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Productivity and the Post-1990 U.S. Economy[†]

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ABSTRACT

In this paper, we show that ignoring corporate intangible investments gives a distorted picture of the post-1990 U.S. economy. In particular, ignoring intangible investments in the late 1990s leads one to conclude that productivity growth was modest, corporate profits were low, and corporate investment was at moderate levels. In fact, the late 1990s was a boom period for productivity growth, corporate profits, and corporate investment.

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1. Introduction

The standard measure of productivity is gross domestic product (GDP) per hour worked. The thesis of this paper is that this measure of productivity is not a good measure of actual output produced per hour worked, which we call *economic productivity*. The reason is that output is understated by GDP because many investments are not accounted for in the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) measure of product. If the importance of these unaccounted investments relative to GDP remained constant over time, growth in GDP per hour would be equal to growth in economic productivity. But in the post-1990 U.S. economy, the relative importance of these investment varied a lot. We find that excluding them in the measure of U.S. output leads to a large underestimate of productivity growth in the late 1990s.

In this paper, this unaccounted investment will be called *intangible investment*.[1] They are expenditures that increase future profits but, by national accounting rules, are treated as an operating expense rather than as a capital expenditure. Examples include advertising, research and development, and, most important of all, investments in building organizations. Most intangible investments are not directly observable, but they can be inferred using standard growth theory and data from the U.S. national income and product accounts (NIPA). We do this and show that movements in accounting and economic measures of productivity are very different during the 1990s. In particular, we find that productivity growth prior to 1997 was even weaker than suggested by GDP per hour worked, that there was a productivity boom in the late 1990s, and that productivity growth returned to its low level subsequent to the boom. In fact, corporate profit share was high in the 1997–2000 boom.

[1] We use this term because the bulk of the investments are not tangible.

Our accounting has other implications, in particular, for corporate profits and corporate investment. In the late 1990s output boom, the corporate profit share reported by the BEA was low. (See U.S. Department of Commerce (1929–2002).) A low profit share is not typical in booms. The reason the corporate profit share fell in the 1997–1999 boom is simple accounting: accounting profits understated economic profits because corporations were making large intangible investments in the late 1990s that they expensed. Adding intangible investments to accounting profits and to accounting investment implies a very different picture of the U.S. economy.

2. The Model Economy

In this section, we present a version of the model economy that we used to analyze secular movements in corporate equity values. (See McGrattan and Prescott 2004.) Here, we use the model to compare accounting and economic measures of key aggregate statistics.

The economy is populated by a large number of identical, infinitely lived households. They make decisions about consumption, labor supply, and saving. These decisions are event contingent, where the events are generated by a finite state Markov chain with stationary transition probabilities. The period t state is $s_t \in S$.

Preferences of the stand-in household are ordered by

$$E \sum_{t=0}^{\infty} \beta^t \, U(C_t/N_t, L_t/N_t) \tag{2.1}$$

where C_t is total consumption, L_t is total labor supply, and N_t is the working-age population.

There are two stand-in firms, one for the corporate sector and one for the noncorporate

sector. The constant-returns technology for the corporate sector, sector 1, is given by

$$
\begin{aligned}
Y_{1,t} &= f^c(K_{1m,t}, K_{1u,t}, L_{1,t}, s_t) \\
K_{1m,t+1} &= (1-\delta_{1m})K_{1m,t} + X_{1m,t} \\
K_{1u,t+1} &= (1-\delta_{1u})K_{1u,t} + X_{1u,t} \\
\hat{K}_{1m,t+1} &= [(1-\hat{\delta}_{1m})\hat{K}_{1m,t} + (1-\hat{\delta}_{1x})X_{1m,t}]/(1+\pi_{t,t+1})
\end{aligned}
$$

where $Y_{1,t}$ is the output of the sector, $K_{1m,t}$ is the beginning-of-period stock of measured capital, $K_{1u,t}$ is the beginning-of-period stock of unmeasured capital, $\hat{K}_{1m,t}$ is the beginning-of-period book value of the stock of measured capital, $L_{1,t}$ is the labor input, $X_{1m,t}$ is new investment in measured capital, $X_{1u,t}$ is new investment in unmeasured capital, and $\pi_{t,t+1}$ is the inflation rate between t and $t+1$. Later, we use the fact that f^c has a unit elasticity between capital and labor, with the capital share equal to θ.

Stocks $K_{1m,t}$ and $\hat{K}_{1m,t}$ can be different if tax rules allow for differences between depreciation for taxes and actual economic depreciation. They can also be different if there is inflation. The stocks of measured and unmeasured capital depreciate at rates δ_{1m} and δ_{1u}, respectively. For tax purposes, capital consumption allowances are equal to $\hat{\delta}_{1m}\hat{K}_{1m,t} + \hat{\delta}_{1x}X_{1m,t}$ and can exceed $\delta_{1m}K_{1m,t}$ because of accelerated depreciation allowances or allowances by the IRS for expensing tangible investments.

The constant-returns technology for the noncorporate sector, sector 2, is

$$
\begin{aligned}
Y_{2,t} &= f^{nc}(K_{2m,t}, L_{2,t}, s_t) \\
K_{2m,t+1} &= (1-\delta_{2m})K_{2m,t} + X_{2m,t} \\
\hat{K}_{2m,t+1} &= [(1-\hat{\delta}_{1m})\hat{K}_{2m,t} + (1-\hat{\delta}_{1x})X_{2m,t}]/(1+\pi_{t,t+1})
\end{aligned}
$$

where $Y_{2,t}$ is the output of the sector, $K_{2m,t}$ is the beginning-of-period stock of measured

capital, $\hat{K}_{2m,t}$ is the beginning-of-period book value of the stock of measured capital, $L_{2,t}$ is the labor input, and $X_{2m,t}$ is new investment in measured capital. Later, we use the fact that f^{nc} has a unit elasticity between capital and labor, with the capital share equal to α.

The rate of economic depreciation of noncorporate capital is δ_{2m}. For tax purposes, total depreciation is $\hat{\delta}_{2m}K_{2m,t} + \hat{\delta}_{2x}X_{2m,t}$. We assume that intangible capital investment in the noncorporate sector is negligible and therefore do not include it.[2]

Policy in this economy is a set of tax rates and transfer functions that depend on the state s_t. Both the households and the firms pay taxes.

We consider recursive competitive equilibria with equilibrium elements that are stationary functions of the economy's state vector. Because of our assumption that s_t is a Markov process with time-invariant transition probabilities, the aggregate state in period t is $(K_{1m,t}, K_{1u,t}, \hat{K}_{1m,t}, K_{2m,t}, \hat{K}_{2m,t}, s_t)$. For convenience, let $K_t = (K_{1m,t}, K_{1u,t}, \hat{K}_{1m,t}, K_{2m,t}, \hat{K}_{2m,t})$. For a stationary recursive equilibrium, the state in period t is a function of the period t event history $s^t = (s_0, \ldots, s_t)$, a fact that we use later.

The problem of the household is to maximize (2.1) subject to the period t budget constraints:

$$(1 + \tau_{c,t})C_t + A_{t+1} = (1 - \tau_{d,t})D_{1,t} + D_{2,t} + (1 - \tau_{n,t})W_tL_t + (1 + i_t)A_t + T_t \qquad (2.2)$$

where A_t is asset holdings at the beginning of period t. The household, during period t, receives income from corporate and noncorporate distributions, $D_{1,t}$ and $D_{2,t}$, respectively, wages at after-tax rate $(1 - \tau_{n,t})W_t$, assets at after-tax rate i_t, and net transfers from the

[2] Most of the investment in the noncorporate sector is in the household and government sectors, with little or no expenditures on items such as research and development, advertising, and investments in organizational capital.

government T_t. Distributions $D_{1,t}$ and $D_{2,t}$ are both net of taxes paid by corporate and noncorporate firms.

Corporate firms maximize the present value of after-tax distributions to the household, namely,

$$\sum_t \sum_{s^t} (1 - \tau_{d,t}(s^t)) p_t(s^t) D_{1,t}(s^t).$$

Corporate distributions are

$$\begin{aligned} D_{1,t} = {} & p_{1,t} Y_{1,t} - W_t L_{1,t} - X_{1m,t} - q_t X_{1u,t} \\ & - \tau_{1,t} \left[p_{1,t} Y_{1,t} - W_t L_{1,t} - \hat{\delta}_{1m} \hat{K}_{1m,t} - \hat{\delta}_{1x} X_{1m,t} - \tau_{1k,t} K_{1m,t} - q_t X_{1u,t} \right] \\ & - \tau_{1k,t} K_{1m,t} + \tau_{x,t} X_{1m,t}. \end{aligned}$$

Noncorporate firms maximize the present value of distributions, namely,

$$\sum_t \sum_{s^t} p_t(s^t) D_{2,t}(s^t).$$

Thus, noncorporate distributions are

$$\begin{aligned} D_{2,t} = {} & p_{2,t} Y_{2,t} - W_t L_{2,t} - X_{2m,t} \\ & - \tau_{2,t} [p_{2,t} Y_{2,t} - W_t L_{2,t} - \hat{\delta}_{2m} \hat{K}_{2m,t} - \hat{\delta}_{2x} X_{2m,t} - \tau_{2k,t} K_{2m,t}] \\ & - \tau_{2k,t} K_{2m,t} + \tau_{x,t} X_{2m,t}. \end{aligned}$$

Note that income taxes are paid once on noncorporate income (net of proprietors' implicit labor income).

There is a final goods producer that combines corporate and noncorporate goods to solve

$$\max_{y_1, y_2} \quad F(Y_1, Y_2) - p_1 Y_1 - p_2 Y_2.$$

The composite output $Y = F(Y_1, Y_2)$ good is used for consumptions and investments:

$$Y_t = C_t + X_{1m,t} + q_t X_{1u,t} + X_{2m,t} + G_t$$

where G_t is government consumption. The function F displays constant returns to scale. An implication is that equilibrium distributions are zero, and therefore we do not consider these distributions.

There is growth in the economy due to population growth and productivity. We detrend income and product variables by dividing first by population and second by $(1+\gamma)^t$, the trend in productivity. To construct hours per capita, we divide total labor input by population. We adopt the notation of lowercase letters for variables that are stationary. For example, $c_t = C_t/[N_t(1+\gamma)^t]$ is detrended consumption and $\ell_t = L_t/N_t$ is detrended labor supply.

It also convenient to introduce notation for the marginal products of capital. Let $r_{1m,t}$, $r_{1u,t}$, and $r_{2m,t}$ be the marginal products of measured corporate capital, unmeasured corporate capital, and measured noncorporate capital, respectively.

We now are ready to lay out the national accounts for our model economy.

3. National Accounts to Model Economy Accounts

In this section, we specify the mapping from U.S. national accounts to the model economy accounts. Our model accounts are summarized in Table A in the appendix, with formula specifying entries as a function of model variables. Table B reports the main categories of the U.S. national accounts, with average values relative to GDP in the 1990s. Table C specifies the model account numbers as a function of the statistics in the U.S. national

accounts and the values of these statistics.[3]

3.1. Adjustments

There are four important differences between the accounts our model economy dictates and the U.S. national accounts. First, our model output does not include consumption taxes as part of consumption and as part of value added, but NIPA GDP does. A consequence of this is that, unlike NIPA, our accounts are consistent in using producer prices for inputs and outputs. Second, we treat some financial services included in NIPA as intermediate rather than as final. Third, our model treats expenditures on all fixed assets as investment. Thus, consumer durables are treated as an investment in the model accounts rather than as consumption expenditures. We introduce a consumer durable services sector in much the same way as an owner-occupied housing sector is introduced into NIPA. Households rent the consumer durables to themselves. A related adjustment is made for government capital. Finally, and most importantly for the purposes of this paper, our model output includes corporate intangible investment. Intangible investments are expensed and therefore not included in the national accounts.

3.1.1. Adjustments for consumption tax

Our *consumption taxes* are all *non-property* taxes on production and imports less subsidies plus business current transfer payments. The reason that we include business transfers in consumption taxes is that they are mostly liability payments, which de facto are a tax. NIPA reports total consumption taxes, which we must assign to the corporate and noncorporate sectors. The sums of consumption and property taxes are reported by sector. We

[3] Numbered lines in Table C correspond to numbered lines in Table A.

assign aggregate consumption taxes to sectors in proportion to their sums of consumption and property taxes. We subtract the consumption tax from the value added of each sector.

On the product side we assume that all components of NIPA personal consumption expenditures, which include consumer durable expenditures, are taxed at an equal rate. In fact a small part of what we call consumption taxes fall on other components of product, but we do not have good estimates of how much. Thus, we make the simplifying assumption that all consumption taxes fall on personal consumption expenditures. Fortunately, the assignment does not affect the results of this study.

The results of our adjustments for consumption taxes are summarized in Table C (lines 4, 8, 10, and 14).

3.1.2. Adjustments for intermediate services

Corporate value added includes some services that are not included in our notion of final goods or services.[4] In particular, NIPA imputes to net interest and to consumption an amount equal to the expenses of handling life insurance and pensions, which are intermediate goods in the production of a final good, namely, a diversified financial portfolio. On the income side, we subtract these expenses (which are about 1 percent of GDP) from corporate net interest (Table B, line 6). On the product side, we subtract these expenses from personal consumption expenditures (Table B, line 16).

In our mapping from national accounts to model accounts in Table C, these calculations are listed as "imputed personal business expense." They appear under capital income (line 4) and private consumption (line 10).

[4] There have been major changes recently in the accounting of financial services. Most intermediate services are now excluded from GDP.

3.1.3. Adjustments for capital services

We make adjustments in our model accounts for consumer durables and government capital so as to treat them like all other fixed assets accounted for in NIPA.

The implicit rental price of consumer durables that we use is consumer durable depreciation divided by the value of the stock of durables plus the after-tax return on capital. Using estimates from McGrattan and Prescott (2004), we assume that the return is 4.1 percent per year.[5] The imputation to consumption is this rental price times the stock of consumer durables. There are two imputations to value added. First, we add depreciation of consumer durables to noncorporate depreciation. Second, we add the return on capital times the stock of consumer durables to noncorporate profits.

In Table C, these calculations are summarized in imputed capital services under noncorporate capital income (line 8) and private consumption (line 10).

In NIPA, the services of government capital are equal to its depreciation. Thus, net income is zero. We define net income of government capital as our average after-tax return on capital (4.1 percent) times the value of this capital stock. We add this income to profits of the noncorporate sector on the value added side of the accounts and to public consumption on the product side.

In Table C, these calculations are summarized in imputed capital services under noncorporate capital income (line 8) and public consumption (line 11).

[5] If i is not close to this value, then returns to capital in the model are not consistent with observed capital stocks and tax rates.

3.1.4. Adjustments for intangible investments

The last adjustment we make to corporate income is to add back investments that had been expensed. We do not have direct measures of these expenses but can infer them from our theory and NIPA data. In this section, we use the theory to estimate the average level of intangible investment and the equilibrium path since 1990.

The average level of intangible investment in the 1990s

As in McGrattan and Prescott (2004), we can take an indirect approach, using observations on corporate profits and returns to tangible assets to estimate a return to intangible assets. NIPA profit before corporate income tax is

$$\begin{aligned}\text{NIPA profit } &= r_{1m}k_{1m} + r_{1u}k_{1u} - \delta_{1m}k_{1m} - \tau_{1k}k_{1m} - qx_{1u} \\ &= (r_{1m} - \delta_{1m} - \tau_{1k})k_{1m} + q(r_{1u}/qk_{1u} - x_{1u}). \end{aligned} \tag{3.1}$$

If economic and accounting depreciation are equal and returns are equated for all assets, then the first-order conditions of the model in Section 2 imply that the following hold:[6]

$$i = r_{1u}/q - \delta_{1u} \tag{3.2}$$

$$i = \frac{(1-\tau_1)(r_{1m} - \tau_{1k}) + \tau_1\delta_{1m}}{1-\tau_x} - \delta_{1m} \tag{3.3}$$

$$x_{1u} = (\gamma + \eta + \delta_{1u})k_{1u} \tag{3.4}$$

$$x_{1m} = (\gamma + \eta + \delta_{1m})k_{1m} \tag{3.5}$$

on a balanced growth path, where i is the real interest rate and η is the population growth rate.

[6] We also did calculations allowing for differences in the depreciation rates. Holding the corporate tax rate fixed, we find a higher average level of intangible investment if accounting depreciation exceeds economic depreciation. Thus, to be conservative in our conclusions about the importance of intangible investment, we assume economic and accounting depreciation are equal.

Equations (3.1)-(3.5) can be solved for the average level of intangible investment and capital. This is done as follows. We use BEA data to get estimates of the corporate income tax rate τ_1, the corporate property tax rate τ_{1k}, the subsidy to investment τ_x, the tangible depreciation rate δ_{1m}, and corporate tangible investment x_{1m}. We can use either the noncorporate returns or estimates of preference parameters to get the real interest rate i. Population growth η is around 1 percent per year. Trend technology growth γ is around 2 percent per year.

The system of equations (3.1)-(3.5) is five equations in the five unknowns, $r_{1u}/q - \delta_{1u}$, r_{1m}, qk_{1u}, k_{1m}, and qx_{1u}. Using data from the 1990s, our estimate of the average value of intangible capital qk_{1u} is 0.65 times GDP.[7] This estimate is independent of our choice of δ_{1u}. Our estimate of net investment $qx_{1u} - \delta_{1u}k_{1u}$ is also independent of our choice of δ_{1u}. Net intangible investment averaged 2 percent of GDP.[8]

The equilibrium path of intangible investment since 1990

We can infer the path for intangible using intratemperal first-order conditions of the model. We use two approaches that lead to similar quantitative implications for productivity in the 1990s. The two approaches rely on different assumptions about cost shares over the business cycle.

Our first approach assumes that the capital income share does not vary over the cycle. Let θ be the capital share in the corporate sector, which we take to be the average corporate capital income share, $(r_{1m}k_{1m} + r_{1u}k_{1u})/(p_1y_1)$, or equivalently one less the

[7] The inputs to this calculation are: $\tau_1 = 0.37$, $\tau_{1k} = 0.02$, $\tau_x = 0$, $\delta_{1m} = 0.06$, $x_{1m} = 0.099$, $i = 0.041$, $\gamma = 0.02$, and $\eta = 0.01$.

[8] For convenience we will set $\delta_{1u} = 0$ when we derive time series for $q_t x_{1u,t}$. We are in effect working with net intangible investment.

average corporate labor income share, $1 - w\ell_1/(p_1y_1)$. Using averages in the 1990s, we estimate an average corporate capital share of $\theta = 0.33$. If intangible investments are chosen so that

$$\begin{aligned}\frac{w_t\ell_{1,t}}{p_{1,t}y_{1,t}} &= 1 - \theta_t \\ &= 1 - \theta,\end{aligned}$$

then $q_t x_{1u,t}$ satisfies

$$\begin{aligned}w_t\ell_{1,t} &= (1-\theta)p_{1,t}y_{1,t} \\ &= (1-\theta)[\text{va}_{1,t}^{accounting} + q_t x_{1u,t}] \end{aligned} \tag{3.6}$$

where we have an estimate of θ and time series for corporate compensation, $w_t\ell_{1,t}$ and accounting corporate value added, $\text{va}_{1,t}^{accounting}$, which is equal to corporate value added less intangible investment. The unknown in equation (3.6) is the product $q_t x_{1u,t}$.

In Figure 1, we display the implied time series for intangible investment after 1990. What is striking about this figure is the six-fold increase in the level of intangible investments between 1997 and 2000. This represents a very large change in investment. This change in investment has consequences for output, profits, and total investment.

Output is the sum of corporate and noncorporate income, namely, y_t, after the relevant adjustments to the national accounts are made. Economic corporate profits are capital income, which is corporate income less labor income and depreciation. If we assume an intangible depreciation rate of zero, then economic corporate profits are given by[9]

$$p_{1,t}y_{1,t} - w_t\ell_{1,t} - \delta_{1m}k_{1m,t}.$$

[9] In McGrattan and Prescott (2004b), we do a sensitivity analysis that includes varying δ_{1u}.

Economic corporate investment is the sum of tangible plus intangible investments. Economic profit shares and investment shares are defined relative to output y_t rather than GDP.

In Figure 2, we compare the standard measure of productivity, real GDP per hour worked, with our economic measure y_t/ℓ_t. We normalize hours to be 1 in 1990 so that we can directly compare the magnitudes of GDP and y. We also divide both measures by 1.02^t, the historical trend.

The figure shows that economic productivity fell faster than accounting productivity in the early 1990s but grew much faster at the end of the 1990s. Notice that economic productivity is higher than accounting productivity in 1990 because output y is 8 percent higher than GDP. A comparison with Figure 1 illustrates how important the movements in intangible investment are for output.

In Figure 3, we plot the accounting measure of corporate profits relative to GDP and our economic corporate profits relative to output. Our measure is significantly higher because we do not subtract intangible investment or property tax. Our measure also includes the small part of corporate net interest that is not intermediate services. Our profit share is about 12 percent while NIPA's profit share is 7.5 percent.

Of particular significance is the fact that the patterns are very different. In the late 1990s, economic profits are high while NIPA profits are low.

In Figure 4, we plot the accounting measure of the corporate investment share, namely corporate tangible investment relative to GDP and our economic measure which is total corporate investment—tangible and intangible—divided by output y. Notice that the standard accounting measure shows only a modest investment boom in the late 1990s,

while our measure shows a bigger investment boom.

Our second approach to measuring the path of intangible investment assumes that the ratio of labor income shares across sectors is constant. Let $1-\theta_t$ be the corporate labor income share in period t and let $1-\alpha_t$ be the noncorporate labor income share in period t. Thus, our second approach assumes that

$$\frac{1-\theta_t}{1-\alpha_t} = \frac{1-\theta}{1-\alpha} \tag{3.7}$$

where θ and α are found by taking averages over our sample period. For the corporate sector, the average is $\theta = 0.33$. For noncorporate sector, the average is $\alpha = 0.496$.[10]

Assuming that corporate income shares stay constant puts a lower bound on the increase of intangible investment during the late 1990s as capital income shares are almost surely procyclical. The reason is simple. If accounting profits are low relative to trend, we are attributing the difference to expensed investments. However, accounting profits may appear even lower if compared to boom-time levels. When we assume that income shares vary over the cycle, then we find a larger gap between economic and accounting profits in booms and, hence, a larger amount of intangible investment.

Equation (3.7) and observables can be used to find the value of intangible investment in units of the consumption good as follows. Substituting for the labor shares in (3.7) yields

$$\left(\frac{w_t \ell_{1,t}}{p_{1,t} y_{1,t}}\right)\left(\frac{p_{2,t} y_{2,t}}{w_t \ell_{2,t}}\right) = \frac{1-\theta}{1-\alpha}.$$

This equation can be solved for corporate value added, $p_{1,t}y_{1,t}$, as a function of observables. Variable $p_{1,t}y_{1,t}$ can be used along with accounting value added in the corporate sector to

[10] The capital cost share for the noncorporate sector is high because a significant fraction of this sector's capital is housing and consumer durables, which have a capital cost share near one.

find the value of unmeasured investment, that is,

$$q_t x_{1u,t} = p_{1,t} y_{1,t} - \text{va}_{1,t}^{accounting}.$$

In Figure 5, we plot the equilibrium path for the implied investment in intangible. As before we find a six-fold increase in the level of intangible investments between 1997 and 2000. The main difference between the measures in Figure 1 and Figure 5 are the magnitudes. Assuming varying income shares implies a higher absolute value of intangible investment at the peak in 2000.

What are the consequences for productivity? In Figure 6, we compare the standard measure of productivity, real GDP per hour worked, with the economic measure y_t/ℓ_t adjusted for the intangible investment in Figure 5. Again, we normalize hours to be 1 in 1990 so that we can directly compare the magnitudes of GDP and y. We also divide both measures by 1.02^t, the historical trend.

As in the case of fixed corporate shares, we find that economic productivity fell faster than accounting productivity in the early 1990s but grew much faster at the end of the 1990s. The rise in productivity is somewhat higher in the case that corporate income shares vary. Over the period 1997–2000, we estimate that productivity rose 3.2 percent per year in the case with fixed corporate income shares and 4 percent per year in the case with varying corporate income shares. However, both cases show a much different picture than GDP per hour.

4. Supporting Evidence

As we noted earlier, we do not have direct measures of all intangible investments. There are some direct measures of one important component of intangible investment, namely research and development. In Figure 7, we plot expenditures for research and development performed by industry. Some of these expenditures are capital expenditures and therefore are not included in our notion of intangible investments. However, we find a similar pattern of investment. Investment in R&D fell rapidly in the first half of the 1990s and rose rapidly in the second half. This is what we find for total intangible investment.

5. Summary

U.S. growth in GDP per hour worked, which we call accounting productivity, was well below trend in the 1973–1995 period and then recovered to the historical level of 2 percent per year growth beginning in 1995. (See Figure 2.) This picture is what most of the leading researchers in productivity accounting find.[11] They, as do we, use hours worked estimates based on the Current Population Survey.[12]

We find that economic productivity, which includes corporate intangible investment in output, displays a very different pattern. As shown in Figure 2, we find that there was a productivity growth boom in the 1997–99 period with productivity growth of 4 percent per year, well in excess of the 2 percent historical trend. Prior and subsequent to this

[11] See, for example Jorgenson et al. (2003, p. 45) and Groningen Growth and Development Centre and The Conference Board (2004).

[12] There are two other measures of U.S. hours worked. The BEA estimate, which uses state unemployment tax records to estimate the number of paid workers, and the BLS estimate, which uses an establishment survey to estimate the number of paid workers. The BEA hours estimate, which is an annual series, paints the same picture as CPS hours. The BLS hours estimate, which is a quarterly series, paints a different picture in the post-2000 period. With the BLS estimate of aggregate hours, estimated productivity growth is 1 percent higher in the 2000–2003 period. See Kunze (2004) and Eldridge, Manser, and Otto (2004) for details.

boom, average productivity growth was closer to 1 percent, which is about half of the level of trend growth.

Our accounting resolves the puzzle of why corporate accounting profits were so low in the 1998–2000 boom. Corporations were making large intangible investments, which lowered their accounting profits, but not their economic profits. The economic profits share of economic income was high in the boom. (See Figure 3.) Our accounting also resolves the puzzle of why investment share of output was not much higher in this boom than standard accounting figures indicate. With the accounting numbers dictated by economic theory, the share increases, and increases a lot in the boom. (See Figure 4.)

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Appendix

In this appendix, we display the national accounts that we work with, the NIPA categories before we make our adjustments, and a mapping from the national accounts to the model accounts. Table A lists the account categories for our model along with formulas for variables in the model. Table B lists the NIPA categories along with average values relative to GDP in the 1990s, which give the reader a sense of the magnitudes of the adjustments. Table C provides a mapping between these accounts. In the main text, we provide justifications for the calculations summarized here.

Table A. Model Economy Accounts

		Model Expression
1	Corporate Domestic Value Added	$p_1 y_1$
2	Depreciation	$\delta_{1m} k_{1m}$
3	Labor income	$w\ell_1$
4	Capital income	$r_{1m} k_{1m} + r_{1u} k_{1u} - \delta_{1m} k_{1m}$
5	Noncorporate Domestic Value Added	$p_2 y_2$
6	Depreciation	$\delta_{2m} k_{2m}$
7	Labor income	$w\ell_2$
8	Capital income	$r_{2m} k_{2m} - \delta_{2m} k_{2m}$
9	Total Domestic Value Added	y
	Domestic Product	
10	Private consumption	c
11	Public consumption	g
12	Corporate measured investment	x_{1m}
13	Corporate unmeasured investment	$q x_{1u}$
14	Noncorporate investment	x_{2m}
15	Total Domestic Product	y

Table B. National Accounts, Average in 1990s Relative to GDP

1	Corporate Domestic Value Added	0.589
2	Consumption of fixed capital	0.066
3	Compensation of employees	0.378
4	Corporate profits with IVA and CCadj	0.075
5	Taxes on production and imports[a]	0.056
6	Net interest and miscellaneous payments	0.013
7	Noncorporate Domestic Value Added	0.400
8	Consumption of fixed capital	0.053
9	Compensation of employees	0.240
10	Rental income of persons with IVA	0.014
11	Proprietors' income with IVA and CCadj	0.068
12	Taxes on production and imports[a]	0.020
13	Net interest and miscellaneous payments	0.051
14	Statistical discrepancy	0.011
15	Total Domestic Value Added	1.000
	Domestic Product	
16	Personal consumption expenditures	0.670
17	Durable goods	0.082
18	Nondurable goods and services	0.588
19	Government consumption expenditures and gross investment	0.189
20	Consumption expenditures	0.156
21	Gross investment	0.033
22	Gross private domestic investment[b]	
23	Corporate	0.099
24	Noncorporate	0.055
25	Net exports of goods and services	−0.013
26	Total Domestic Product	1.000
	Addendum:	
27	Consumption taxes	0.047
28	Consumption of fixed capital, durable goods	0.062
29	Current-cost net stock of government fixed assets	0.604
30	Current-cost net stock of consumer durable goods	0.308

[a] This category includes business transfers and excludes subsidies.

[b] The breakdown into corporate and noncorporate investments is based on data from the *Flow of Funds Accounts* (Federal Reserve Board of Governors (1945–2002)). For corporate investment, we sum investment of nonfinancial corporate business, financial corporations, and 10% of farm business.

Table C. Mapping from National Accounts to Model Accounts[a]

		Model	NIPA
1	Corporate Domestic Value Added ($p_1 y_1$)		
2	Depreciation ($\delta_{1m} k_{1m}$)	0.066	
	Consumption of fixed capital		0.066
3	Labor income ($w\ell_1$)	0.378	
	Compensation		0.378
4	Capital income ($r_{1m}k_{1m} + r_{1u}k_{1u} - \delta_{1m}k_{1m}$)	0.120	
	Corporate profits with IVA and CCadj		0.075
	Net interest and miscellaneous payments		0.013
	Less: Imputed personal business expense[b]		−0.010
	Taxes on production and imports		0.056
	Less: Consumption taxes		−0.034
	Corporate unmeasured investment		0.020
			0.120
5	Noncorporate Domestic Value Added ($p_2 y_2$)		
6	Depreciation ($\delta_{2m} k_{2m}$)	0.115	
	Consumption of fixed capital		0.053
	Consumption of fixed capital, durable goods		0.062
			0.115
7	Labor income ($w\ell_2$)	0.251	
	Compensation		0.192
	70% Proprietors' income with IVA and CCadj		0.048
	Statistical discrepancy		0.011
			0.251
8	Capital income ($r_{2m}k_{2m} - \delta_{2m}k_{2m}$)	0.132	
	Rental income of persons with CCadj		0.014
	30% Proprietors' income with IVA and CCadj		0.020
	Net interest and miscellaneous payments		0.051
	Current surplus of government enterprises		0.001
	Taxes on production and imports		0.020
	Imputed capital services[c]		0.038
	Less: Consumption taxes		−0.012
			0.132
9	Total Domestic Value Added (y)	1.062	1.062

See footnotes at the end of the table.

Table C. Mapping from National Accounts to Model Accounts (cont.)

		Model	NIPA
	Domestic Product		
10	Private consumption (c)	0.611	
	Personal consumption expenditures		0.670
	Less: Consumption taxes		−0.042
	Imputed capital services[c]		0.013
	Consumption of fixed capital, durable goods		0.062
	Less: Consumption expenditures, durable goods		−0.082
	Less: Imputed personal business expense[b]		−0.010
			0.611
11	Public consumption (g)	0.180	
	Government consumption expenditures		0.156
	Imputed capital services[c]		0.025
			0.180
12	Corporate measured investment (x_{1m})	0.099	
	Gross domestic private investment, corporate		0.099
13	Corporate unmeasured investment (qx_{1u})	0.020	
	Corporate unmeasured investment		0.020
14	Noncorporate investment (x_{2m})	0.152	
	Gross domestic private investment, noncorporate		0.055
	Personal consumption expenditures, durable goods		0.082
	Less: Consumption taxes		−0.005
	Government investment		0.033
	Net exports		−0.013
			0.152
15	Total Product (y)	1.062	1.062

[a] Model and NIPA values based on averages over 1990s in Table B.

[b] Expense is for handling life insurance and pension plans.

[c] Imputed capital services are equal to 4.1% times the current-cost net stock of government fixed assets and consumer durables goods.

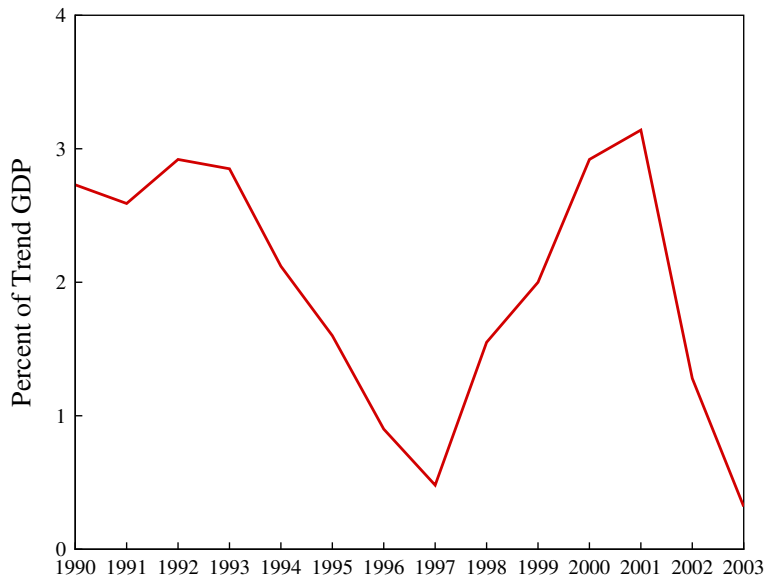

Figure 1. Intangible Investment
(Corporate Income Shares Fixed)

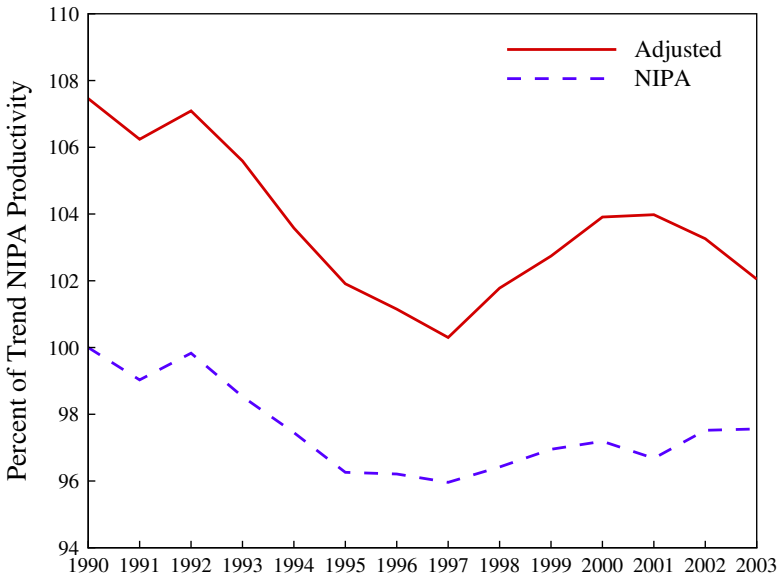

Figure 2. Productivity Relative to a 2% Trend
(Corporate Income Shares Fixed)

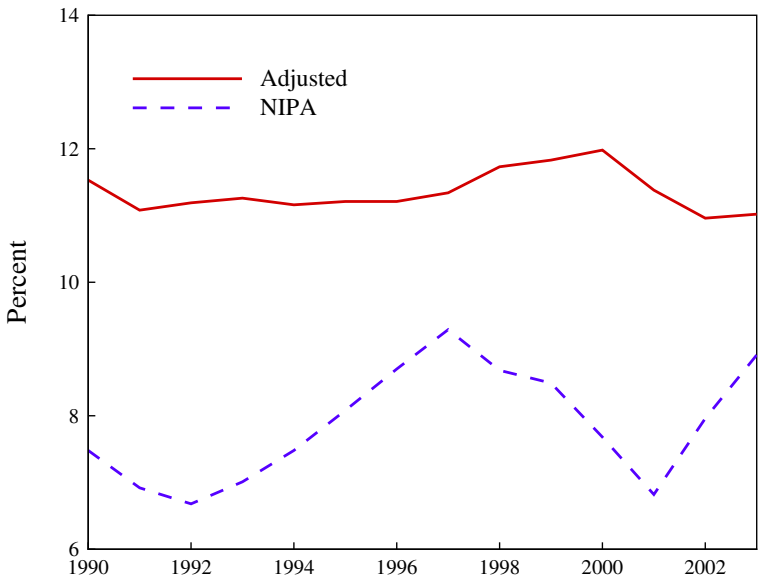

Figure 3. Corporate Profit Shares of Income
(Corporate Income Shares Fixed)

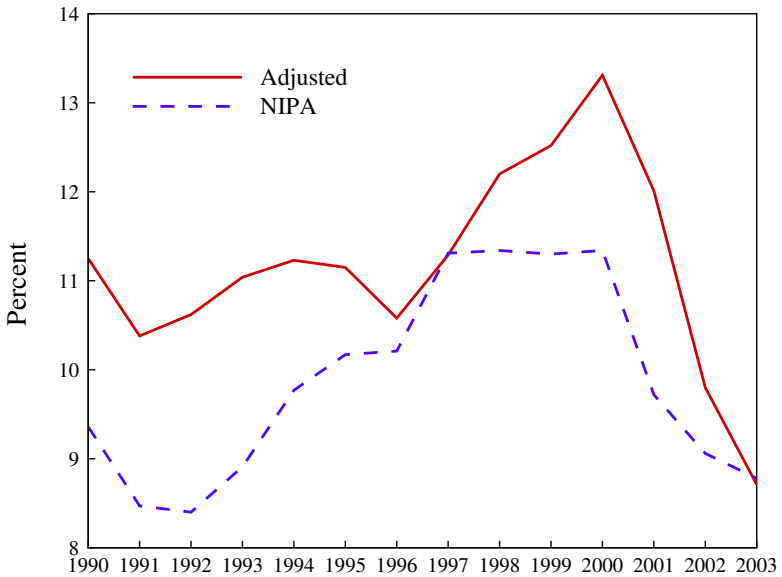

Figure 4. Corporate Investment Shares of Income
(Corporate Income Shares Fixed)

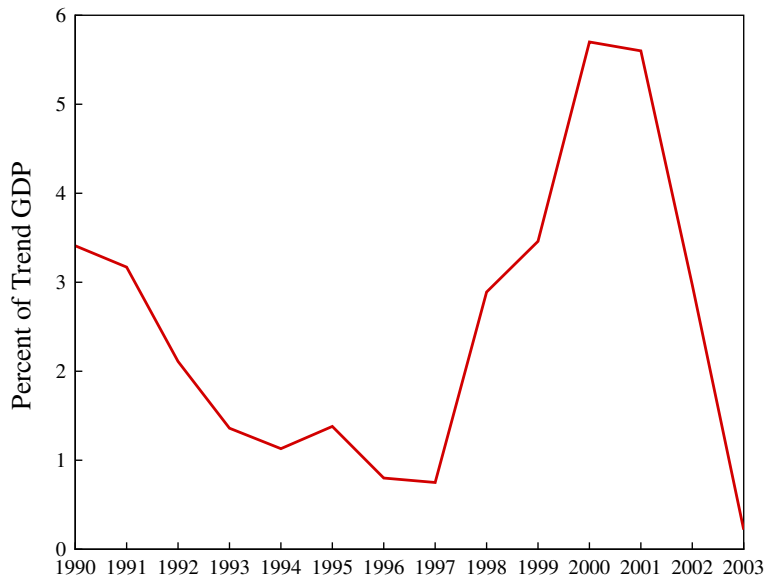

Figure 5. Intangible Investment
(Corporate Income Shares Varying)

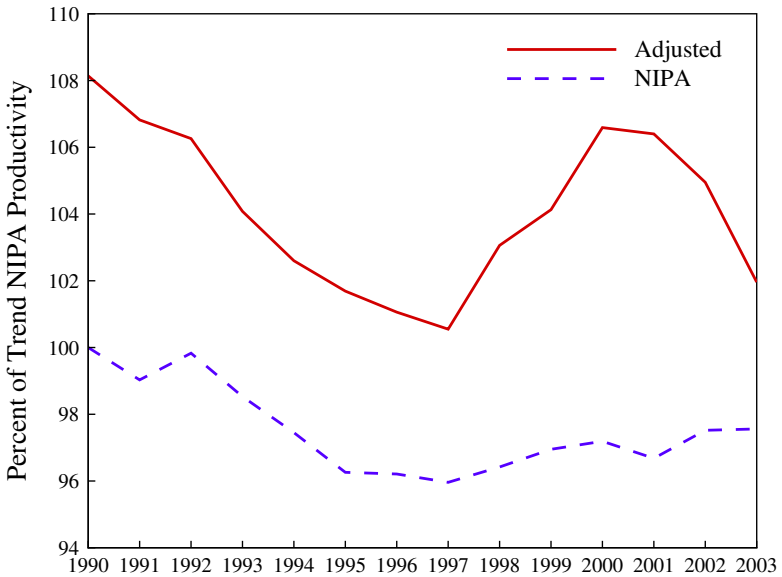

Figure 6. Productivity Relative to a 2% Trend
(Corporate Income Shares Varying)

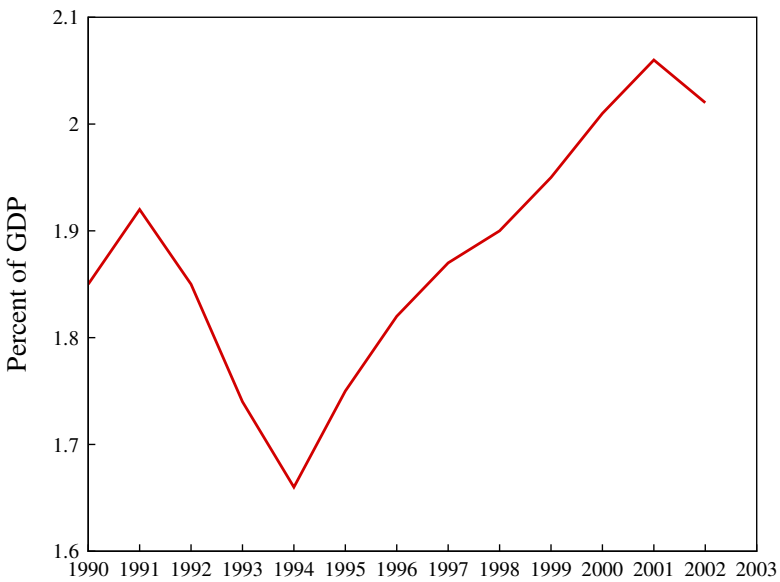

Figure 7. Industry Research and Development