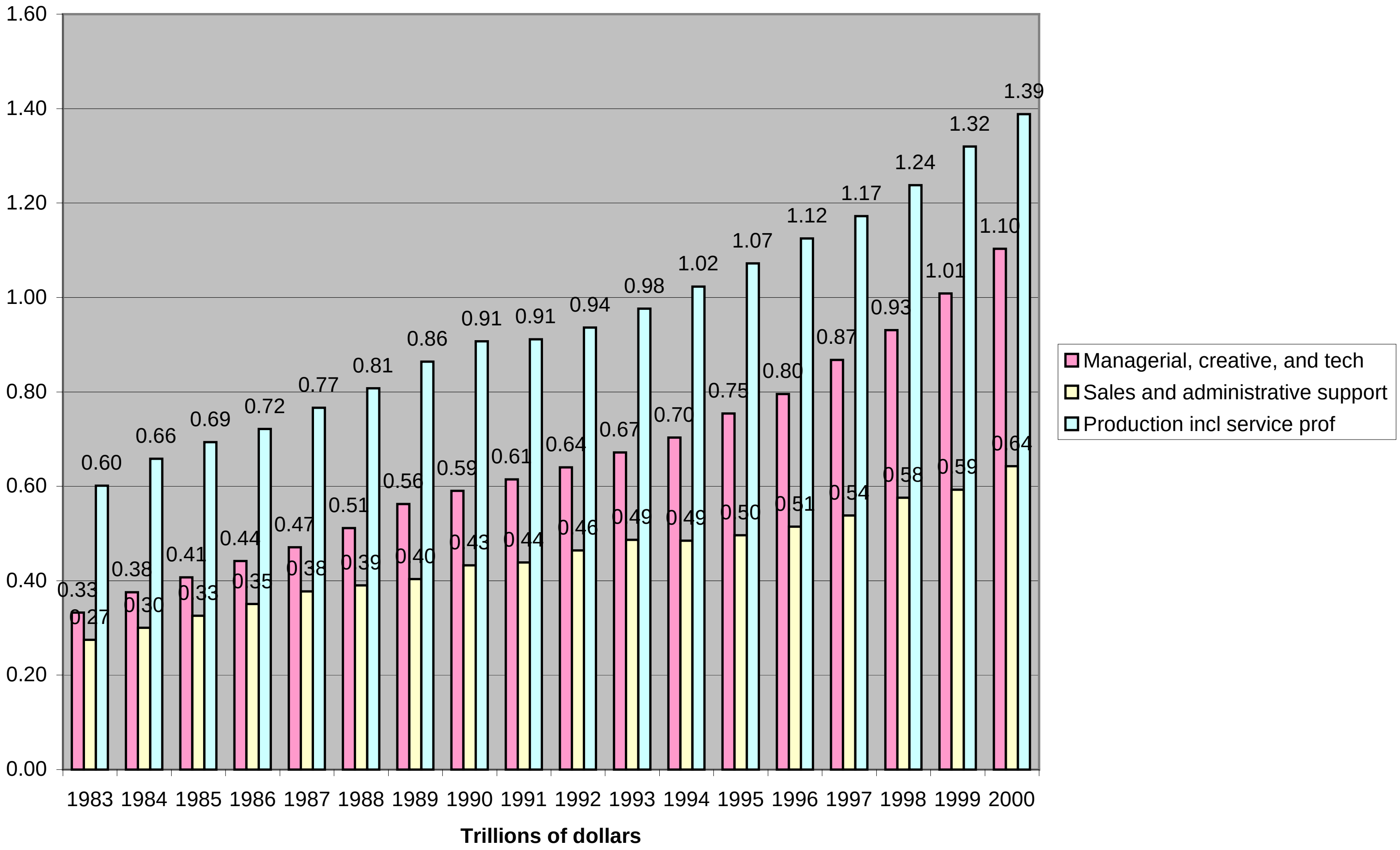


Figure 4. Cost of goods sold as a proportion of revenues

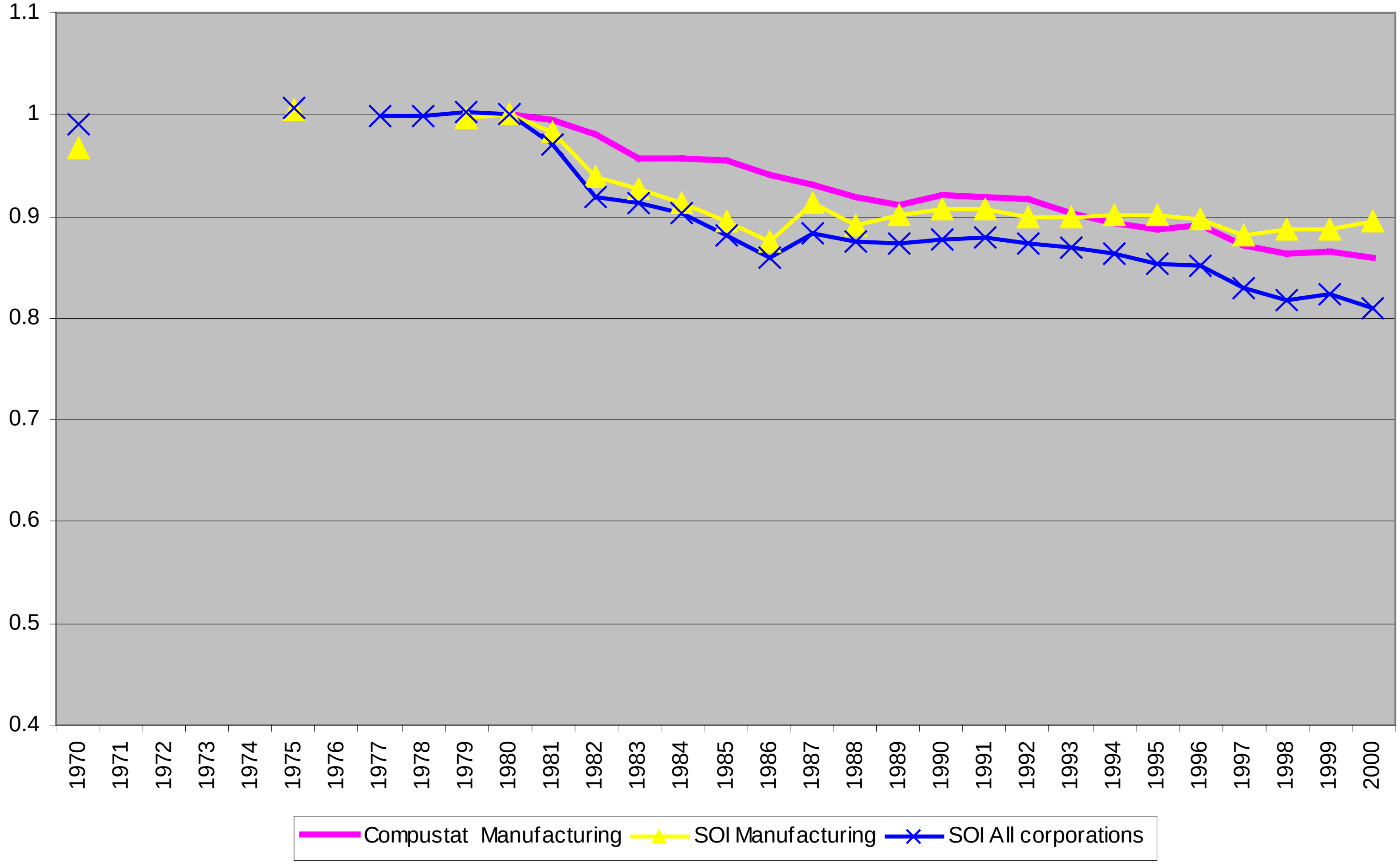


Figure 5. Personal Consumption Expenditures
Percent of GDP

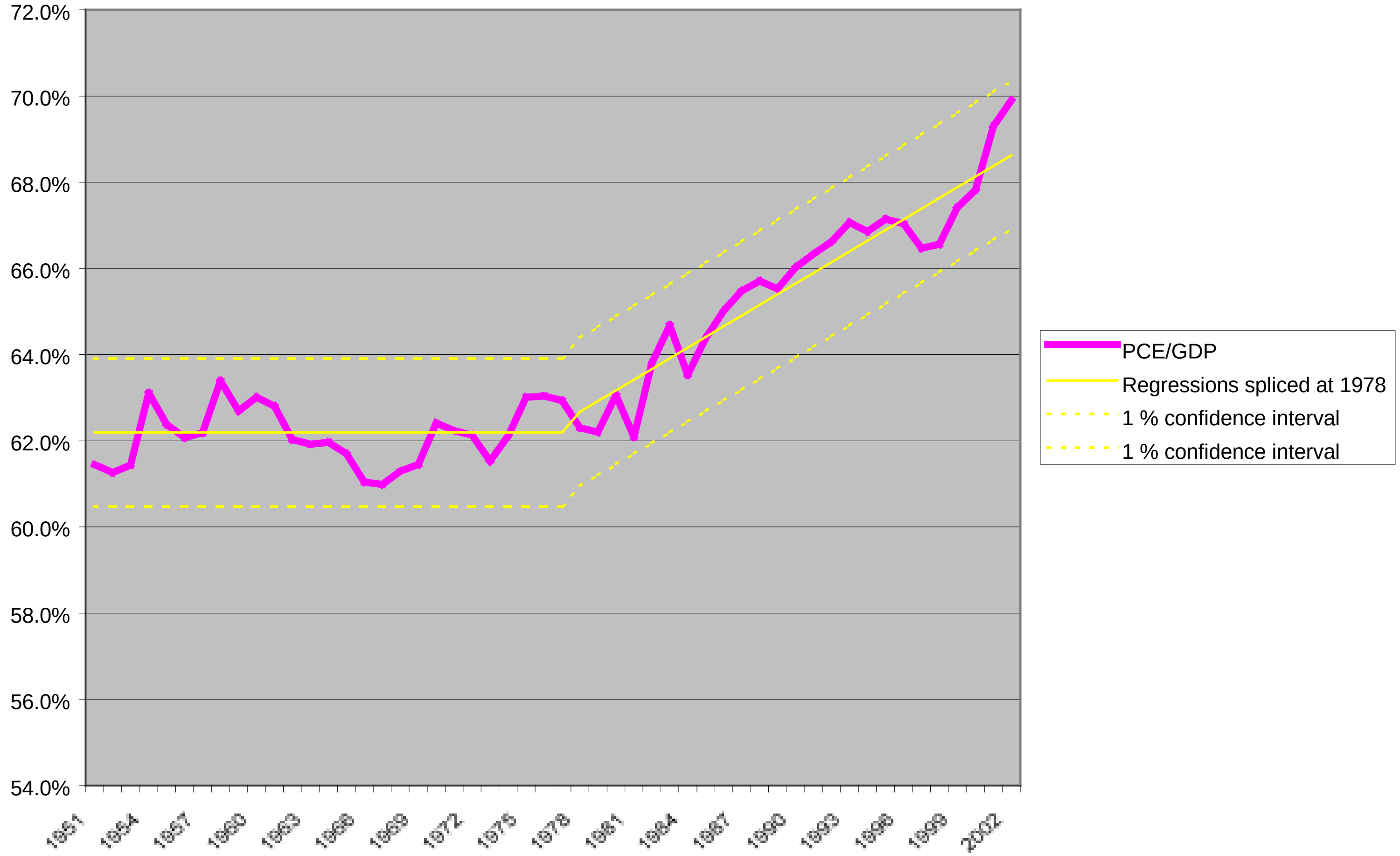


Figure 6.
Regression of Consumption on Intangibles

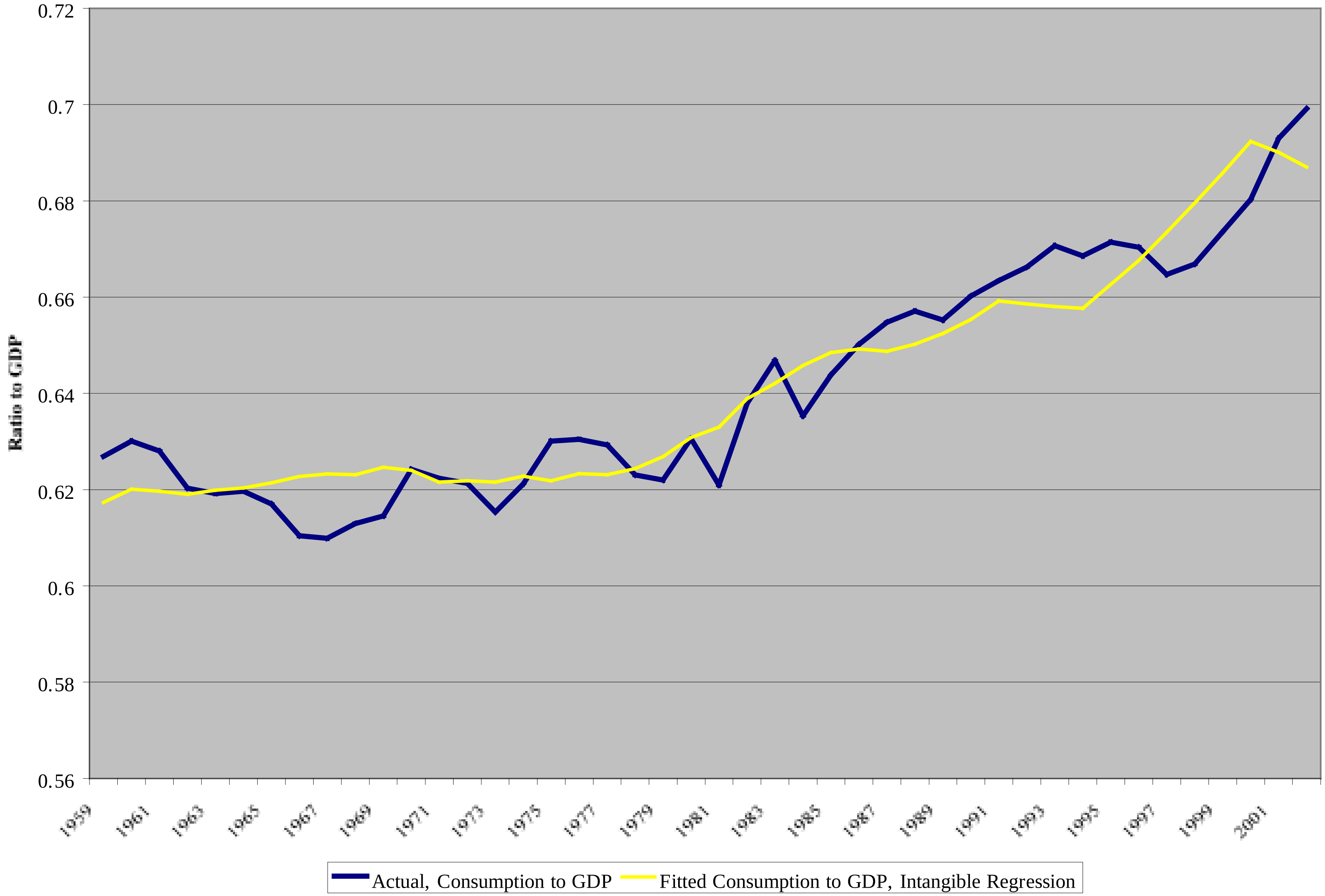
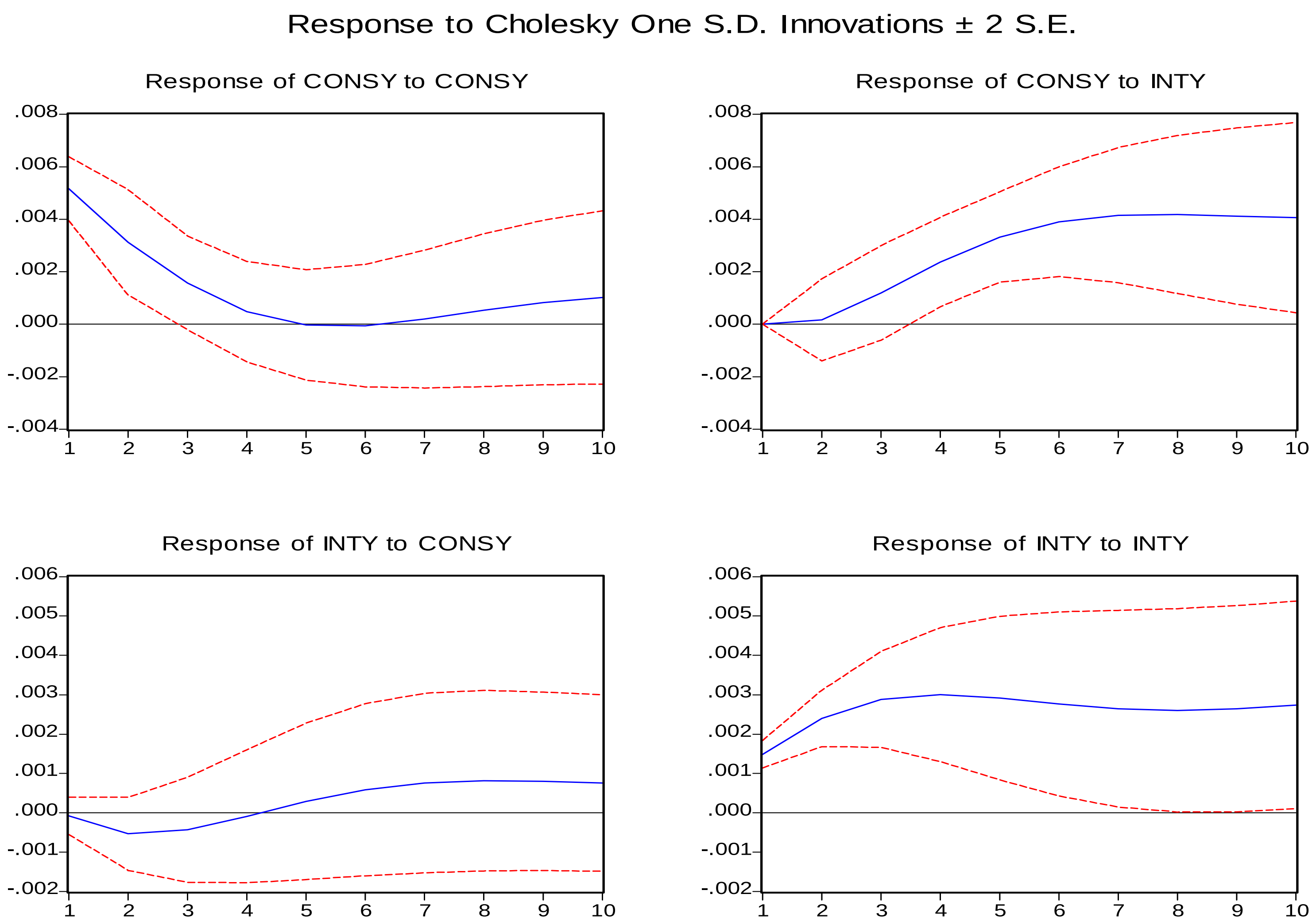


Figure 6A



Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of CONSY to CONSY
Response of CONSY to INTY
Response of INTY to CONSY
Response of INTY to INTY
.008
.006
.004
.002
.000
-.002
-.004
.005
.003
.001
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**Figure 7. Exogenous growth theory:
US Corporate Equity Valuations
ratio to GDP**

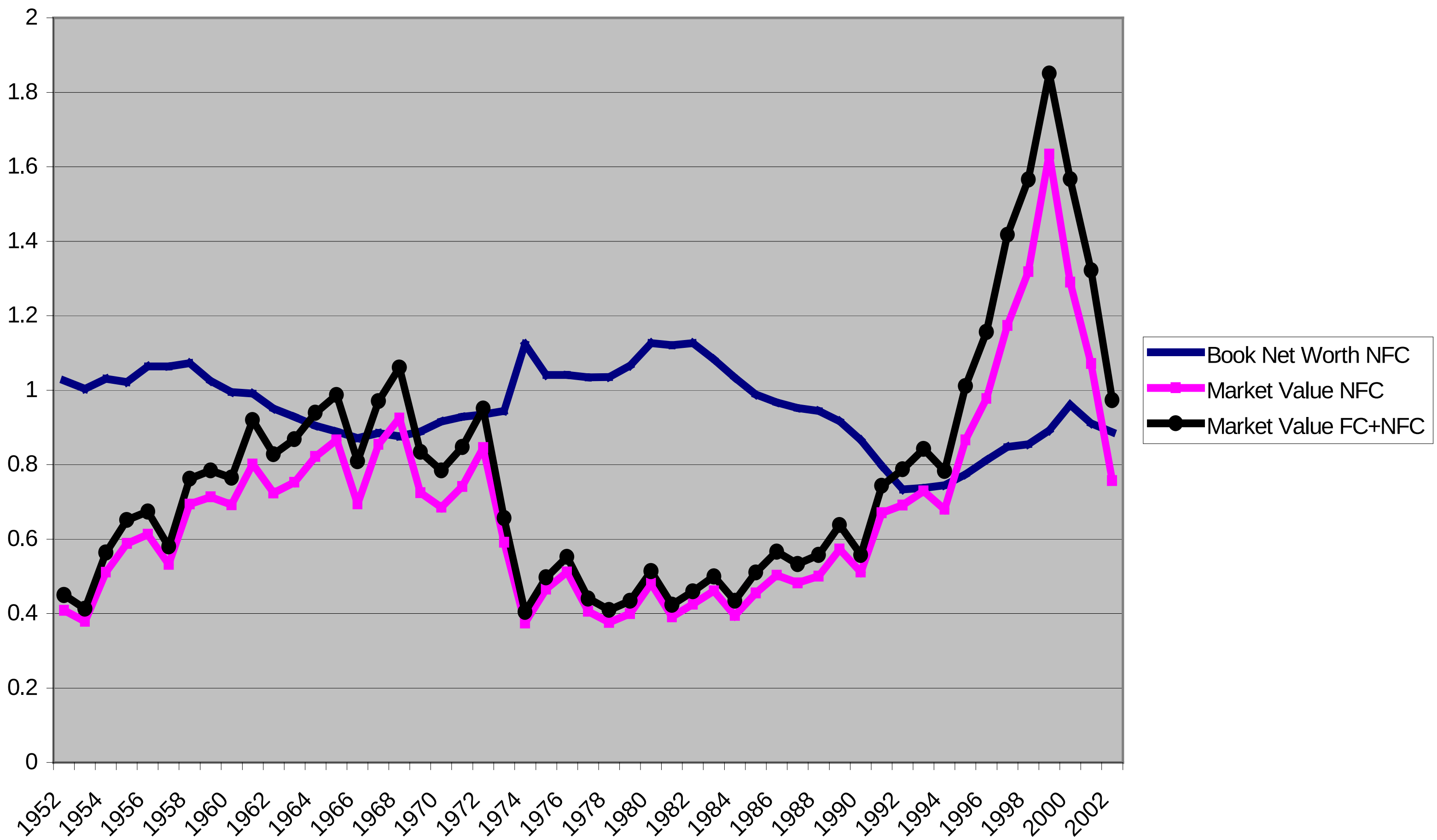

Figure 8. Endogenous theory
Market value and book net worth, including intangibles

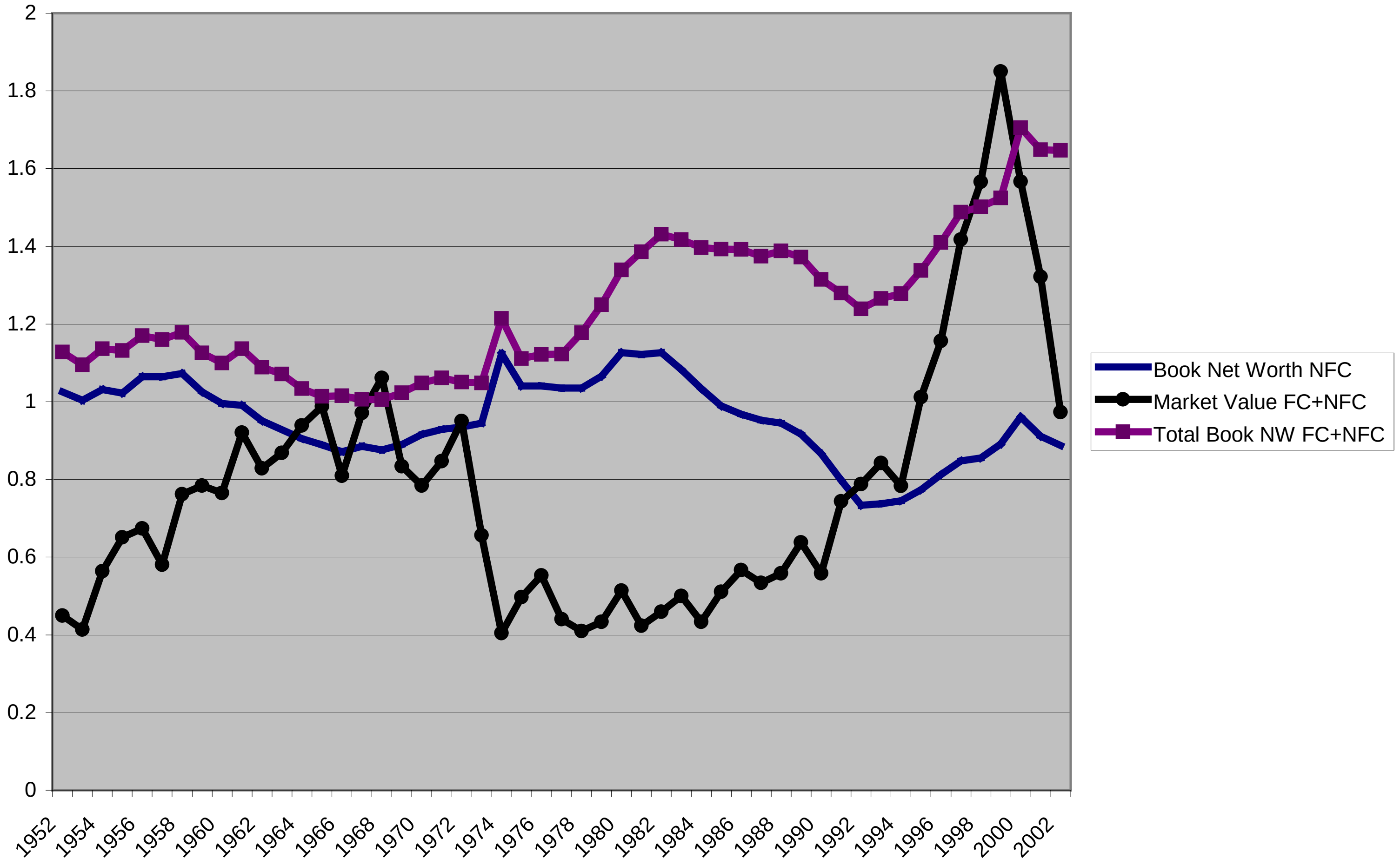

Table 1.	GDP	R&D	Advertising	Software	R&D	Advertising	Software
		Billions of current dollars				Percent of GDP	
1959	507.4	4.065	11.27	0	0.8 %	2.2 %	0.0 %
1960	527.4	4.516	11.96	0.1	0.9 %	2.3 %	0.0 %
1961	545.7	4.757	11.86	0.2	0.9 %	2.2 %	0.0 %
1962	586.5	5.124	12.43	0.2	0.9 %	2.1 %	0.0 %
1963	618.7	5.456	13.1	0.4	0.9 %	2.1 %	0.1 %
1964	664.4	5.888	14.15	0.5	0.9 %	2.1 %	0.1 %
1965	720.1	6.549	15.25	0.7	0.9 %	2.1 %	0.1 %
1966	789.3	7.331	16.63	1	0.9 %	2.1 %	0.1 %
1967	834.1	8.146	16.87	1.2	1.0 %	2.0 %	0.1 %
1968	911.5	9.008	18.09	1.3	1.0 %	2.0 %	0.1 %
1969	985.3	10.011	19.42	1.8	1.0 %	2.0 %	0.2 %
1970	1039.7	10.449	19.55	2.3	1.0 %	1.9 %	0.2 %
1971	1128.6	10.824	20.7	2.4	1.0 %	1.8 %	0.2 %
1972	1240.4	11.715	23.21	2.8	0.9 %	1.9 %	0.2 %
1973	1385.5	13.299	24.98	3.2	1.0 %	1.8 %	0.2 %
1974	1501	14.885	26.62	3.9	1.0 %	1.8 %	0.3 %
1975	1635.2	15.824	27.9	4.8	1.0 %	1.7 %	0.3 %
1976	1823.9	17.702	33.3	5.2	1.0 %	1.8 %	0.3 %
1977	2031.4	19.642	37.44	5.5	1.0 %	1.8 %	0.3 %
1978	2295.9	22.457	43.33	6.6	1.0 %	1.9 %	0.3 %
1979	2566.4	26.097	48.78	8.7	1.0 %	1.9 %	0.3 %
1980	2795.6	30.929	53.57	10.7	1.1 %	1.9 %	0.4 %
1981	3131.3	35.948	60.46	12.9	1.1 %	1.9 %	0.4 %
1982	3259.2	40.692	66.67	15.4	1.2 %	2.0 %	0.5 %
1983	3534.9	45.264	76	18	1.3 %	2.1 %	0.5 %
1984	3932.7	52.187	88.01	22.1	1.3 %	2.2 %	0.6 %
1985	4213	57.962	94.9	25.6	1.4 %	2.3 %	0.6 %
1986	4452.9	60.991	102.37	27.8	1.4 %	2.3 %	0.6 %
1987	4742.5	62.576	110.27	31.4	1.3 %	2.3 %	0.7 %
1988	5108.3	67.977	118.75	36.7	1.3 %	2.3 %	0.7 %
1989	5489.1	74.966	124.77	44.4	1.4 %	2.3 %	0.8 %
1990	5803.2	83.208	129.59	50.2	1.4 %	2.2 %	0.9 %
1991	5986.2	92.3	127.57	56.6	1.5 %	2.1 %	0.9 %
1992	6318.9	96.229	132.65	60.8	1.5 %	2.1 %	1.0 %
1993	6642.3	96.549	139.54	69.4	1.5 %	2.1 %	1.0 %
1994	7054.3	99.203	151.68	75.5	1.4 %	2.2 %	1.1 %
1995	7400.5	110.87	162.93	83.5	1.5 %	2.2 %	1.1 %
1996	7813.2	123.412	175.23	95.1	1.6 %	2.2 %	1.2 %
1997	8318.4	136.231	187.529	116.5	1.6 %	2.3 %	1.4 %
1998	8790.2	147.867	201.594	144.1	1.7 %	2.3 %	1.6 %
1999	9274.3	163.245	222.30	162.5	1.8 %	2.4 %	1.8 %
2000	9824.6	183.724	247.50	179.4	1.9 %	2.5 %	1.8 %
2001	10082.2	192.873	231.30	180.4	1.9 %	2.3 %	1.8 %
2002	10446.2	193.420	237.40	182.8	1.9 %	2.3 %	1.7 %

Table 2: Creative Workers

Occupations	1950	1960	1970	1980	1990	2000
Total	58999	68007	80071	97639	117914	135208
creative occupations	1107	1582	2613	3672	5575	7855
Engineers, etc.	586	947	1375	1517	2004	2326
Scientists, etc.	152	205	440	846	1630	3090
Writers, artists, etc.	369	429	798	1309	1941	2439
% of total						
creative occupations	1.9 %	2.3 %	3.3 %	3.8 %	4.7 %	5.8 %
Engineers, etc.	1.0 %	1.4 %	1.7 %	1.6 %	1.7 %	1.7 %
Mathematicians, scientists, etc.	0.3 %	0.3 %	0.5 %	0.9 %	1.4 %	2.3 %
Writers, artists, etc.	0.6 %	0.6 %	1.0 %	1.3 %	1.6 %	1.8 %

Newly-Defined Categories

Occupations	2000	2001	2002
Total	136891	136933	136485
Creative occupations	8968	8921	8490
Architecture & Engineering	2988	2937	2731
Computer & Mathematical	3318	3261	3117
Life, Physical, & Social Science	1251	1275	1287
Arts, Design, Entertainment, Sports, Media	2662	2724	2642
% of total			
Creative occupations	6.6 %	6.5 %	6.2 %
Architecture & Engineering	2.2 %	2.1 %	2.0 %
Computer & Mathematical	2.4 %	2.4 %	2.3 %
Life, Physical, & Social Science	0.9 %	0.9 %	0.9 %
Arts, Design, Entertainment, Sports, Media	1.9 %	2.0 %	1.9 %

Table 3. Median pay of full-time workers

	2000 Number	Median pay	Estimated payroll	Estimated Payroll, Percent of total
Executive	15368	840	12909120	21.8 %
Professional Specialty	16087	832	13384384	22.6 %
Creative professional totals	6209	911	5935113	10.0 %
Engineers, Architects, etc.	2156	1098	2367288	4.0 %
Mathematicians and computer scientists	1890	992	1874880	3.2 %
Natural scientists	490	913	447370	0.8 %
Social scientists	296	826	244496	0.4 %
Writers, artists, athletes and entertainers	1377	727	1001079	1.7 %
Service professionals	9878	754	7449271	12.6 %
Technicians	3652	648	2366496	4.0 %
Sales	10133	550	5573150	9.4 %
Administrative Support	14468	469	6785492	11.5 %
Service	11020	355	3912100	6.6 %
Precision production	12163	613	7455919	12.6 %
Operators	15411	446	6873306	11.6 %
Farming, forestry and fishing	1616	334	539744	0.9 %
Total	99918	593	59259967	

Table 4. Cost of goods sold as proportion of revenue

	Statistics of Income		Compustat
	All corporations	Manufacturing	Manufacturing
1970	65.5 %	68.6 %	
1971			
1972			
1973			
1974			
1975	66.6 %	71.4 %	
1976			
1977	66.0 %		
1978	66.0 %		
1979	66.3 %	70.8 %	
1980	66.1 %	71.0 %	76.8 %
1981	64.2 %	69.8 %	76.5 %
1982	60.8 %	66.7 %	75.4 %
1983	60.4 %	65.7 %	73.8 %
1984	59.7 %	64.9 %	73.1 %
1985	58.3 %	63.5 %	72.7 %
1986	56.8 %	62.2 %	70.7 %
1987	58.4 %	64.8 %	70.0 %
1988	57.9 %	63.2 %	69.3 %
1989	57.8 %	63.9 %	68.7 %
1990	57.9 %	64.4 %	69.2 %
1991	58.2 %	64.4 %	69.6 %
1992	57.7 %	63.9 %	69.6 %
1993	57.5 %	63.8 %	68.7 %
1994	57.1 %	63.9 %	67.9 %
1995	56.4 %	63.9 %	67.2 %
1996	56.2 %	63.7 %	67.7 %
1997	54.9 %	62.6 %	66.7 %
1998	54.0 %	62.9 %	66.5 %
1999	54.4 %	62.9 %	66.7 %
2000	53.5 %	63.5 %	65.8 %
2001			68.6 %

Table 5. Contemporaneous correlations between consumption and intangible investments, 1959-2002. (all variables in nominal terms, divided by gross domestic product)				
	Consumption	Research and Development	Software	Advertisement
Research and Development	.940	1.000		
Software	.937	.977	1.000	
Advertisement	.680	.670	.637	1.000

Table 6. OLS Regression of Consumption on Intangibles, 1959-2002 (all variables in nominal terms, divided by gross domestic product)				
Dependent variable: Consumption	Constant	Research and Development	Software	Advertisement
Coefficient	0.562	3.226	2.006	1.320
T-statistic	28.1	1.714	1.904	1.542

Table 7. Vector Autoregressions, 1961-2002		
	Coefficients (t-statistics in parentheses)	
	CONSY	INTY
CONSTANT	.244 (3.55)	-.024 (-1.22)
CONSY(-1)	.606 (3.80)	-.079 (-1.72)
CONSY(-2)	-.043 (-.292)	.121 (2.88)
INTY(-1)	.220 (0.222)	1.612 (11.30)
INTY(-2)	.557 (0.99)	-.653 (-4.04)
Adj. RSq.	.956	.994
Granger causality test exclusion probability	INTY: .0001	CONSY: 0145