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THE ACCUMULATION OF HUMAN AND NONHUMAN CAPITAL, REVISITED

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In the over 25 years since Jorgenson and Fraumeni (1989) published their first article integrating human capital measures with the national accounts, the Bureau of Economic Analysis's (BEA's) U.S. National Income and Product Accounts (NIPAs) and U.S demographics have changed significantly. The original paper is a national income accounting paper with production and factor outlay, income, receipt and expenditure, capital accumulation, and wealth accounts in current and constant prices. In this paper, we update the Jorgenson-Fraumeni human capital estimates and integrate them into the latest NIPA accounts. A comparison of the aggregates for the U.S. and their trends between the earlier 1949–19 period and later 1998–2009 period is informative. The benefit from integrating human capital components into BEA's NIPA over a long historical time period allows us to quantify the impact of the end to the gains in average educational attainment, changes in female labor force participation, and the possible impact of the greying of America.

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1. Introduction

Just over 25 years ago, Jorgenson and Fraumeni (J-F) published their first paper on human capital (1989). This first paper emphasized the importance of human capital by presenting human capital estimates for the United States embedded in a complete national income accounting system. As the current paper and the previous paper demonstrate, including human capital in the U.S. national

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accounts makes fundamental, significant, and very large changes to the accounts. Since that time much has changed: the U.S. Bureau of Economic Analysis National Income and Product Accounts (NIPAs) have been substantially revised and the average number of years of formal schooling completed in the U.S. has increased by over 50 percent. In addition, increasing attention is being paid to the topic of human capital. The purpose of this paper is two-fold: 1) to integrate the J-F human capital accounts for the U.S. with an up-to-date and internally consistent system of U.S. national accounts, and 2) to compare U.S. aggregates between the original and the more recent accounts, particularly those related to human capital.

"Beyond GDP" is a catchword, popularized by the Stiglitz-Sen-Fitoussi Commission (2009), which calls for innovation in economic accounts. Even before the final 2009 report was released, commission activities influenced related efforts and resulted in a workshop on human capital in Turin, Italy November 3–4th, 2008. At this event, jointly organized by the OECD and the Fondazione Agnelli, Fraumeni (2008) presented a paper which proposed a simplified (streamlined) approach to estimating J-F human capital. Subsequently, the OECD Human Capital Project began with Gang Liu as the primary economist involved in estimating J-F-type human capital for 16 countries using a simplified approach. With that project, the number of countries with J-F human capital estimates increased from six to 18. Later, J-F estimates for Argentina and China were independently constructed as well as new estimates for the U.S., bringing J-F country coverage to 20.[1] Interest in human capital measurement continues to the present, with a report on OECD practices (OECD, 2012), a UNECE Task Force (United Nations Economic Commission for Europe, 2016), and World Bank and UN reports on wealth (World Bank, 2011 and UNU-IHDP and UNEP, 2014), which both featured human capital.[2] There is no question that human capital is critical to the future growth of countries and the well-being of individuals; the increasing attention being paid to human capital is in recognition of this fact.[3]

Figure 1 shows how average educational attainment in the U.S. has changed at the five year frequency between 1950 and 2010 for three age groups: younger individuals aged 25–34, older individuals aged 55–64, and a broader age category for those aged 15–74 which includes the majority of the adult population.[4] In

[1]The countries include: Argentina, Australia, Canada, China, Denmark, France, Great Britain, India, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Poland, Rumania, South Korea, Spain, Sweden, and the U.S.. See Argentina (Coremberg, 2010), Australia (Wei, 2007, 2008), Canada (Gu and Wong, 2009), China (Li and co-authors 2009b,2010a,2013,2014 and annual reports beginning in 2009), India (Gundimeda *et al*., 2007), New Zealand (Le, Gibson, and Oxley, 2005), Norway (Liu and Greaker, 2009), Sweden (Ahlroth and Bjorkland, 1997), the U.S. (Christian, 2009, 2010, 2014, 2016) and Mira and Liu (2010) and Liu for the OECD human capital consortium countries (2011, 2014). O'Mahony and Stevens (2004) applied J-F methodology to evaluate government provided education in Great Britain; O'Mahony and Samek (2016) applied J-F methodology to evaluate the impact of health on human capital in the United Kingdom. As the references above indicate, for several countries, OECD human capital project estimates exist as well as estimates constructed during the course of other research projects.

[2]One of the activities of the UNECE Task Force is to debate how human capital accounts should be integrated into the SNA. Once there is a consensus among task force members and those concerned with the SNA, this paper could be recasted as one presenting a SNA with human capital elements for the U.S.

[3]Christian (2010) discusses international efforts to measure human capital in more detail.

[4]See Barro and Lee (2013a, 2013b).

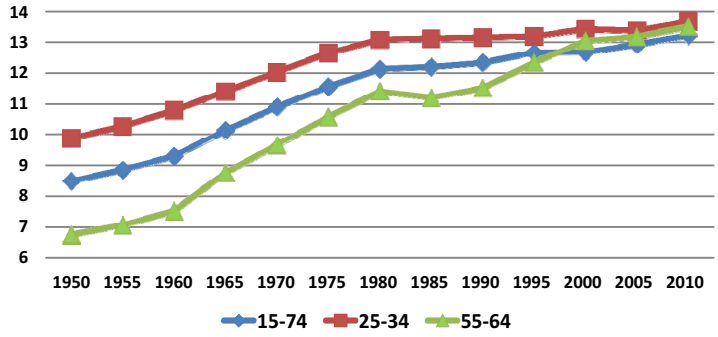


Figure 1. Average Years of School Completed [Colour figure can be viewed at wileyonlinelibrary.com]
Source: Barro-Lee (2013b).

1950 the difference in average educational attainment between the three age groups averaged around 1.5 years (6.7 years for those aged 55–64, 8.5 years for those aged 15–74, and 9.9 years for those aged 25–34). By 2010 average educational attainment is almost identical across the three age groups, with the average for those aged 15–74 increasing from 8.5 to 13.2 years of formal schooling. The advances continued almost without abatement over the whole period, except for the oldest group during the 1980–90 period; however the pace of these increases slowed after 2000. This paper traces through these changes in educational attainment that occurred over the last 25 years to their effects on human capital via the lifetime income approach.

An important component of this paper is to integrate human capital estimates with a system of national accounts. Since the March 1986 data for the original 1989 paper was collected, six comprehensive U.S. Bureau of Economic Analysis NIPA revisions have occurred. The U.S. Bureau of Economic Analysis NIPA are the basis for almost all of the core accounts excluding human capital. There have been many definition, classification, source data, methodological, and presentation changes as a result of the revisions. Many were concerned with prices or quality change, such as hedonic price indexes for computers and implementation of chained Fisher ideal indexes. Other changes include the classification of software and research and development as investment, separation of government expenditures into consumption versus investment, measurement of implicit services provided by property and casualty insurance and by commercial banks, and a complete revamping of the table presentation of the accounts.[5] In addition, the U.S. Bureau of Economic Analysis NIPAs changed to be in greater conformity with the System of National Accounts.[6]

This paper includes results for 1948 to 1984, the years covered in the original paper, and from 1998 to 2009, the years covered in a paper by Christian (2010).

[5]See Boskin (2000) and various issues of the Survey of Current Business (U.S. Department of Commerce).

[6]For example, the term operating surplus was introduced during the 2003 comprehensive revision.

Human capital related estimates for 1948 to 1984 are identical to those in the original paper, but nonhuman estimates for all years are updated.[7,8]

2. Human Capital Accounts Methodology

The J-F model of human capital (Jorgenson and Fraumeni, 1989, 1992a, 1992b) measures human capital using the lifetime income approach. It measures the stock of human capital using an estimate of a population's lifetime labor income, current and future, in present discounted value. Investment in human capital captures the impact of events that have a positive impact on the human capital stock, such as births, formal education, and immigration. Depreciation of human capital captures the impact of events that have a negative impact on the human capital stock, such as deaths, aging, and emigration. Investment and depreciation—either in total, or for a particular reason such as education—are valued by the extent to which they add to or subtract from the human capital stock.

The lifetime income approach to measuring human capital (of which the J-F model is the most well-known example) is a commonly used approach to measuring human capital. Alternative approaches include the cost approach (Kendrick, 1976), which measures the stock of human capital using the cost of producing it, and the indicators approach, which measures human capital using indicators such as the average level of education, i.e. Barro and Lee (2013a). The J-F human capital approach integrates within the same conceptual framework as the national accounts to allow comparability with market GDP.

The J-F model can be used to measure both a market and a nonmarket component of human capital. Human capital inputs and outputs are both included. Human capital inputs generate labor income as they result from activities of individuals. The market component of human capital is valued using lifetime market labor income. The nonmarket component is measured using an estimate of lifetime nonmarket time spent in activities other than market work, schooling, or personal maintenance, and valued using an opportunity cost equal to a tax-adjusted market wage. On the output side, the value of this nonmarket time is considered consumption as it yields no future services. The value of time spent in school is considered investment as it typically results in higher lifetime market and nonmarket lifetime labor income. The J-F model can also be used to measure human capital for an entire population (including children), or for a component of that population such as employed people or people of working age. Births are also considered an investment in human capital and are measured by the expected market and nonmarket lifetime income. Human capital for people of working age or for employed people is referred to as "active" human capital.

In the J-F model, the population is cross classified by age, sex, and education, and average lifetime labor income is the present discounted value of labor income. Estimates in a given year use average yearly earnings and school

[7]The updated nonhuman estimates are based on the May 28, 2014 U.S. Bureau of Economic Analysis NIPA tables.

[8]Estimates were not available for the middle period: 1985–97 when this paper was written.

enrollment rates by age, sex, and education; discounted earnings reflect mortality rates by age and sex, and an assumed discount rate and skills-neutral income growth rate. Average yearly market earnings are set to average post-tax labor income by age, sex, and education. Average yearly nonmarket earnings are set to the average value of nonmarket time by age, sex, and education, defined as time not spent in market work, at school (assumed to be 1300 hours per year for enrolled persons), or in personal maintenance (assumed to be 10 hours per day for all persons). Nonmarket time is valued at the average pre-tax market wage rate by age, sex, and education, multiplied by one minus the marginal tax rate to reflect the opportunity cost of leisure or household production. Age is topcoded at age 75, and levels of education reflect years of education from 0 to 17 or more (0–18 or more in the 1998–2009 results). The actual calculation of lifetime income begins at older ages, and then works its way back through younger ages. The model splits a lifetime into five stages. From ages 0 to 4, people do not attend school or earn income. From ages 5 to 13 (5 to 14 in the 1998–2009 results), people do not earn income, but may attend school. From ages 14 to 34 (15 to 34 in the 1998–2009 results), people may earn income and/or attend school. The school attending maximum age is assumed due to data limitations. The differences in the ages between the phases in the earlier and later results reflects a change in the earliest age of labor income recorded in Census data. From ages 35 to 74, people no longer attend school, but continue to earn income. Because of data limitations, at age 75 or higher, people do not attend school or earn income.

For people age 75 and older, average market and nonmarket lifetime labor income is assumed to be zero:

$$i_{y,a,s,e} = 0 \text{ if } a = 75+$$

where iy,s,a,e is average lifetime income (market, nonmarket, or combined) in year y for people of age a, sex s, and level of education e.

For ages 35 to 74, average lifetime labor income is equal to average current earnings, plus lifetime earnings at the next age older, adjusted for survival, discounting, and income growth:

$$i_{y,a,s,e} = yi_{y,a,s,e} + [(1+\rho)^{-1}(1+g)sr_{y,a,s,e}]i_{y,a+1,s,e} \quad \text{if } a = 35,\ 36,\ \ldots,\ 74$$

where yiy,a,s,e equals average nominal yearly income (market or nonmarket) and sry,a,s,e equals the survival rate in year y for people of age a, sex s, and level of education e; ρ equals the real discount rate; and g is the real income growth rate. In the results presented here, the discount rate is set to 0.04, and the income growth rate is set to 0.02 as in the 1989 accumulation paper.[9]

[9]The discount and labor income growth rates were set in the original accumulation paper as best judgmental estimates. Subsequently, based on research by Jorgenson and Yun (1991), in Jorgenson and Fraumeni (1992b), the rates were set at 4.58 and 1.32 percent, respectively. In Jorgenson and Fraumeni (1992b) various rate scenarios are presented showing the impact on investment in education, including rates of 6 percent and 1 percent. What matters in the lifetime income equation is the ratio of (1+g) to (1+ρ), which is 98 percent at 4 and 2 percent rates, 97 percent at 4.58 and 1.32 percent rates, and 95 percent at 6 and 1 percent rates; however the estimate differences cumulate over time.

Survival rates differ by age and sex, but are the same across levels of education within age and sex.

For ages 14 to 34 (15 to 34 in the 1998–2009 results), lifetime income estimates take into account the probability of attending school:

$$i_{y,a,s,e} = yi_{y,a,s,e} + senr_{y,a,s,e}[(1+\rho)^{-1}(1+g)sr_{y,a,s,e+1}]i_{y,a+1,s,e+1} + (1-senr_{y,a,s,e})$$
$$[(1+\rho)^{-1}(1+g)sr_{y,a,s,e}]i_{y,a+1,s,e} \qquad \text{if } a = 14, 15, \ldots, 34$$

where *senr*y,a,s,e is the school enrollment rate in year *y* of people of age *a*, sex *s*, and level of education *e*.

For ages 5 to 13 (5 to 14 in the 1998–2009 results), people are too young to earn income, and so yearly income is set to zero:

$$i_{y,a,s,e} = senr_{y,a,s,e}[(1+\rho)^{-1}(1+g)sr_{y,a,s,e+1}]i_{y,a+1,s,e+1} + (1-senr_{y,a,s,e})[(1+\rho)^{-1}$$
$$(1+g)sr_{y,a,s,e}]i_{y,a+1,s,e}$$
$$\text{if } a = 5, 6, \ldots, 13$$

and for ages 0 to 4, people are too young to attend school, so school enrollment rates are also set to zero:

$$i_{y,a,s,e} = [(1+\rho)^{-1}(1+g)sr_{y,a,s,e}+1]i_{y,a+1,s,e} \qquad \text{if } a = 0, 1, \ldots, 4$$

Note that future lifetime income is measured by the discounted and labor growth-adjusted lifetime income of those who are older in the estimate year. For example, consider a woman who is aged 40 in the year 2000 with a college degree. We use the income of a woman with a college degree who is age 41 in 2000 to estimate what the 40 year old woman's income will be after a year. Specifically, in 2000 the woman receives her 2000 income, while in 2001 after she has aged a year, she receives the income of the 41 year old observed in 2000, adjusted for income growth and discounted to 2000 dollars. Thus, our estimates of lifetime earnings in year 2000 depend only on observations in year 2000, and our assumptions about income growth and discounting. The stock of human capital in a given year is equal to the sum of lifetime income across a population, weighted by population by age, sex, and education:

$$hc_y = \sum_s \sum_a \sum_e (p_{y,a,s,e} \times i_{y,a,s,e})$$

where *p*y,a,s,e is the population in year *y* of people of age *a*, sex *s*, and level of education *e*. Note that this is computed using market, nonmarket, or combined lifetime income. It can also be computed using the entire population, or using a subset of the population (for example, people of working-age only).

Investment in human capital is measured using births, education, and (when available) immigration. Investment from births is the impact of births (the arrival of persons age 0) on the human capital stock, and is equal to

$$bi_y = \sum\nolimits_s (p_{y,0,s,0} \times i_{y,0,s,0})$$

Investment in education is the impact of education (people moving up from education level e to education level $e+1$) on the human capital stock, and is equal to

$$si_y = \sum\nolimits_s \sum\nolimits_a \sum\nolimits_e senr_{y,a,s,e} [p_{y,a,s,e} \times (i_{y,a,s,e+1} - i_{y,a,s,e})]$$

The 1998–2009 results include an additional component of investment, residual net investment. This is the impact of measured changes in the size and distribution of the population by sex, age, and education that cannot be attributed to measured births, deaths, or schooling. These changes exist for two reasons. The first is migration, which is not directly measured in the 1998–2009 results. The second is measurement error; in particular, the data on births, deaths, and educational attainment do not line up exactly with population estimates from year to year. The primary source of data for the 1998–2009 results are the March demographic and October school enrollment supplements to the Current Population Survey, adjusted to match published national aggregates for population, births, deaths, and enrollments, with survival rates from the Centers for Disease Control. Throughout this paper residual net investment is included in the relevant aggregates for 1998–2009, such as investment.

To measure human capital in real terms, the population (measured by age, sex, and education) is treated as the quantity, and the lifetime income component (similarly measured by age, sex, and education) is treated as the weight.[10] The ratio of the nominal value to quantity index yield the implicit price.

Alternative assumptions to those in the original accumulation paper would substantially alter the magnitude of the estimates. The assumptions that could have the largest impact are the use of opportunity cost valuation (with average, rather than marginal wages), the choice of the discount rate and the labor income growth rate, and the inclusion of leisure as a valued nonmarket activity. Abraham (2010) discusses several of these assumptions. With regard to nonmarket valuation at an average wage, two points are made with reference to Rosen (1989). First, nonmarket time should be valued at the marginal wage rate. Second, it may be that the marginal value of nonmarket time is less than that of market time. Abraham also comments that adults who do not work are likely to differ from those who do work even if they are of the same age, gender, and have the same amount of education. She notes out that an individual's discount rate should be higher than the 4 percent that J-F posit because individuals face uncertainty as to the return to educational investment. In addition, she questions attributing all of the growth in labor income to workers as some labor income growth likely arises from capital induced productivity improvements. For selected years, a paper by Jorgenson and Fraumeni (1992b) presents separately market and nonmarket human capital components for time, investment in education, and wealth and looks at the impact on investment in education for various possible combinations

[10]The System of National Accounts term "volume" refers to the same concept as "quantity" as used in this paper.

of discount rates and labor income growth rates. For the selected years shown across all three components, the nonmarket components account for approximately 60 to 70 percent of the total components. Christian (2016), with methodology that modifies J-F in several important respects, estimates that nonmarket wealth increases steadily from 67 percent of total wealth in 1977 to 71 percent of total wealth in 2013; while nonmarket investment in education between 1977 and 2013 rises from 45 to 51 percent of total investment in education.[11] According to Jorgenson and Fraumeni (1992b), investment in education is 45 to 55 percent lower for the 1 percent/6 percent scenario compared to the 2 percent/4 percent scenario. The American Time Use Survey allows the separation of leisure from other nonmarket activities only beginning in 2003, therefore excluding leisure from nonmarket time in earlier periods is difficult. In 2009 according to the American Time Use Survey, of those engaged in leisure activities, men spent 5.8 hours and women spent 5.1 hours in such activities.[12,13] Furthermore, the separability between leisure from other nonmarket activities is not always easy. For example, cooking while watching television contains elements of both. None of the assumptions in the 1989 accumulation paper are modified for the 1998–2009 period to retain comparability with the original estimates.[14]

3. Overview of the Accounts

This paper updates the original "accumulation" paper accounts, which included a comprehensive set of accounts that embedded human capital measures into modified U.S. Bureau of Economic Analysis NIPA accounts. The modified U.S. Bureau of Economic NIPA accounts were based on Christensen-Jorgenson (C-J) national income accounts (1973), which are summarized in Jorgenson (1980). Subsequently the C-J accounts were revised by a number of researchers working with Jorgenson: Stiroh, Landefeld, and Samuels, among others. The most recent and complete version of the modified U.S. Bureau of Economic NIPA accounts is described in Jorgenson and Landefeld (2006, 2009) and Jorgenson (2010). However, only the original "accumulation" paper added human capital measures to create "full" national account constructs based on the private domestic and private national economies.[15] A purpose of this paper is to provide a fully integrated set of national accounts that includes human capital and is consistent with the concepts included in the U.S. Bureau of Economic Analysis NIPAs.

The following Figure 2 briefly summarizes the five J-F accumulation paper accounts which are presented in more detail in a later section. Although the organization of the accounts is the same as in the original "accumulation" accounts,

[11]Christian (2016) does not estimate the value of time in household production and leisure.

[12]U.S. Bureau of Labor Statistics (2011). 96 percent of males and females engaged in leisure activities.

[13]Leisure is in the consumption aggregate "time in household production and leisure." Accordingly, valuing it has no impact on human capital wealth.

[14]It is not possible to alter the assumptions for the earlier period covered in this paper as the original 1989 paper data sets and inputs were not saved.

[15]The "new architecture" Jorgenson and Landefeld accounts (2006, 2009) also include a foreign transactions current account and a U.S international position account.

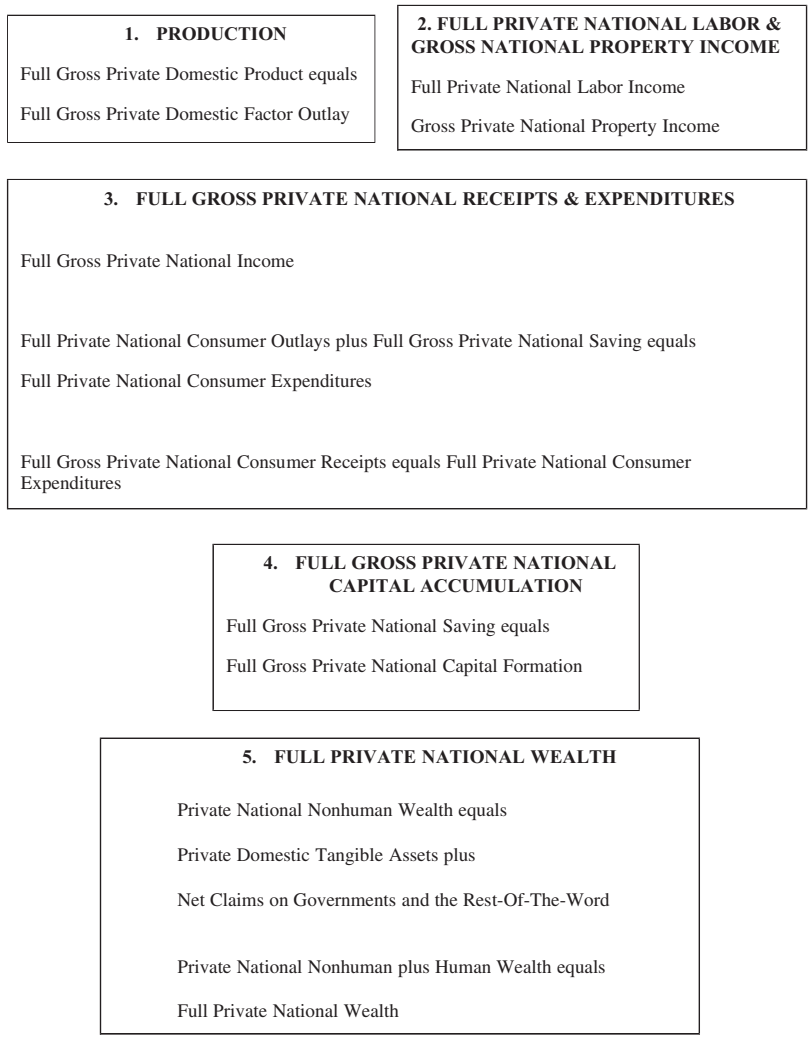


Figure 2. Overview of the Five Accounts

many individual elements of these accounts are revised to reflect the many national income accounting and tabular changes that have occurred since the publication of the original paper. For comparison, the detailed accounting tables presented later show data for 1982 (the base year in the original accumulation paper) and for 2009 (the current base year for the U.S. Bureau of Economic Analysis NIPAs).

The complete accounting and integrated system with human capital measures in each account includes a production account, incorporating data on output and input; an income and expenditures account, giving data on income, expenditures, and saving; an accumulation account, allocating saving to various types of capital formation, and a balance sheet, containing data on private national

wealth. The accumulation accounts are related to the wealth accounts through the accounting identity between period-to-period changes in wealth and the sum of net saving and the revaluation of assets.

Including human capital in a comprehensive set of national accounts makes fundamental changes to the national accounts, which are double-entry accounts.[16] Production and factor outlay is increased by the sum of investment in education and births and time in household production and leisure.[17] The income account takes the recipients' point of view. In this account, all human components in the production account are allocated to labor income. This income includes imputations for nonmarket labor income. This imputation is for the value of services provided by human capital that are not received as cash or the equivalent. In the receipts and expenditures account, the labor income arising from human capital is included as a receipt; it is identical to that which appears in the income account. On the expenditures side, the sum of all human capital components are identified as either consumption or savings. Time in household production and leisure is recorded as consumption, while the other human capital components, as described in the next account, are included in savings.[18] In that account, investment in human capital (education, births, and residual for later periods) is entered into the savings and capital accumulation (investment) parts of the account.[19] The final account is the wealth account, which includes the sum of market and nonmarket lifetime labor income.

The production account is for the private domestic economy; the other accounts use private national as the conceptual basis. The private domestic concept excludes the output and inputs of the government sector.[20] The receipts and expenditure account is based on the accounting identity that the value of consumer receipts equals the value of outlays plus saving. Thus, compensation of government employees appears on the receipts side of the income and expenditure account. In general, the private national concept includes account relevant activities that occur in the U.S., but restricts included relevant activities to those made by (such as expenditures), received by (such as income), or held by (such as wealth) private entities.

To give a sense of how relative magnitudes have changed over time, Figures 3 and 5–8 indicate the nominal dollar shares of the major components of the major aggregates included in the accounts in 1982 and 2009.[21,22]

[16]A double-entry set of accounts is a system where every entry in an account requires an equal entry into its companion account so that the accounts always remain in balance. For example, when human capital is recognized as producing an output, human capital must be recognized as being factor of production (factor outlay) by the exact same amount.

[17]The residual, as previously described, is included in investment for the later periods.

[18]Time in household production and leisure is recorded as both income and consumption as the individual implicitly receives income from himself because of the value of his time and uses this income to finance consumption.

[19]Human capital saving is equal to human capital investment in the account

[20]The original accumulation paper excluded the government sector because of the complications, data requirements, and overall difficulty of including the government sector.

[21]The "Full" aggregates include human capital accounts components.

[22]A recent paper by Christian (2016) shows little change in the nominal shares between 1982 and 2009 in Figures 3 and 5–8 using the same data sources across both time periods. In this paper, data sources and some methodology changed between 1982 and 2009. Christian's paper discusses the methodology he used to extend his estimates back through time.

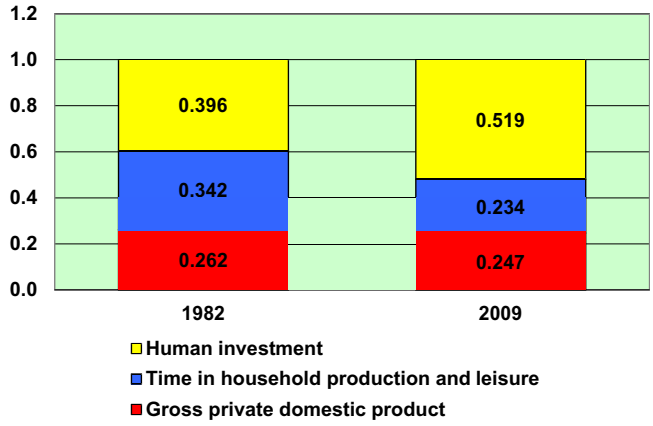


Figure 3. Shares of Full Gross Private Domestic Product 1982 and 2009 [Colour figure can be viewed at wileyonlinelibrary.com]

Differences in the nominal shares of full gross private domestic product (see Figure 3) between the 1982 and 2009 accounts may include changes in the labor force participation rate of women. Time in household production and leisure values time other than time in 1) sleep and maintenance (assumed to be 10 hours per day and given a zero valuation), 2) formal schooling (assumed to be 1300 hours per year for any enrolled individual), and 3) market work (which varies depending upon estimated hours). Time in household production and leisure is valued using the opportunity cost market wage. Human investment depends on the impact of births (a population increase) and formal schooling (increases in wages accrued to those with higher levels of education) on lifetime income, which includes both market and nonmarket income. As Figure 4 illustrates, female labor force participation has almost doubled between 1948 and the end of the period, from just over 30 percent to around 60 percent, however it rose by something less than 10 percentage points between 1982 and 2009. With the increase in female market

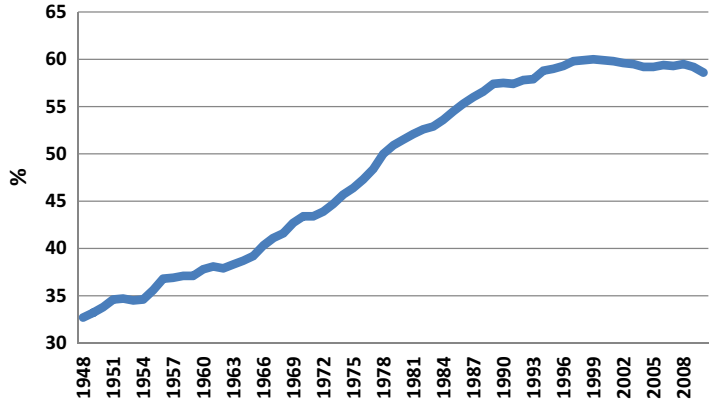


Figure 4. Female Labor Force Participation Rates January 1, 1948–2010 [Colour figure can be viewed at wileyonlinelibrary.com]

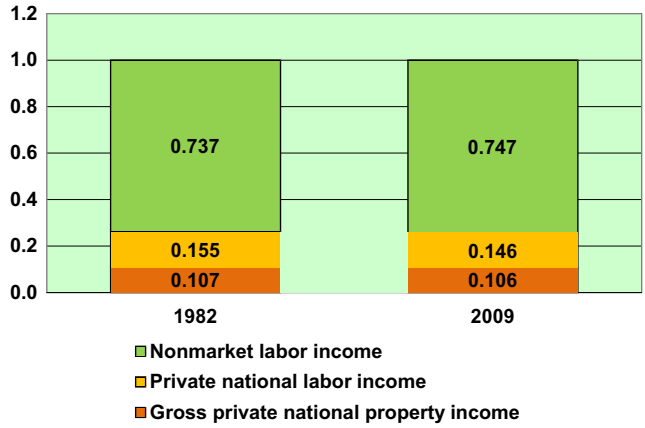


Figure 5. Shares of Full Private National Labor and Gross National Property Income 1982 and 2009 [Colour figure can be viewed at wileyonlinelibrary.com]

work time, time spent in household production and leisure in full gross private domestic product has decreased. The corresponding nominal share of the value of time in household production depends on the time spent and wages paid to both men and women. Also, investment in education has risen between 1982 and 2009 with the higher educational attainment of both men and women, but most notably for women.[23] At the same time, the nominal share of the "Full" component which is included in gross private domestic product is lower in the 1982 account than in the 2009 account.

All of the major nominal subcomponents of gross private national income are between 4.2 and 4.7 times greater in the 2009 account than in the 1982 account. The major subcomponents include private domestic outlay for labor services, private national labor income, nonmarket labor income, full private national labor income, gross domestic private outlay for capital services, and gross private national property income (see Table 2). Gross private national property income (see Figure 3) is almost the same nominal share of the sum of labor and property income in the 1982 and 2009 accounts. Note that nonmarket labor income includes both human investment and time in household production and leisure, so a possible trade-off between these two components of nonmarket labor income is masked in the aggregate shown in Figure 5. The nominal share of the private (market) component of labor income is slightly lower in the 2009 account with a correspondingly higher share for the nonmarket component of labor income.

Overall, the nominal share of capital formation in full private national consumer expenditures (see Figure 6) is greater in the account for 2009. Often

[23]According to the Barro and Lee (2013b) estimates, in 2010 the percent of the total population aged 15 and above that completed the tertiary level of education is almost identical for females and males (both to two significant digits at 27 percent), however, females compared to males made the greatest gains in this category over the period from 1980 to 2010. In 1980, the percent of the female population aged 15 and above that completed the tertiary level of education was 14 percent; while for males it was 20 percent.

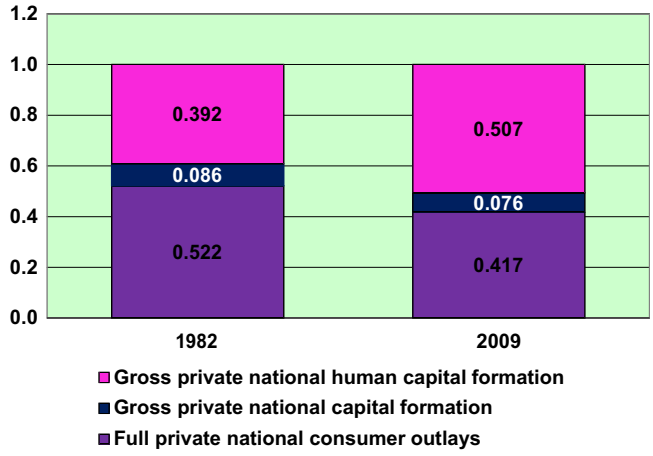


Figure 6. Shares of Full Private National Expenditures 1982 and 2009 [Colour figure can be viewed at wileyonlinelibrary.com]

analysts are concerned about the level of private national capital formation, missing the possible important role that human capital formation has played since the early to mid-eighties. The nominal share of gross private national human capital formation in the 1982 account and full private national consumer outlays in 2009 are similar. The reverse is also true: the nominal share of full private national consumer outlays in the 1982 account and gross private national human capital formation in the 2009 account are similar. The importance of including both human and private (nonhuman) capital formation is highlighted by this figure.

Human capital saving is clearly the largest component of full gross private national saving (see Figure 7). On average individuals have invested more in education since 1982. The increase in the average U.S. educational attainment is certainly in part a response to the demand for more highly skilled workers, which has resulted in a wage premium paid to those workers compared to those with fewer skills.[24]

It might be surprising that the nominal share of human wealth in full private national wealth is lower in the 2009 account, given the increase in the nominal share of human capital saving (see Figure 8). This may be a result of an increase in depreciation as the baby-boomers approach retirement.[25] There are other possible contributing factors, such as a change in the return to education. The nominal share of depreciation in full gross saving is much higher in the 2009 account (80 percent) than in the 1982 account (47 percent). The share of U.S. resident population age 55 through age 64 rose from 9 percent in 1950, to 10 percent in 1980, and to 12 percent in 2010.[26] Private national human wealth is by far the

[24]See Figure 1 in Hotchkiss and Shiferaw (2011).

[25]For a description of baby boom phenomena and its impact on the U.S. population in the U.S., see Colby and Ortman (2014).

[26]U.S. Census Bureau (2011), population Table 7 and population projections by age and sex Table 8; U.S. Census Bureau, undated and 2000.

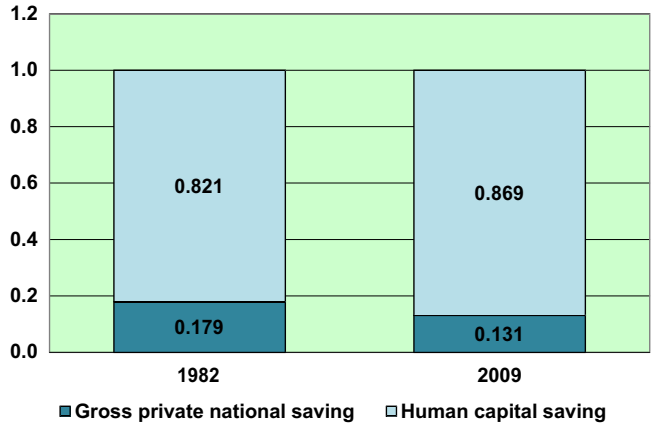
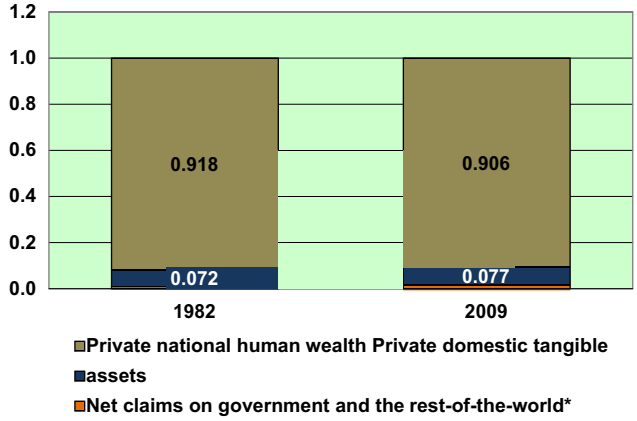


Figure 7. Shares of Full Gross Private National Saving 1982 and 2009 [Colour figure can be viewed at wileyonlinelibrary.com]

largest component of full private national wealth, accounting for over 90 percent of the nominal total in both years.

4. Accounts Presentation and Discussion

In this section, details of the accounts are presented in three ways with: 1) definitional tables for 1982 and 2009, 2) rates of growth tables for major aggregates by sub periods, and 3) contribution tables for major aggregates by sub periods. The rates of growth tables show rates of growth from 1949–84, 1949–73, 1973–84, 1998–2009, 1998–2000, 2000–05, and 2005–09. The contributions tables,



* The nominal shares for net claims on government and the rest-of-the-world are .0099 and .0164 for 1982 and 2009, respectively.

Figure 8. Shares of Full Gross Private National Wealth 1982 and 2009 [Colour figure can be viewed at wileyonlinelibrary.com]

since contributions require lagged components, are for average contributions from 1950–84, 1950–73, 1974–84, 1999–2009, 1999–2000, 2001–05, and 2006–09.[27] As the original accumulation paper used Tornqvist indices, so does this updated and revised version.[28,29] With Tornqvist indices, contributions are a weighted rate of growth, where the weights are an average of the nominal dollar share in the previous period and the contemporaneous period and the rate of growth is a logarithmic growth rate of the quantities from the previous period to this period. The sub period breakpoints reflect economic conditions; in the productivity literature it has been clearly documented that productivity shifted downward post-1973; the period 1999–2000 corresponds to the end of the 1995–2000 "IT Boom" period which began in 1995; and by 2006 the economy was headed towards the Great Recession (Jorgenson *et al.*, 2014). Tables corresponding to all rate of growth and time series tables in the original accumulation paper are in the online appendices; the time series tables are the data which underlie all figures and tables in the body of the paper. Accordingly, this paper provides a complete basis for review and analysis of the accounts presented herein which embed human capital related measures in a national income accounting framework.

The first account (see Table 1) is the production account.[30] As in the "new architecture" accounts (Jorgenson and Landefeld, 2006, 2009), the core U.S. Bureau of Economic Analysis NIPA are modified in a number of ways, but the accounts presented in this table excluding the human capital accounts are almost all from the U.S. Bureau of Economic Analysis NIPA. In the product account to allow for integration with productivity accounts, property-type taxes are included, but some other types of taxes such as primarily sales taxes, are not included.

Imputations for nonhuman capital services (see line 16 of the product account) add into gross private domestic product several capital services that are not in U.S. Bureau of Economic Analysis NIPA GDP. These include those for consumer durables and real estate held by institutions and producer durable equipment held by institutions. The other imputation included in line 16 of the product account is the difference between the value of household real estate capital services imputed in the "new architecture" accounts and that included in U.S. Bureau of Economic Analysis NIPA GDP. These modifications are relatively minor in scale; as was already clearly seen in Figure 3, the human capital components dominate the production account.

For the sub periods that we consider, prices and quantities generally increase over time. For that reason and because the sum of the price and quantity rates of

[27]For example, the 1950 contribution is a weighted rate of growth, where the weight is the average of the 1949 and 1950 nominal values and the rate of growth is the rate of growth between the 1949 and 1950 quantities.

[28]Some of the sub components of the aggregates shown in this paper for the most recent period, 1998–2009, are constructed using Fisher indices. However, all aggregates in paper tables are constructed using Tornqvist indices.

[29]The human capital account components are identical to those in the original accumulation paper, but other components are revised over all periods to reflect changes and revisions in the U.S. Bureau of Economic Analysis NIPA at various times.

[30]All table numbers in the account tables refer to U.S. Bureau of Economic Analysis NIPA table numbers unless otherwise specified.

TABLE 1

PRODUCTION, UNITED STATES 1982 AND 2009 (BILLIONS OF DOLLARS)

		Product	1982	2009
1		Gross national product (table 1.7.5, line 4)	3,381.5	14,565.1
2	−	Rest-of-world gross national product (table 1.7.5, line 2 minus line 3)	36.5	147.2
3	−	Compensation of government employees (table 6.2B, line 76 for 1982; table 6.2D, line 86 for 2009)	388.9	1,666.2
4	−	Government consumption of fixed capital (table 5.1, line 17)	113.9	442.7
5	=	Gross private domestic product (NIPA definition)	2,842.2	12,309.0
6	−	Federal taxes on production and imports (table 3.5, line 2)	41.0	91.4
7	−	Federal current transfer receipts from business (table 3.2, line 17)	3.7	46.7
8	+	Capital stock tax (table 3.5, line 12)	0.0	0.0
9	−	State and local taxes on production and imports (table 3.5, line 13)	200.0	934.8
10	−	State and local current transfer receipts from business (table 3.3, line 18)	3.2	44.0
11	+	Business property taxes (table 3.5, line 27)	85.3	435.1
12	+	Business motor vehicle licenses (table 3.5, line 28)	2.1	8.7
13	+	Business other taxes (table 3.5, sum of lines 29–31)	16.4	67.2
14	+	Subsidies less current surplus of federal government enterprises (table 3.2, line 32 minus line 19)	16.7	56.1
15	+	Subsidies less current surplus of state and local government enterprises (table 3.3, line 25 minus line 20)	2.2	22.8
16	+	Imputations for nonhuman capital services	298.9	1,234.6
17	=	Gross private domestic product	3,015.9	13,016.6
18	+	Time in household production and leisure	3,944.5	12,311.0
19	+	Investment in human capital, births*	2,184.7	9,551.5
20	+	Investment in human capital, education*	2,383.9	15,955.0
21	+	Investment in human capital, residual	0.0	1,841.2
22	=	Full gross private domestic product	11,529.0	52,675.4
		Factor Outlay	**1982**	**2009**
1		Compensation of employees, all private industries (table 6.2B for 1982 and table 6.2D for 2009, both line 3)	1,505.6	6,129.5
2	+	Entrepreneurial labor income (imputation)	162.6	828.9
3	+	Full property outlay (line 17 from the Product account, minus lines 1 and 2 from the factor outlay account)	1,347.6	6,058.2
4	=	Gross private domestic factor outlay	3,015.9	13,016.6
5	+	Imputations for human capital services from product account above (lines 18–21)	8,513.1	39,658.7
6	=	Full gross private domestic factor outlay	11,529.0	52,675.4

Note: Totals may differ slightly from the sums due to rounding.

*The split between birth and education in 1982 is imputed from a somewhat later version of the accounts presented in the original accumulation paper. Accordingly, this is the only place in this paper where this split is shown.

growth must equal the nominal dollar rate of growth, the rates of growth for quantities and prices are typically less than the rate of growth of nominal dollars.[31] Because quantities per capita are divided by a population denominator that is always growing throughout the period, the rate of growth of the quantity is always greater than the rate of growth of the quantity per capita. Discussion focuses on the decomposition of the nominal growth rates into price and quantity components.

[31]By logarithmic rules, the log of a product is equal to the sum of the log of each component of the product.

By sub periods, with one exception, the full product, full investment and full consumption price rates of growth are always greater than the quantity rates of growth (see appendix A Table 1).[32,33] Both full investment and full consumption encompass human capital related components; the former includes human capital investment (births and education) and the latter includes time in household production and leisure. Between the account for the earlier period (1948–84) and that for the later period (1998–2009), the nominal share of full investment in full product becomes larger than the nominal share of full consumption in full product (see appendix B Table 3). By sub periods, full investment prices, which grow at a higher rate than full consumption prices in the earlier period, grow at a lower rate than full consumption prices in the later period, with the exception of 1998–2000. However, in all sub periods except for 1949–73, full consumption quantities and quantities per capita grow at a higher rate than the full investment corresponding constructs.[34] However, in 1949–73, the difference between the rates of growth is at most .001 percentage point. Full investment quantities per capita decrease in all sub periods beginning in 1973 or after. Population growth averaged about 1 percent per year during that time period. The quantity of human capital investment increased only slightly between 1973 and 1984 and actually decreased between 1998 and 2009 (see appendix B Table 2).[35]

By sub periods, full property outlay quantities and quantities per capita always grow at a much faster rate than full labor outlay quantities and quantities per capita (see appendix A Table 2). The decline in quantities per capita in all of the later sub periods again reflects the slowdown in human capital investment growth, which is included in full labor outlay. This decline is offset slightly by the increase in the quantity of time in household production and leisure.[36] As Figure 1 shows, the gains in average educational attainment slowed during this later time period.

The first contribution figure (see Figure 9) presents both sides of the production account as well as the implied multifactor productivity growth in a market plus nonmarket production account that is consistent with full product output and inputs.[37] Note that with a production account that includes both market and nonmarket components, future labor quality impacts productivity as well as current labor quality when human capital is measured by J-F lifetime income.

[32]Nonhuman consumption and investment is constructed from the producer point of view.

[33]In the original accumulation paper, the term "current prices" was used to refer to nominal dollars, the term "constant prices" was used to refer to quantity, and the term "price index" was used to refer to price.

[34]United States national population grew at a rate of .0131 in 1949–84, .0146 in 1949–73, .0097 in 1973–84, .0915 in 1998–2009, .0216 in 1998–2000, .092 in 2000–05, and .0093 in 2005–09. The population figures from 2000–09 are intercensul estimates, which means that the change between 1999 and 2000 is expected to be revised eventually. The one year growth rate between 1999 and 2000 is .0341. Accordingly, all quantity per capita growth estimates for 1998–2000 are likely biased downward. Subsequent sub period growth rates are also impacted, but to a significantly lesser degree.

[35]Population data was collected on January 11, 2015 from the U.S. Bureau of the Census website. See U.S. Bureau of the Census (undated, 2000). July 1 population estimates are used in this paper.

[36]The quantity of time in household production and leisure is shown in appendix B Table 14 under the title "nonmarket consumer outlays."

[37]Some titles are truncated in Figure 9 because of space considerations. For example, capital and labor income are simply labeled "capital" and "labor" respectively. Note that frequently in productivity analyses, the word "services" is used instead of the word "income."

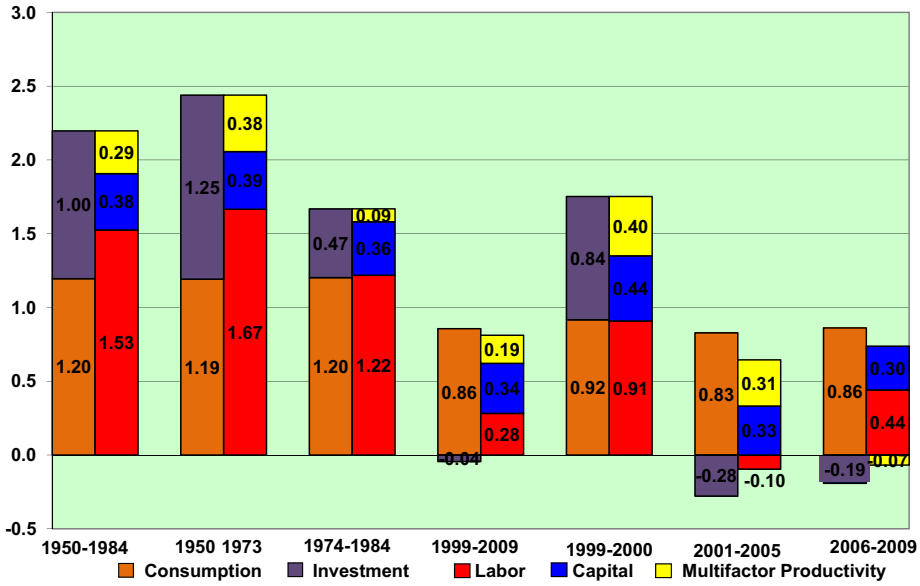


Figure 9. Contributions to Full Gross Private Domestic Product and Economic Growth [Colour figure can be viewed at wileyonlinelibrary.com]

Particularly younger individuals are often expected to increase their educational attainment over time; if this happens it impacts on future labor quality. In a market only production account, only the current labor quality matters. In the multifactor productivity calculations, the same human capital components appear on both sides of the equation with the same quantities, prices and nominal shares for inputs and output. Multifactor productivity depends upon the prices and quantities for the market components and their relative shares. In another paper, Liu and Fraumeni compare production accounts with and without human capital (forthcoming).

With human capital measures integrated into the production account, major trends in accounts without human capital are still evident. As expected multifactor productivity growth falls beginning in the 1974–84 sub period, recovers strongly in 1999–2000, but falls again, and even becomes negative, during the last period, 2006–09, which includes the Great Recession and the slow recovery. Except during the 1950–73 sub period, the contribution of full consumption to overall economic growth outweighs that of full investment. Except during the 1999–2009 and 2001–05 sub periods, the contribution of full labor to economic growth outweighs that of full capital. The negative contribution of full labor in 2001–05, which dominates the 1999–2009 period, is due to the factor mentioned earlier: the slowdown in human capital investment. Full capital contributes more to economic growth than multifactor productivity growth in all periods.

The second account is the labor and property income account (see Table 2). Human capital components only enter into labor income. Figure 5 showed that there is very little change in the nominal share of gross private national labor income in total income between the 1982 and 2009 accounts and that nonmarket

labor income represents almost 75 percent of total income. In this account, the split of personal income taxes between labor and property income is imputed in the modified U.S. Bureau of Economic Analysis NIPA set of accounts.[38]

By sub period, full private national labor income growth demonstrates a typical pattern for a labor aggregate, but there is no consistent growth pattern for gross private national property income in the earlier sub periods (see appendix A Table 3). For labor income, the growth in prices is consistently greater than the growth in quantities and the growth in quantities is consistently greater than the growth in quantities per capita as expected. The growth in property income prices is greater than growth in quantities for only two of the seven sub periods: 1949–84 and 1973–84. The growth in prices for each of the three aggregates in all later period sub periods is always less than the growth in prices in all of the earlier period sub periods.

The third account is the consumer receipts and expenditures account (see Table 3). The aggregate full gross private national saving includes human saving as well as nonhuman saving (see appendix B table 15 and line 10 of the Expenditures part of the account). The receipts part of the account includes all human capital components listed in the Product account of Table 1.

Consumer durables are excluded from expenditures as in the modified "new architecture" accounts and these accounts as consumer durables are considered investment (see line 2 of the Expenditures part of the account). Figure 6 showed that the nominal share of gross private national human capital formation in full private national consumer expenditures is much greater in the 2009 estimates than in the 1982 estimates.

By sub periods, price growth is almost always greater, and usually significantly higher, than quantity growth in the expenditure component and in the consumer outlays and saving subcomponents (see appendix A Table 4). The only subcomponent and sub period for which quantity growth is greater than price growth is the consumer outlays subcomponent for the 1998–2000 sub period.

The fourth account is the gross private national capital accumulation account (see Table 4). This account, as well as demonstrating how full gross private national saving is equal to gross private national capital formation, derives net private national saving and change in private national wealth (see the Saving part of Table 4). Depreciation experienced the greatest relative change between the 1982 and 2009 estimates in any of the sub components which show the relationship between gross private national saving and change in private national wealth. The 2009 estimates for gross private national saving, human capital saving, and full gross private national saving are all four to six times the corresponding 1982 estimates, however the 2009 estimate for depreciation is well over nine times the corresponding 1982 estimate. As previously noted, human capital depreciation has risen significantly potentially as a result of the aging of the baby-boomer population. Accordingly, the 2009 estimate for net private national saving is only just over two times the corresponding 1982

[38]The figures for personal income taxes on labor income through 1958 are taken directly from Ando and Brown (1963). Since their data from 1929–58 show negligible latter period variation in the proportion of personal income taxes on labor incomes in total personal income taxes from .755, this proportion is assumed to apply to all years after 1958.

TABLE 2

Full Private National Labor and Gross Private National Property Income, United States, 1982 and 2009 (billions of dollars)

		Labor Income	1982	2009
1		Private domestic outlay for labor services (line 1 plus line 2 of the Factor Outlay account in table 1)	1,668.2	6,958.4
2	+	Income originating in general government (table 1.13, line 56)	346.8	1,517.4
3	+	Compensation of employees in government enterprises (table 1.13, line 37)	42.1	148.8
4	+	Compensation of employees, rest-of-world (table 1.13, line 61)	−0.2	−7.8
5	−	Personal income taxes attributed to labor income (imputation)	261.9	843.1
6	=	Private national labor income	1,795.0	7,773.7
7	+	Nonmarket labor income (sum of lines 18–21 of the Product account in table 1)	8,513.1	39,658.7
8	=	Full private national labor income	10,308.1	47,432.4
		Property Income	**1982**	**2009**
1		Gross domestic private outlay for capital services (imputation)	1,347.5	6,058.1
2	+	Capital income originating in the rest-of-world (imputation)	36.5	155.0
3	+	Personal interest income (table 2.1, line 14)	463.7	1,263.9
4	−	Net interest and miscellaneous payments on assets (table 1.7.5, line 20)	277.5	563.1
5	+	Government rents and royalties (table 3.2, line 15 plus table 3.3, line 15)	8.6	18.2
6	−	Personal interest payments to business (table 2.1, line 30)	59.3	273.9
7	+	Investment income of social insurance funds less transfers to general government (table 3.14, line 8 plus line 22, minus lines 11 and 24)	1.9	123.8
8	+	Rest-of-world contributions to government social insurance (table 3.6, line 32)	1.2	5.0
9	−	Corporate profits tax liability (table 3.2 line 7 plus table 3.3 line 10)	63.0	246.0
10	−	Personal property taxes (table 3.4, sum of lines 18, 19, and 20)	7.3	28.2
11	−	Business property taxes (line 4 from the Factor Outlay account in table 1)	103.8	511.0
12	−	Personal income taxes attributed to property income (imputation)	85.0	273.6
13	−	Federal estate and gift taxes (table 5.11, line 19)	7.5	20.6
14	−	State and local estate and gift taxes (table 5.11, line 20)	2.6	4.3
15	−	Business transfer payments to foreigners (table 4.1, line 28)	3.4	21.2
16	−	Rents and royalties received by the Federal government (table 3.2, line 15)	5.1	7.0
17	−	Rents and royalties received by state and local governments (table 3.3, line 15)	3.5	11.2
18	−	Dividends received by government (table 3.1, line 10)	0.2	20.9
19	=	Gross private national property income	1,241.2	5,643.1

Note: Totals may differ slightly from the sums due to rounding.

estimate. As the 2009 estimate for revaluation, which is added to net saving, is just over 1.5 times the 1982 estimate, the 2009 estimate for change in private national wealth is between 1.5 and 2 times the 1982 estimate.

By sub periods, given the relative changes in the magnitudes, it is not surprising that the full net saving quantity growth is negative for all sub periods except for 1949–84 and 1949–73 (see appendix A Table 5). If it were not for the strong growth in the 1949–73 sub period, the 1949–84 sub period growth would also be negative. In the 2000–05 sub period, even the full net saving price growth is negative. With low rates of quantity growth for all components for all sub periods

TABLE 3

Full Gross Private National Consumer Receipts and Expenditures, United States, 1982 and 2009 (billions of dollars)

		Receipts	1982	2009
1		Gross private domestic factor outlay (line 4 of the Factor Outlay account of table 1)	3,015.9	13,016.6
2	+	Income originating in rest-of-world (table 6.1 , line 82)	36.5	147.2
3	+	Compensation of employees in general government and government enterprises (line 3 from the Product account in table 1)	388.9	1,666.2
4	+	Investment income of social insurance funds less transfers to general government (table 3.14, line 8 plus line 22, minus lines 11 and 24)	1.9	123.8
5	+	Rest-of-world contributions to government social insurance (table 3.6, line 32)	1.2	5.0
6	+	Personal interest income (table 2.1, line 14)	463.7	1,263.9
7	−	Net interest and miscellaneous payments on assets (table 1.7.5, line 20)	277.5	563.1
8	+	Government rents and royalties (table 3.2, line 15 plus table 3.3, line 15)	8.6	18.2
9	−	Personal interest payments to business (table 2.1, line 30)	59.3	273.9
10	−	Corporate profits tax liability (table 3.2, line 7 plus table 3.3, line 10)	63.0	246.0
11	−	Personal property taxes (table 3.4, sum of lines 18, 19, and 20)	7.3	28.2
12	−	Business property taxes (sum of lines 11–13 from the Product account in table 1)	103.8	511.0
13	−	Personal tax and nontax payments (table 2.1, line 24)	346.9	1,116.7
14	−	Federal estate and gift taxes (table 5.11, line 19)	7.5	20.6
15	−	State and local estate and gift taxes (table 5.11, line 20)	2.6	4.3
16	−	Business transfer payments to foreigners (table 4.1, line 28)	3.4	21.2
17	−	Rents and royalties received by the Federal government (table 3.2, line 15)	5.1	7.0
18	−	Rents and royalties received by state and local governments (table 3.3, line 15)	3.5	11.2
19	−	Dividends received by government (table 3.1, line 10)	0.2	20.9
20	=	Gross private national income	3,036.5	13,416.7
21	+	Nonmarket labor income (sum of lines 18–21 from the Product account in table 1)	8,513.1	39,658.7
22	=	Full gross private national income	11,549.6	53,075.4
23	+	Government transfer payments to persons other than benefits from social insurance funds (table 3.1 line 19 - table 3.12 lines 4 and 28 minus table 3.14 line 14)	97.2	757.3
24	+	Government net purchases of nonproduced assets (table 3.1, line 36)	−1.5	3.4
25	+	Capital transfer payments to persons and financial stablization payments (table 5.11 sum of lines 12–14)	0.2	142.9
26	=	Full gross private national consumer receipts	11,645.5	53,979.0
		Expenditures	1982	2009
1		Personal consumption expenditures (table 1.1.5, line 2)	2,073.9	9,842.9
2	−	Personal consumption expenditures, durable goods (table 1.1.5, line 4)	253.0	1,023.3
3	+	Imputation for nonhuman capital services (line 16 of the Product account in table 1)	298.9	1,234.6
4	=	Private national consumption expenditure	2,119.8	10,054.2
5	+	Consumption of nonmarket goods and services (line 18 Of the Product account in table 1)	3,944.5	12,311.0
6	=	Full private national consumption expenditure	6,064.3	22,365.2

Table 3 *Continued*

		Expenditures	1982	2009
7	+	Personal transfer payments to foreigners (table 2.1, line 33)	6.7	66.1
8	+	Current Transfer Receipts from persons (table 3.1, line 13)	7.1	83.5
9	=	Full private national consumer outlays	6,078.1	22,514.8
10	+	Full gross private national saving (line 11 of the Saving account in table 8)	5,567.6	31,464.2
11	=	Full private national expenditures	11,645.5	53,979.0

Note: Totals may differ slightly from the sums due to rounding.

TABLE 4

FULL GROSS PRIVATE NATIONAL CAPITAL ACCUMULATION AND SAVING, UNITED STATES, 1982 AND 2009 (BILLIONS OF DOLLARS)

		Saving	1982	2009
1		Gross private saving NIPA (table 5.1, line 43)	783.7	3,150.7
2	+	Personal consumption expenditures, durable goods (line 2 of the Expenditures account in table 3)	253.0	1,023.3
3	+	Surplus, social insurance funds (table 3.14, line 1 plus line 16 minus lines 10 and 23)	−33.1	−251.0
4	+	Statistical discrepancy (table 5.1, line 42)	6.8	72.2
5	−	Taxes on wealth (Estate and gift taxes, table 5.11 line 18)	10.1	24.9
6	+	Government net purchases of nonproduced assets (table 3.1, line 36)	−1.5	3.4
7	+	Capital transfer payments to persons and financial stablization payments (table 5.11, sum of lines 12–14)	0.2	142.9
8	=	Gross private national saving	999.0	4,116.5
9	+	Human capital saving (sum of lines 19–21 of the Product account in table 1)	4,568.6	27,347.7
10	=	Full gross private national saving	5,567.6	31,464.2
11	−	Depreciation*	2,624.8	25,060.4
12	=	Net private national saving	2,942.8	6,403.8
13	+	Revaluation*	10,643.00	16,509.8
14	=	Change in private national wealth	13,585.8	22,913.6
		Capital Formation	**1982**	**2009**
1		Gross private domestic investment excluding intellectual property products (table 1.1.5, line 7 minus line 12)	508.3	1327.2
2	+	Intellectual property products (table 1.1.5, line 12)	72.7	550.9
3	+	Personal consumption expenditures, durable goods (line 2 of the Expenditures account in table 3)	253.0	1,023.3
4	+	Net lending of federal government (table 3.2, line 45)	185.4	1,476.7
5	+	Net lending of state and local governments (table 3.3, line 38)	16.1	371.4
6	−	Deficit, federal social insurance funds (table 3.14, line 10 minus line 1)	34.3	253.1
7	−	Deficits, state and local social insurance funds (table 3.14, line 23 minus line 16)	−1.2	−2.1
8	+	Net foreign investment (Table 4.1, line 29)	−3.4	−381.7
9	=	Gross private national capital formation	999.0	4,116.5
10	+	Gross private national human capital formation (sum of lines 19–21 of the Product account in table 1)	4,568.6	27,347.7
11	=	Full gross private national capital formation	5,567.6	31,464.2

Note: Totals may differ slightly from the sums due to rounding.

*For 1982, depreciation and revaluation are taken directly from the original 1989 paper; human and nonhuman depreciation and revaluation are not available separately for that year.

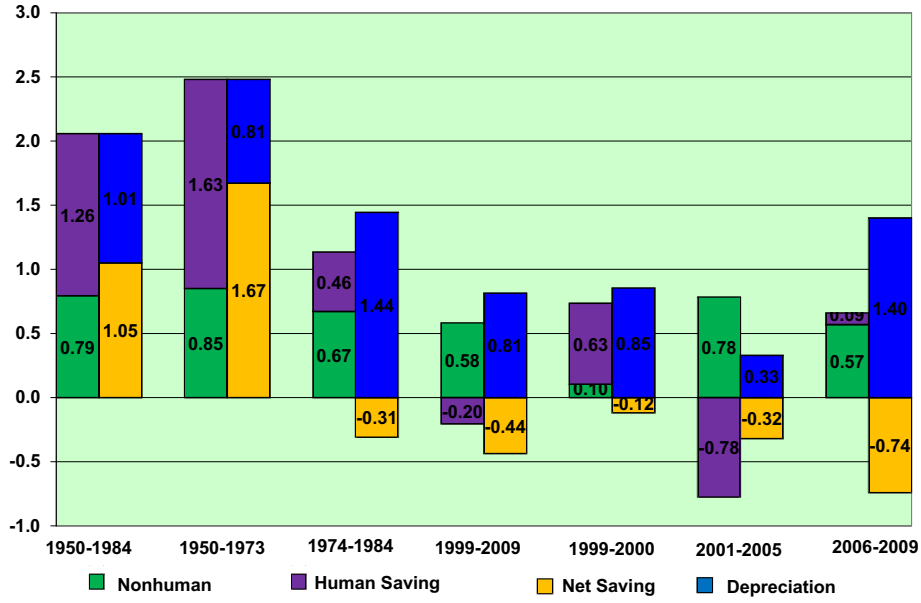


Figure 10. Contributions to Full Gross Private National Saving [Colour figure can be viewed at wileyonlinelibrary.com]

beginning in 1998 or after, quantities per capita growth are all negative as well with one exception: full depreciation in the 2005–09 sub period.

Figure 10 shows negative contributions for net saving for all periods beginning in 1974 or after as contributions are weighted quantity rates of growth. As full gross private saving is the aggregate, depreciation has a positive contribution. However, this perspective changes when looking at net saving, which is probably the more relevant aggregate. The contribution of depreciation is particularly large during the two sub periods when economic growth was lower: 1974–84 and 2006–09. During the 2006–09 sub period, unemployment was high and labor force participation declined, both factors reducing gross and net human saving, the latter due to human depreciation increasing. The human saving quantity reached its maximum for the broader sub period 1999–2005 in 2000, at the end of the "IT Boom" period (see appendix B Table 16). Accordingly, it is not surprising that the contribution of human saving is a large negative during the 2001–05 sub period. In this sub period, the contribution of total saving is not appreciably different from zero.

Figure 11 combines information from the income account of Table 2, the full private consumer outlays component of Table 3, and the net private national saving component of Table 4. In this figure, growth in the level of living is the difference between growth rates of expenditures and incomes. If the contribution of net saving is negative, clearly your standard of living is affected. Even though all income is spent or saved, if depreciation of tangible, intangible, and human capital is substantial, you are less well off than otherwise. Total growth is the highest in the 1950–73 sub period. Half of the subcomponents experience a maximum contribution in this sub period: labor income, level of living, and net saving. In all sub periods starting in 1973 or after, as just described, the contribution of net

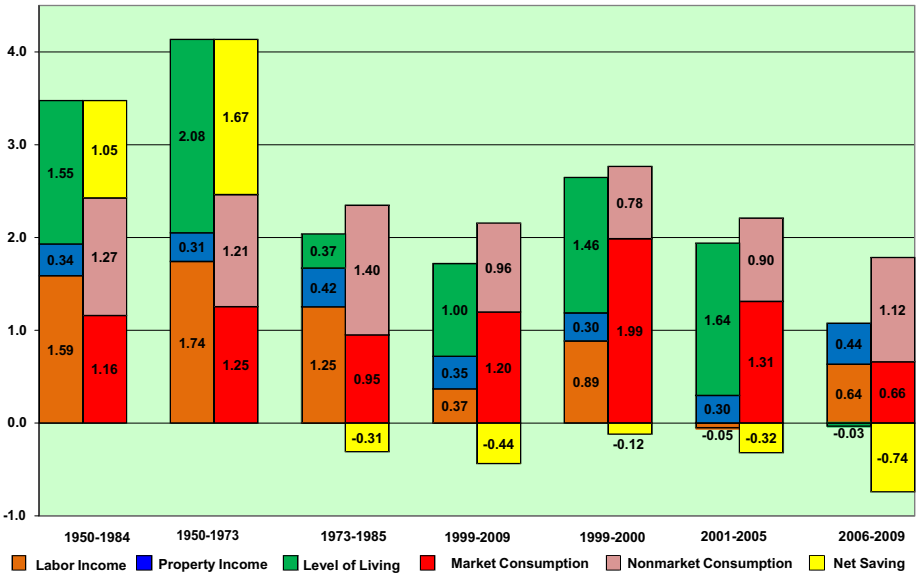


Figure 11. Contributions to Full Private National Expenditure and Income [Colour figure can be viewed at wileyonlinelibrary.com]

saving is negative. The contribution of market consumption is the highest overall sub periods in 1999–2000 at the end of the "IT Boom" period, and continues to be an important contributor in the 2001–05 sub period before reaching its minimum during the 2006–09 Great Recession and slow recovery sub period. The level of living contribution is even negative during this last sub period. The

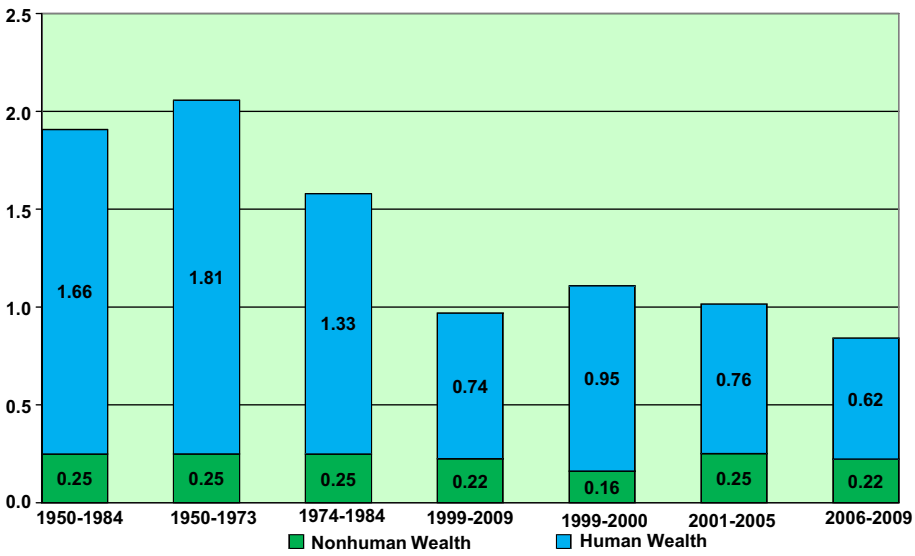


Figure 12. Contributions to Full Private National Wealth [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 5

Full Private National Wealth, United States, 1982 and 2009 (billions of current dollars)

					1982	2009
1		Private domestic tangible assets			13,127.0	52,657.8
		Net claims on federal, state, and local governments				
2	+	a. Federal, monetary			171.4	1,842.6
		(i)	+	Vault cash of commercial banks[a]	19.6	54.9
		(ii)	+	Member bank reserves[a]	26.5	977.0
		(iii)	+	Currency outside banks[a]	136.6	873.3
		(iv)	+	Par to market value adjustment (imputation)	−11.3	−62.7
3	+	b. Federal, nonmonetary			1,231.3	6,072.0
		(i)	+	U.S. government total liabilities[a]	1,796.8	11,003.5
		(ii)	−	U.S. government financial assets[a]	283.3	1,387.1
		(iii)	+	Net liabilities, federally-sponsored credit agencies[a]	−6.4	−71.4
		(iv)	+	Assets of social insurance funds[b]	65.7	2,915.4
		(v)	−	U.S. government liabilities to rest-of-world[c]	177.4	4,478.6
		(vi)	+	U.S. government credits and claims abroad[c]	99.7	202.2
		(vii)	−	Monetary liabilities[a]	182.7	1,905.2
		(viii)	+	Par to market value adjustment (imputation)	−81.1	−206.6
4	+	c. State and local			147.6	1,840.1
		(i)	+	State and local total liabilities[a]	578.3	4,714.6
		(ii)	−	State and local financial assets[a]	392.7	2,662.0
		(iii)	+	Par to market value adjustment (imputation)	−38.1	−212.4
5	+	Net claims on the rest-of-world			247.8	1,436.8
		a.		Private U.S. assets and investments abroad[c]	793.1	15,025.6
		b.	−	Private U.S. liabilities to foreigners[c]	545.3	13,588.8
6	=	Private national nonhuman wealth			14,925.0	63,849.3
7	+	Private national human wealth			166,990.4	616,779.1
8	=	Full private national wealth			181,915.4	680,628.4

Note: Totals may differ slightly from the sums due to rounding.

a Board of Governors of the Federal Reserve System, Flow of Funds Accounts, various issues.

b U. S. Department of Treasury, Treasury Bulletin, February issues.

c "The International Investment Position of the United States," Survey of Current Business, various issues.

contribution of nonmarket consumption, which is the contribution of time in household production and leisure, is lower in all sub periods beginning in 1999 than in all previous sub periods.

The fifth, and last account, is for full private national wealth (see Table 5). Using either nominal shares or contributions to examine subcomponents of wealth, the magnitudes for human wealth clearly dominate (see Figures 8 and 12 and appendix B Table 22). The magnitudes of private domestic tangible assets, which are clearly larger than the magnitudes of net claims on governments and the rest-of-the world, are small compared to the magnitude for human wealth.[39] Tangible assets represent less than 10 percent of full private national wealth.

By sub periods (see appendix B Table 6), price growth is almost always greater than quantity growth. Both exceptions are for nonhuman wealth. In the sub period 1949–73, nonhuman wealth price and quantity grow at a relatively

[39]Tangible assets include both fixed assets, such as equipment and structures, and current assets, such as inventory. The opposite of a tangible asset is an intangible asset. Computer software, patents, trademarks, copyrights, goodwill, research and development, and brand recognition are all examples of intangible assets. In this paper, land is included as a tangible asset; subsoil assets are not included.

strong rate (approximately between three and four percent), with quantity growth being greater. In the sub period 2005–09, the nonhuman wealth price decreased at a very large rate. For human wealth, in the earlier period, 1949–84, the difference between the price rate of growth and the quantity rate of growth is over three and one- half percentage points; in the later period, 1998–2009, this difference fell by over one percentage point.

The final figure (see Figure 12) shows the contribution of nonhuman versus human wealth to growth in full private national wealth. The significant variation in growth in sub period 1950–73 compared to 1974–84 can be attributed to the contribution of human wealth, which is well over one percent in each of these sub periods. The contribution of human wealth to growth in total wealth continued to be strong in all later sub periods, but it is always less than one percent. As Figure 1 illustrates, average educational attainment for those aged 15 through 74 increased at a rapid rate from 1950 to 1980, with the rate of increase substantially slowing from 1980 to 2010. In the earlier three sub periods and again in 2001–05, nonhuman wealth contributes .25 percentage points to growth in total wealth. Its contribution is less in 1999–2009, 1999–2000 and 2006–09. The typical decrease in both the contribution of human and nonhuman wealth results in lower growth in total wealth in the later period compared to the earlier period.

5. Conclusion

Without looking at a set of national accounts with integrated human capital components, researchers, analysts, and policy-makers will have an incomplete picture of economic growth. Major economic trends are very much evident in the results: the slowdown in the sub period 1974–84 relative to the sub period 1950–84, the rebound in the sub period 1999–2000 at the end of the "IT Boom" period, another slowdown in the sub period 2001–05, followed by a weak economy in the sub period 2006–09. The benefit from integrating human capital components most clearly comes from quantification of the impact of an end to the gains in average educational attainment and female labor force participation and the greying of America.

Recently, in a number of countries including China and India, the average educational attainment of the young aged 25 through 34 have substantially surpassed the average educational attainment of the older aged 55 through 64.[40] By contrast, in 2010 the average educational attainment of the young in the U.S. is barely above the average educational attainment of older individuals.[41] A typical situation is for sub period price growth to be larger than quantity growth. The contribution of net saving is negative in all sub periods beginning on or after 1974 and estimates of depreciation more than doubled as a share of gross saving between 1949 and 2009 (see appendix B Table 19).[42] How will the decrease in the contribution of human capital play out in the future? Will the economies of many

[40]See Fraumeni and Liu (2014).

[41]See the Barro-Lee data set (Barro and Lee, 2013b).

[42]For all years, 1998 through 2009, human depreciation is approximately 90 percent of total depreciation.

other countries, particularly emerging countries, continue to catch up, and if so, at what pace? Does this mean that the U.S government should be encouraging policies to increase investment in human capital? What story will the missing period, 1985–97, tell, with further research to fill in the gap? The answers to these questions are unknown, but they can only be explored using accounts which include human capital components.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendices A and B are available online.

Appendix A Table 1: Full Gross Private Domestic Product, rates of growth, 1949–1984, 1998–2009
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