Human Capitalists*

Andrea L. Eisfeldt† Antonio Falato‡ Mindy Z. Xiaolan§

Abstract

Human capitalists are compensated with profit sharing and shared firm ownership. Much like traditional equity holders, human capitalists earn dividends and capital gains from US firms’ growing profit streams. In this paper, we use theory and data to quantify the macroeconomic importance of human capitalists for accurate measurement shares of value added and income shares in the US corporate sector. We explain why, given empirical patterns of compensation and firm ownership in the US, along with the presence of firm profits, value added and income shares can deviate in a way that benefits the income of human capitalists. Using two measures of non-wage income as a share of output, we show that since the 1960s human capitalists have become an increasingly important share of value added and income in the US. A parsimonious model of “technological complementarity” between physical capital and human capitalists can replicate this fact as a response to investment-specific technological change.

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†UCLA Anderson School of Management and NBER, Email: andrea.eisfeldt@anderson.ucla.edu
‡Federal Reserve Board, Email: antonio.falato@frb.gov
§Department of Finance, University of Texas at Austin, Email: mindy.xiaolan@mccombs.utexas.edu
1 Introduction

Human capitalists are firm employees whose income is equity-based, for example in the form of equity share grants or stock options. As partial owners of US firms, in return for their human capital input, human capitalists accrue a share of firm profits through firm dividends and capital gains in addition to earning wages. Combining several data sources, we construct the stylized facts which describe the evolution of human capitalists’ income across US firms and industries, and over time. We show that human capitalists have become an increasingly important class of corporate income earners. Using a structural model featuring complementarity between high-skill human capital and physical capital, we set forth a unified, technology-based, explanation of the quantitative rise of human capitalists in the share of US value added and corporate income.

The labor share in the US has declined, especially in the corporate sector, since the early 1980s (e.g., Elsby, Hobijn, and Sahin (2013), Neiman and Karabarbounis (2014)). At the same time, wage growth has been anemic relative to that of corporate profits. These facts seem to point to a secular shift of income away from households which provide labor and toward the owners of physical capital. On the other hand, many argue that technological progress has greatly increased the demand for, and importance of, high-skilled human capital. Amidst this debate, a national income accounting puzzle has arisen. Physical capital’s share of value added has not kept pace with the profits of the corporate sector (Barkai (2017), Rognlie (2015)), implying a missing production factor (Karabarbounis and Neiman, 2018). Who owns this missing factor, and has therefore increasingly appropriated the economic rents from production? In this paper, we revisit the role of high-skill human capital, as analyzed by Krusell, Ohanian, Rios-Rull, and Violante (2000), and show that human capitalists have increasingly benefited from firms’ growing profits. We also provide a model, and substantial empirical evidence, that the greater participation of high-skilled human capital in firm ownership, along with complementarity between high-skill human capital and physical capital, are key to accurate measurement of shares of value added and income.
We start by characterizing the stylized facts of the secular evolution of human capitalists’ income share. The main measurement challenge is to gather information on non-wage income. We construct two measures based on information from the SEC filings of the universe of publicly-traded US corporations to accurately measure the total returns earned by owners of human capital. Our first measure directly quantifies the non-wage income based on the ownership data. The crucial part of human capitalists’ total return, which is novel to our analysis and of considerable, as well as increasing, importance, comes from the growth in human capitalists’ shares in firm ownership. For this piece of human capitalists’ total return, we collect data on the number of shares reserved for employee unexercised stock option (or restricted equities) compensation. Specifically, we combine and hand-collect data from different sources based on 10-K filings to construct a measure of employees deferred equity-based compensation at both firm-level and industry-level from 1960 to 2005. The deferred component as a fraction of value added has risen strongly over the last decades. Indeed, we show that human capitalists now garner a significant portion of firms’ total profits and capital gains. The ratio of growth of deferred compensation to value added has increased by more than 7% from 1980 to 2005.\footnote{Based on the hand-collected 10-k footnote filing, the ratio of the value of reserved shares to the total market value of firms has about tripled since the 1980s, and was around 12% by the end of 2015.} Important to note that the correction of the total human capitalists income by adding the deferred compensation reverses the downward trend in the high-skill labor share. We also adopt another measure of human capital income share based on widely-available accounting variable, Selling and General Administrative expense. It is known that a large portion of SGA expense is wages, salaries, and any capital gains from stock grants or exercised stock options. Both measures indicate that human capitalists’ share of income has risen strongly over the last decades. Importantly, we also confirm that, using our data and our more comprehensive measure of the human capital share, that, since the 1960s, the physical capital share of value added has been flat while the labor share has steadily declined.

To put structure on the facts describing the rise of human capitalists, and to understand
the implications for shares of value added and income, we develop and study a parsimonious model featuring “technological complementarity” between physical capital and human capitalists. The model employs a CES production function in which, at estimated parameter values, physical capital and human capital are complements, while unskilled labor is a substitute for these two capital inputs. In addition, we model technological progress via a standard shock to (physical) investment good prices (Greenwood et al. (1997), Papanikolaou (2011), Kogan and Papanikolaou (2014)). In response to a reduction in investment goods prices, the model is able to replicate the stylized facts we document. Moreover, the mechanism at the core of the model is testable. Across industries, the model predicts that there should be a negative relation between the human capitalists’ share and investment good prices, as it is optimal for firms to employ more human capitalists as physical capital gets cheaper. We confirm this result in our data.

Our model builds on the work of Krusell, Ohanian, Ríos-Rull, and Violante (2000), who were the first to model and document the complementarity between high-skilled human capital and physical capital. We modify their framework in two key ways. The first is that we treat high-skilled human capital as a stock that can be accumulated through investment, rather than as a flow labor input. The second is that this stock of human capital earns an equilibrium return that depends on its current marginal product, but also on its outside option, as in Eisfeldt and Papanikolaou (2013). Consistent with the findings in Krusell et al. (2000), our structural production parameter estimates imply greater complementarity between high-skilled human capital and physical capital, and more substitutability between physical capital and labor. This is important, since our estimation is also novel, in the sense that it relies on variation in the growth of shares of income across industries. Given the complementarity we estimate, and high-skilled human capitalists’ compensation in the form of firm ownership, we find that human capitalists’ income has increased substantially due to the observed increase in firm profits documented by, for example Barkai (2017).

To quantitatively explore the relation between investment good prices and the human
capitalist’s shares of value added and income, we construct a core industry-level dataset for
capital and labor shares for the 1950 to 2009 period by merging our data describing reserved
shares for employee stock-based compensation and firms’ Selling and General Administrative
expense with the NBER-CES dataset. This dataset covers a very broad set of manufacturing
firms, and contains a reliable measure of value added. Our data confirms across-industries
the cross-country fact of Neiman and Karabarbounis (2014), namely that there is a negative
relation between the labor share and investment goods prices. In addition, we document the
complementarity between high-skilled human capital and physical capital. There is a robust
negative relationship between human capitalists’ share of value added and investment good
prices.

We then use our model to get quantitative estimates of the degree of complementarity
between physical and human capital. Given the rich cross-sectional variation on investment
good prices and factor shares, we conduct our estimation across industries to explore the
heterogeneous degrees of technological complementarity across industries and over time.
The estimated version of the structural model also allows us to explore the quantitative
implications of the complementarity mechanism. Unlike the prevailing explanations on the
secular trends in factor share Neiman and Karabarbounis (2014), Barkai (2017), Autor et al.
(2017)) which feature within industries forces that drive down labor share, the rise of human
capitalists through technological complementarity appears to be driven in large part by the
rise of specific industries.

Our paper makes two key contributions in addition to providing the first comprehensive
measurement of firm ownership and hence the non-wage compensation by human capitalists,
a more broad class of high-skilled labor than that studied in the executive compensation
literature Frydman and Jenter (2010). The first is to correct the measurement of the
factor shares of income value added accruing to labor, capital, profits, and high-skilled
human capital for observed patterns of firm ownership. Empirically, high-skilled human
capital is compensated not only with flow wage compensation, but also (and increasingly)
by sharing in their firms’ profits through equity compensation, i.e., owners of high-skilled human capital are “human capitalists”. Excluding equity compensation to high-skilled labor results in mis-measurement of the total return to high-skilled human capital, and in factor shares. We show that, in the data, it is precisely in the industries and firms for which capital goods prices declined more that equity compensation to high-skilled human capital has increased substantially. Using the correctly measured total return to human capital, we show that within industries over time, there is a positive relation between the human capital share, and the physical capital share (consistent with complementarity), and a negative relation between the labor and capital shares (consistent with substitutability).

Our second key contribution is to document a link between the observed change in factor shares in value added, driven by declining capital goods prices, and the resulting change in factor income shares. The difference between shares of value added and shares of income is driven by the presence of corporate profits, and a sharing rule that implies that the owners of production factors do not necessarily own the firms’ profits in proportion to their shares of value added. In existing macro models of factor shares, such as Karabarbounis and Neiman (2018), it is assumed that the households which own physical capital also own firm profits. This implies that any increase in profits from declining capital goods prices accrues to capital producing households. While this may appear to be a reasonable assumption, without other frictions it is not clear what prevents other households, for example labor-providing households, from owning shares in firms’ profits. Moreover, we show that there is a negative relationship within firm over time between investment goods prices and high-skilled human capital owners earnings and wealth. That is, the evidence suggests that human

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2 While shares of value added are based on current flow value added or output, shares of income can include compensation for contributions to firm value from future output. In order to retain talent, firms are willing to pay high-skilled human capital up to their contribution to firm value, which can easily exceed their contribution to current output.

3 Note the relationship between capital structure and shares of corporate income. If secured debt and leases are close substitutes, then assuming that capital owners earn the rental rate is similar to assuming that they own firms’ debt. Equity holders then earn the firm’s profits after all factors are paid their marginal products. Assumptions about ownership of rental income and profits then imply ownership of the firm’s debt and equity claims.
capitalists have benefited disproportionately from declining investment goods prices. The human capital input is complementary to physical capital, and necessary for production, which has resulted in an increasing fraction of ownership in firms’ growing profit shares.

**Related Literature** Our paper contribute to the following distinct strands of literature. First, there is an ongoing discussion on the driving forces of the secular evolution of factor shares in the macroeconomic literature (e.g., Elsby et al. (2013), Neiman and Karabarbounis (2014), Lawrence (2015), Hartman-Glaser et al. (2016), Autor et al. (2017)). This literature has focused on raw labor share, but less is known about intermediate levels of the income distribution. And direct evidence on the relation between investment good prices and factor shares is still limited/mixed (Acemoglu (2002)).

Our theoretical focus on the investment-specific technological change builds on the earlier macro and asset pricing literature (e.g., Greenwood et al. (1997), Papanikolaou (2011), Kogan and Papanikolaou (2014), Krusell et al. (2000)). We broaden this literature by examining its implications for factor shares and using new micro data to characterize the shape of the aggregate production function.

Relatively, our analysis has implications for the broader debate on income distribution between capital and labor, and the concern on the rising inequality (Piketty (2014), Caicedo et al. (2016), Gabax et al. (2016), Stokey (2016)), which on the finance side has generally focused on the very top of the income distribution (e.g., Gabaix and Landier (2008), Kaplan and Rauh (2010), Frydman and Saks (2010), Frydman and Papanikolaou (2015)). Our analysis broadens this literature by highlighting the importance of employees below the very top executive level.

Last but not least, a growing literature in macro and finance highlights the importance of a “missing factor” intangible/organizational capital (e.g., Eisfeldt and Papanikolaou (2014), Barkai (2017), Karabarbounis and Neiman (2018)). We bring new micro data to bear with the measurement challenges and examine the importance of the rents generated by the
missing factor from a national income accounting perspective, which has received so far limited attention in this literature.

\section*{2 Empirical Facts}

This section presents our measures of human capitalists’ income share. We document the link between declining investment good prices and the rise of human capitalists’ income and ownership share of firms. Specifically, we show that there is a negative relation between investment good prices and the human capitalists’ shares, which holds in the time-series, in the cross-section of industries, as well as within-firm over time. We also take a first step toward exploring the relation for human capitalist wealth.

\subsection*{2.1 Sample Construction}

We construct our income and factor shares measures from micro data for a large sample of US corporations over the 1958 to 2010 period from Compustat, which covers the universe of publicly-traded US firms\footnote{\textsuperscript{4}Compustat data are from 10-K statements filed with the Securities and Exchange Commission.}. We exclude financial firms (SIC codes 6000-6999), regulated utilities (SIC codes 4900-4999). Since Compustat does not have information on value added, payroll, and investment good prices, we retrieve it at the 4-SIC industry level from the NBER-CES Manufacturing Industry Database, which is based largely on the Annual Surveys of Manufacturing datasets (Becker, Gray and Marvakov, 2013)\footnote{\textsuperscript{5}The NBER-CES dataset includes 459 (140) unique industries at the 4-SIC (3-SIC) level. While most of the variables in the NBER-CES are taken from the Annual Surveys of Manufacturing, price deflators and depreciation rates are derived from other data published by the Census Bureau, the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Federal Reserve Board. NBER-CES data and documentation are available at http://www.nber.org/nberces.}. The merged Compustat-NBER-CES dataset covers all firms in the manufacturing and health sectors and roughly half of the firms in the consumer goods and high-tech sectors, but does not cover other sectors. The covered sectors represent over forty percent (half) of the aggregate value of sales (human capitalist’s flow income) in the Compustat universe. Consumption good prices
are from St Louis FRED. The combined dataset for the 1958 to 2010 period comprises up to
6,174 industry-year observations for 459 4-SIC industries, and 86,940 firm-year observations
for 7,356 firms.

2.2 Human Capital Share of Income

The income to human capitalists consists of two pieces. The first piece is the current flow
compensation (e.g., wages, salaries) to the high-skill human capitalist, and the second piece,
which is novel to our analysis, comes from the deferred compensation in forms of equities
or stock options. Given that the granted unvested restricted equities and stock options
are promised to the high-skill employees but not yet realized, this amount of un-taxable
income should be, but was not properly accounted as high-skill income. We construct two
main empirical proxies to capture the importance of human capitalists in terms of their flow
income and deferred compensation.

Ownership-Based Measure  The main measurement challenge is to gather information
on the second piece of income, the non-wage component. However, the considerable and
increasing component of human capital income comes from the deferred compensation in
forms of equity grants (i.e., equities or stock options) over the last few decades. We make
use of firms’ accounting procedure of recording the equity-based compensation at the time
of granting to construct a novel measure of the deferred compensation share of income. As
the standard accounting procedure, when companies grant restricted stocks or stock options
to employees, they reserve a corresponding amount of shares in their balance sheet. The
amount reserved for employees’ equity grants reflects the number of common equity shares
that would be issued by the firm if all stock options outstanding as of year-end were exercised.
As such, reserved shares reflect not just the amount of outstanding stock options but also
their vesting.

6This item is typically under the treasury stock in the liability side of the balance sheet.
We obtain the reserved shares data (RS) from different sources. RS is available from Compustat until 1996. We extend it past 1996 using information from Risk Metrics for the 1996-2005 period. Risk Metrics (formerly the Investor Responsibility Research Center (IRRC)) covers firms from the S&P 500, S&P midcap, and S&P smallcap indexes, and is sourced from 10-K statements filed with the SEC. See the detailed data description in Appendix 6.2. We define the ownership share of human capitalists as the ratio of the value of shares reserved for employee equity-based compensation (RS) to the stock market capitalization of the firm. This share captures the employee-owned fraction of the firm value, and we can further infer the importance of profit sharing as a fraction of human capitalists’ total income.

We construct our first measure to correct the human capitalists’ total income based on the value of reserved shares. We convert the total amount reserved for equity-based compensation into an annual flow of new grants to high-skill employees (ΔRS). To do so, we use the detailed breakdown of the value of new vs. outstanding grants in the IRRC data to estimate the fraction of outstanding grants that is due to new grants in any given year. As shown in Table 1, new grants are about 20 percent of outstanding grants in a given year, on average. We use this multiple to construct our measure of deferred equity compensation. In each year, we aggregate the firm-level value of RS at the industry level, and multiply the industry-level value of RS by 0.2, which is the fraction of outstanding grants that comes from new grants. Figure 1 reports ΔRS as share of value added. The deferred equity-based compensation grows from 0.8% of value added in 1980 to 7.5% at the end of 2005.

For robustness, we find that our reserved-shares based measure of deferred income is highly correlated with the value of newly granted stock options. We obtain the average (Black-Scholes) value of newly granted stock options (BSSO) to market capitalization ratio using the data available from 1996-2005, and infer the newly granted option value to value

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7Scaling the value of reserved shares by the stock market valuation helps alleviate the potential concern of market timing. Companies may give more equity-based compensation at the time that stock prices are high.
added ratio for the rest of the sample. In the sample, the correlation between BSSO to value added ratio and ∆RS to value added ratio is 0.69. Figure 3 plots the aggregated BSSO share, which closely tracks our measure of ∆RS income share in the 1996-2005 period. We also use the Black-Scholes value of employee stock options in our cross-sectional regressions for robustness. Further validating our measure, in the 1996-2005 period the average value of the ownership share tracks closely that of outstanding stock options, and their aggregate values have a time-series correlation of 0.96. Finally, in that period we also have information on whether a firm discloses all available reserved shares in its 10K filing. This is the case for 80 percent of the firms, further supporting the accuracy of our estimate bases on RS.

Our approach to measuring deferred equity compensation has two main advantages. First, reserved shares are less subject to changes in tax treatment and reporting requirements. For example, changes in accounting rules for expensing equity grants can shift firms’ incentives to rely on stock options to restricted stocks as their preferred method of deferred compensation. Since reserved shares include both shares authorized for restricted stocks and for stock options, our measure is not affected by these changes. In addition, reserved shares are not affected by changes in expensing practices for stock options that occurred over our sample period. Publicly-traded firms did not generally expense stock options before 1996, and started doing so by reporting the intrinsic value of restricted stock and stock option grants, on a voluntary basis since 1996, and as a requirement since the introduction of the Financial Accounting Standards Board (FASB) new standard— FAS–123R—in 2004. The value of employee stock options is reported using an intrinsic-value-based method at the time they are granted on financial reports as a compensation expense over the period of vesting. Hence, before 2004, firms could expense granted employee stock options at the fair-value-based method. Reserved shares in the balance sheet are not impacted by changes in expensing practices.

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8For example, if the vesting period is 3 years, one-third of the value calculated at time of grant is expensed for each of the next 3 years.
9Since most of the employee stock options are granted at the money, so firms favor employee stock options as part of the compensation scheme because the fair value of at the money options is zero.
Second, our approach to use firm-level information in the balance sheet from SEC filings allows for timely and comprehensive coverage of equity-based pay. For example, for stock options, their value is not included in payroll measure when they are granted, but when they are exercised, and inclusion is limited to “non-qualified” plans (which are taxed at the income rate), but exclude all other plans (“qualified” or part of retirement accounts), which are taxed as capital gains. The institutional features and tax treatment of equity-based compensation are complex and lead to measurement challenges with standard data sources. The main challenge is that payroll-based measures of wages either exclude altogether or significantly underestimate the value of equity-based employee pay. This type of compensation is generally part of a variety of plans, such as stock option plans, restricted stock or restricted stock units (RSU) plans, employee stock purchase (ESPP) or stock ownership (ESOP) plans, as well as employee stock grants in retirement and 401(k) plans. Relative to wages, the distinctive feature of these plans is that they involve significant deferral, which complicates measurement of income accrual. In addition, the tax treatment of these plans for employees is as income or capital gains depending on whether they constitute “non-qualified” or “qualified” plans, respectively. As a result of these complications, standard measures of payroll that are used in the literature, such as, for example, the BLS Employment Cost Index (ECI), do not include any type of equity-based pay. Others, such as, for example, BLS nonfarm compensation per hour (CPH) or Census Bureau and NIPA/BEA estimates of wages and salaries, only include the payments to employees under plans that are taxed at the personal income rate and reported as payroll by the employer on the IRS Form 941 and as wage income by the employee on the W-2 form. For context, in our data the value of exercised options is an order of magnitude smaller than the overall value of granted and unexpired stock options (at about 1% of stock market capitalization relative to 9%, respectively; see Table 3). Hence, accounting for the granted but not yet exercised portion of stock option grants is crucial to completely capture the income to human capitalists.

We now turn to the correction of human capitalists total income share. We calculate
the human capitalists’ wage income share as the difference between the total labor share of income and the production labor share of income defined as in NBER-CES Manufacturing database. This part captures the current flow income share of human capitalists, as seen in Figure 2. The decline in the high-skill wage income share is also dramatic in our sample, from 17% in 1960 to 12% in 2009. We then adjust for the income share of deferred compensation. Since the “non-qualified” equity-based compensation plans are potentially included in the wage income share measure based on NBER-CES database, we took a conservative approach to avoid double counting. As in Table 1, the value of exercised stock options is 10% of the over value of granted stock options, we scaled the deferred compensation share of income ΔRS/Vadd by 0.9 before adding it to the high-skill wage income share. Figure 2 reports the human capitalists’ total income share after our adjustment. The over increase of total human capitalists income share is from 17% in 1960 to 20% in 2005. The change of deferred compensation share of income completely corrected the decline of high-skill wage income share. Moreover, we observe an over increase of more than 3% in our sample. We hence obtain our first measure of human capitalists’ income share.

**Expense-Based Measure** Our second measure of human capitalists’ income share is based on the widely-available accounting variable, selling, general, and administrative expenses (SG&A), which includes salaries, wages and bonuses of mostly white-collar workers and managers. Since SG&A includes other expenses unrelated to employee compensation, we follow the standard approach in the literature (e.g., Eisfeldt and Papanikolaou 2013) and scale it by 0.3. We also validate this ratio using our first reserved share based measurement. The total human capital income (wage income+deferred compensation) is 37.8% in our sample. In each year, we aggregate the firm-level weighted SG&As at the industry level and construct the industry-level income share as the ratio of aggregate SG&A to value added (SG&A/VADD).

Table 1 reports the summary statistics of the key variables for our analysis. The average
ownership share as the ratio of reserved shares value to market capitalization is 6.2% in the Compustat – NBER-CES merged sample. The average total labor share is 41.8% with more than 65% of labor income from the unskilled labor. Over the sample period from 1958 to 2010, both the expense-based measure of human capital share (SG&A/VADD) and the ownership share experienced the positive annual growth at the rate of 0.4% and 0.5% respectively, while both the total labor share and investment good prices declined at the annual rate of 0.4% and 0.5%. The size of human capital flow income from exercising stock options is large. From the sample period (1996 to 2005), the annual earnings from exercised stock options as a fraction of the stock market valuation is on average 1%, roughly 10.7% of the total stock of granted employee stock options.

[Insert Table [1] Here]

2.3 The Evidence

In this section, we describe both the time series and cross-sectional evidence of human capital shares in US corporation. The dynamics of human capital share, both the flow income share and the ownership share, are very different from the labor share in our sample.

Figures [1] and [2] show the time series of the human capitalists’ income share of our ownership-based measure. The strong rise of the deferred equity-based compensation as a fraction of value added (by 7% over the entire sample period) reverses the downward trend in the high-skill wage income share. Although our primary interest is on adjusting the total human capitalists’ income, we also found that in our sample the ownership share, shares reserved for employee equity-based compensation have about on average tripled relative to the total market value of the firm since the 1980s and stand at about 12% of value by 2015. Note that the increase in the ownership share was not driven by the executives compensation. The executive-owned fraction of public firm shares is relatively stable (2.2% on average) and steadily declining over the period from 1992 to 2015.
Figure 1: ∆ Reserved Shares (RS) as a Fraction of Value Added

The plot reports the time series of our ownership-based measure of deferred human capitalists’ income share. The annualized value of reserved shares for employees equity-based compensation, ∆RS, is calculated as the aggregate value of reserved share by average 5 years of vesting periods. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005).

Figure 4 illustrates the time-series of our expense-based measure of human capital share, and it is negative correlation with investment good prices by plotting annual aggregate across industries of their respective ratios of human capitalists’ income (XSGA) to the aggregate value added over the last decades. For reference, we also plot aggregate capital and labor shares. The human capital share of value added (black-solid line) clearly displays a pronounced secular upward trend amid declining investment good prices. By contrast, the physical capital share has been relatively flat in the U.S. since the 1960s (red-solid line), while the labor share has declined steadily (blue-solid line), which is in line with the cross-country evidence of Neiman and Karabarbounis (2014).

We now turn to describe the cross-sectional behaviors of the income share, non-wage income share, and the ownership share.

[Insert Table 2 Here]
Figure 2: Human Capital Share of Income: Ownership-Based Measure

The plot reports human capitalists' total income share and its composition. The blue dashed line is the high-skilled flow income, calculated as the total labor income share minus the production labor income share (NBER-CES Manufacturing Industry Database). The black dotted line is $0.9\Delta RS$ to value added ratio, which is the average annual value of deferred compensation based on reserved share measure minus the average value of exercised employee stock options. The total human capitalists' income share is the red solid line. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005), NBER-CES Manufacturing Industry Database (1958-2010).

First, cross-industry evidence is consistent with the strong substitution mechanism between human capital and labor, and the complementary mechanism between human capital and physical capital. Table 2 reports industry-level regressions of the human capital share in a given year on the physical capital share and the labor share at the 4-SIC level of industry aggregation, respectively. Both the flow income share (SG&A/VADD) and the ownership share are significantly positively (negatively) correlated with physical capital share (labor share) within-industry over time. The negative correlation between the current flow income share and the labor share is stronger for the unskilled labor share.

Next, we use regression analysis to confirm that the negative time-series relation between investment good prices and the human capitalists’ income share and ownership shares also
hold within-industry and within-firm. To that end, we regress the human capitalists’ income share (both measures) and ownership shares on investment good prices, while controlling for time and industry effects. In the firm-level analysis, to examine within-firm variation in the shares we control for within-industry differences across firms by including firm fixed effects as well as a variety of standard time-varying firm-level controls such as the market-to-book ratio, firm size, cash flow, and a dummy for whether the firm pays dividends in any given year.

[Insert Table 3 Here]

[Insert Tables 4 Here]

Table 3 reports (4-SIC) industry-level regressions of the human capital share of income (Columns 1-2) and the labor share (Columns 3-4) in a given year on investment good prices. The coefficients on investment good prices in Table 3 are robustly negative and strongly statistically significant for both the human capital share and the ownership share measures (Columns 1-2). The estimates are also economically significant. The industry-level estimates imply that a one standard-deviation decline in investment good prices is associated with about 15% (10%) of one standard-deviation increase in the human capital income (ownership) share. We then confirm the robust negative correlation using our corrected total human capital share of income based on the reserved shares measure. In column 6, we identified a economically sizable negative coefficient when regressing the total human capital share on the log of investment good prices: a one standard-deviation decline in investment good prices is associated with 9.4% of one standard-deviation increase in the human capital share at the industry level. In column 7, we show that the increase in the human capital share of income is driven by the increasing importance of the deferred compensation as a fraction of the total human capitalists’ income. Finally, Table 3 shows that there is a positive relation between the labor (payroll) share for both total payroll and production workers payroll and
investment good prices across industries, which is in line with the cross-country evidence in Neiman and Karabarbounis (2014).

Table 4 confirms the relation between human capital share of income and investment good prices at the firm level panel regression. The coefficient estimate in Column (3) of Table 4 implies that a one standard-deviation decline in investment good prices is associated with 3.8% of one standard-deviation increase in the human capital share at the firm level. Column (4) to Column (6) shows the negative relation between ownership share and investment good prices for the sample period from 1958 to 2005. The economic size of the impact of the decline in investment good prices on the ownership share is 7%, larger than that of the current flow income share. Column (7) to (9) confirms the relation in the subsample from 1984 to 2005.

[Insert Table 5 Here]

Physical capital share and human capital share are positive correlated, but the important feature to investigate is the relative growth of the human capital share to the physical capital share as investment good prices decline. Table 5 Column (1) to (3) reports both the industry-level and firm-level regressions of the relative growth of human capital share and physical capital share in a given year on investment good prices. The coefficient estimates are negative and statistically significant. A one standard-deviation decline in investment good prices is associated with 7% (on average) faster growth of the human capital share relative to the physical capital share. This feature is useful for identifying the complementarity at the core of our theory. Column (4) to (6) in Table 5 show robust results when using the earnings from the exercised stock options to proxy the human capitalists’ current flow income. The general concern of the SG&A proxy is that SG&A contains other non-labor related costs (e.g., advertisement) that could potentially lead to overestimation of the human capital income share. However, SG&A could be a better measure than other traditional data sources for skilled labor income because it includes the bonus and earnings from the realized equity compensation to human capitalists. We confirm the relation between the human capital income share and investment good prices. When we can precisely measure the human
capital income component of SG&A, the coefficient estimate implies a more sizable impact of investment good prices on the human capital share of value added.

[Insert Table 6 Here]

In Table 6, we use sample-split analysis to examine whether the data supports the complementarity mechanism. If firms optimally invest in human capitalists because of their complementarity with physical capital, the relation between human capitalists’ shares and investment good prices should be stronger in industries that are more physical capital intensive. In line with this prediction, the economic significance of the coefficient on investment good prices is statistically significant only in the sub-samples of capital-intensive industries. Interestingly, the relation between the human capital share and investment good prices also displays systematic heterogeneity by the degree of skill intensity, and it is much stronger in relatively higher skill-intensity sectors. Overall, the evidence on physical capital intensity supports the unique economic mechanism at the heart of our model. And there is evidence of stronger complementarity in sectors that rely more heavily on skilled workers.

[Insert Table 7 Here]

Finally, we use more detailed firm-level information on employee stock option grants to validate our ownership share proxy. One potential concern is that the value of reserved shares is not exactly the expected earnings of human capitalists. The expected human capital income is the intrinsic option value when options are granted. For the sample from 1996 to 2005, we obtain the detailed information of stock option grants, we can then quantify the relationship between the expected stock option earnings from granted stock options and the investment good prices. In Panel A of Table 7, we confirm that the negative relation with investment good prices holds also for an alternative measure of employees’ profit sharing, the (Black-Scholes) value of their earnings from stock option grants relative to stock market capitalization, which does not involve firms’ estimated issuance needs. Another concern is
that our measures include the compensation of top executives and, as such, may be driven just by this relatively small sub-set of employees. Panel B of Table 7 shows that the negative relation with investment goods prices holds even after we net out the value of stock option grants for the top-5 executives\textsuperscript{10}, indicating that our results reflect the impact on broad-based employee stock-based compensation\textsuperscript{11}.

[Insert Table 8 Here]

We then take one more step toward examining the implications for employee wealth. Table 8 repeats our analysis for another profit sharing measure based on the (Black-Scholes) value of employees’ current and past stock option grants relative to stock market capitalization. Since this measure captures not only new grants but also appreciation of past grants, it is a proxy for employees’ wealth from profit sharing. The negative relation with investment good prices holds also for this more comprehensive measure of employee wealth from profit sharing, confirming the tight link between income and wealth which is highlighted by our model.

3 The Model

In this section, we propose a simple framework building upon Krusell et al. (2000). We show that the stylized facts of factor shares in both time series and cross sections can be explained in an equilibrium model of the firm with technology-capital complementary technology.

3.1 The Economy

The economy is populated by a continuum of firms that produce intermediate goods $j$ using both physical capital $k$ and human capital $h$. There are two sectors of households: one

\textsuperscript{10} We take information on stock option grants for top-5 executives from ExecComp, which is a standard source.

\textsuperscript{11} In Table 5, we confirm that the relation is also robust to measuring the human capitalists’ income share based on the value of exercised stock options.
household sector, denoted by $K$, owns physical capital and provides low-skilled labor, while the other household sector $H$ produces human capital. We refer to the $H$ sector as human capitalists. There is no uncertainty in the economy.

**Final Goods Production**  The final goods are produced using the continuum of intermediate good $j$, which is a unit measure. Final goods production is perfectly competitive, and output is produced via a Dixit-Stiglitz aggregator of intermediate goods.

$$Y_t = \left[ \int_0^1 y_{j,t} \tilde{j}^\epsilon_t \right]^\frac{\epsilon_t}{1-\epsilon_t} \quad (1)$$

$\epsilon_t > \frac{1}{12}$ is the elasticity of substitution between intermediate goods $j$. The intermediate good $j$’s price is $p_t(j)$, which is endogenous and determined by solving for its demand from the final goods producer’s profit maximization problem. Given perfect competition, there are zero profits for the final goods producer, and hence we obtain the standard demand function for the intermediate good $j$:

$$y_{j,t} \equiv D_t(p_t(j)) = Y_t \left( \frac{p_t(j)}{P_t^Y} \right)^{\frac{\epsilon_t}{1-\epsilon_t}} \quad (2)$$

The final consumption good is the numeraire and has a price $P_t^Y = 1$.

**Intermediate Goods Production**  Production of intermediate goods requires both types of capital $k$ and $h$, and also labor $n_t$ supplied by the households in the $k$ sector. In this simple model, we assume that there is no adjustment cost associated either with investment or with adjusting unskilled labor $n_t$. The required rate of return for physical capital and human capital is $R_t^k$ and $w_t^h$ respectively. Labor is compensated with a per-period market wage $w_t$. Firms produce intermediate good $j$ using $k$, $h$, and $n$ according to a constant-

---

12By assuming $\epsilon > 1$, we obtain curvature in the production of final goods: each type of intermediate good $j$ is required for final goods production.

13Alternatively, we can assume that labor is supplied by the human capitalist, or by the both household sectors. The assumption will not affect the result for the labor share of income. The supply of labor in equilibrium is determined by the marginal cost of labor and the marginal benefit of consumption.
return-to-scale CES production function (Krusell et al., 2000):

\[ y_{j,t} = f(z_t, k_t(j), h_t(j), n_t(j)) = z_t \left[ (1 - \alpha_n)A_c ((\alpha_k A_k k_t(j) \rho + (1 - \alpha_k)A_h h_t(j) \rho)^{\sigma} + \alpha_n A_n n_t(j) \sigma \right]^{\frac{1}{\sigma}} \]  

(3)

where \( z_t \) is the factor neutral productivity, \( A_i, i = c, k, h, n \) are factor-augmented technology, and \( \alpha_i, i = k, n \) are distribution parameters. \( \sigma \) governs the elasticity of substitution \( (\frac{1}{1-\sigma}) \) between physical capital and labor, and the elasticity of substitution between human capital and labor. \( \rho \) governs the elasticity of substitution \( (\frac{1}{1-\rho}) \) between physical capital and human capital. If the value of \( \sigma \) or \( \rho \) is greater than zero, it indicates that substitutability is greater than that of a Cobb-Douglas production function.\(^{14}\) If \( \sigma > \rho \), the equipment capital is more complementary with human capital, than with unskilled labor.

The profit-maximizing intermediate sector is owned by both physical capitalists and human capitalists. We assume that the fraction \( \lambda \) of profits \( \Pi_t(j) \) is owned by physical capitalists. This fraction represents the remaining profits available for distribution after the necessary profit-sharing with human capitalists. Either physical capitalists or human capitalists can operate the firm \( j \). Without loss of generality, we assume that physical capitalists are the ones that operate in the intermediate sector subject to the participation constraint of human capitalists.\(^{15}\)

The profit-maximization problem \( P \) of the intermediate sector is:

\[ V_{t}^{k}(j) = \max_{p_t(j), k_t(j), h_t(j), n_t(j), y_{j,t}, \lambda} \lambda \cdot \sum_{t} \Pi_t(j) \]  

(4)

\(^{14}\)If either \( \sigma \) or \( \rho \) is equal to zero, the production function is in Cobb-Douglas form. If either \( \sigma \) or \( \rho \) is equal to one, we have linear or perfect substitution in the production function.

\(^{15}\)We can solve for a version of the model where human capitalists operate, but the main results remain the same.
subject to

\[ \Pi_t(j) = p_t(j)y_{j,t} - R^h_t k_t(j) - w^h_t h_t(j) - w_t n_t(j) \]  \quad (5) 

\[ y_{j,t} = p_t(j) \epsilon_t 1 - \epsilon Y_t \]  \quad (6) 

\[ (1 - \lambda)\Pi_t(j) + \beta \phi_{t+1}(j) \geq O_t = \eta(h_t)V_t(j) \]  \quad (7)

where (6) is the demand for intermediate good \( j \) from equation (2), and (7) is the participation constraint for human capitalists. \( \phi_{t+1}(j) = \sum_{s=t+1}^{\infty} \beta^s (1 - \lambda)\Pi_s(j) \) is the accumulated present value of profit-sharing that physical capitalists promised to human capitalists before production, and \( V_t(j) \) is the present value of the profits of firms. Hence, \( \phi_t + V^k_t = V_t \) for \( \forall j \).

We make two assumptions regarding the outside option of human capitalists. First, we assume that \( O_t \) is the present value of the profit-sharing between physical and human capitalists. Since human capitalists also face the outside option to start a firm in the intermediate sector by hiring unskilled labor with unit cost \( w \) and physical capital \( k \) with unit cost \( R^k \), entrepreneurs then have to share a fraction of profit \( \lambda \) in order to keep the \( h \) sector participating in production. The outside option of a human capitalist is her opportunity to operate an intermediate firm and seize the profits from the operation beyond obtaining the marginal cost of production \( w^h h \), so the fraction of income that is valued as an alternative option is the present value of the shared profits.

In addition, we assume that the outside option for human capitalists is a fraction of the present value of monopolistic profits of the production, and that the fraction \( \eta(\cdot) \) is a function of \( h \), and specifically, increasing in \( h \).\footnote{\( \eta(h) \) is a convex function which is bounded between \([0, 1]\): \( \eta'(h) > 0, \eta''(h) \geq 0 \). It is possible that \( \eta(\cdot) \) is a function of \( k \) as well, but the important assumption for us is that it is a function of \( h \) in order to be consistent with the changing ownership share of human capitalists over time.} Allowing \( \eta(\cdot) \) to be a function of \( h \) gives us flexibility to match the property of changing ownership shares of human capitalists over time and cross industries. This assumption also links the profit sharing to the return of human capital investment, which will be reflected in the Euler equation of the \( h \) sector. The profit
maximization of physical capitalists implies that \( \lambda = 1 - \eta(h) \).

Then, given \( \eta(h) \), the first order conditions (w.r.t. \( k \), \( h \), and \( n \)) of the profit-maximizing choice show a simple markup over the marginal cost under constant return to scale technology:

\[
\begin{align*}
    k &: p_t(j)f_k(j) = \mu_t R^k_t \\
    h &: p_t(j)f_h(j) + \frac{1 - \eta'(h_t)}{1 - \eta(h_t)} \Pi_t = \mu_t w^h_t \\
    n &: p_t(j)f_n(j) = \mu_t w_t
\end{align*}
\]

where the markup over marginal cost is \( \mu_t = \epsilon_t \), the marginal productivity for \( k \) is \( f_k = \alpha_k A_k y^{1-\rho} k^{\rho-1} \), the marginal productivity for \( h \) is \( f_h = (1 - \alpha_k) A_h y^{1-\rho} h^{\rho-1} \), and the marginal productivity of \( n \) is \( f_n = \alpha_n A_n y^{1-\sigma} n^{\sigma-1} \). For simplicity, we now collapse \( A_i \alpha_i \) to \( A \) to reduce the notation for the rest of the paper.

**Agents** The economy is populated with two sectors of household: sector of entrepreneurs, \( K \), that supplies physical capital \( k \) and labor \( n \), while the human capitalists \( H \) supply \( h \).

**Physical Capitalists** owns the production technology that produces physical capital \( k \). We assume linear technology in producing capital goods. Households can transfer final outputs to increase physical capital stock \( k \) at certain prices.\(^{17}\) The laws of motion for equipment capital is as follows:

\[
k_{t+1} = (1 - \delta_k)k_t + I^k_t, \ 0 < \delta_k < 1
\]

Every period, investment decisions of \( I^k_t \) is made. The capital stock of \( k \) depreciates at the rate \( \delta_k \). There is no adjustment cost in investing \( k \). Define \( p^k_t \) as the relative price of physical capital investment goods over the numeraire. \( \tilde{p}^k_t = \frac{p^k_t}{z^k_t} \) is the price of equipment capital investment good with \( z^k_t \) the investment-specific technological (IST) shock. Following

\(^{17}\text{We can extend the current setup to a general environment as in Neiman and Karabarbounis (2014) where there is an intermediate goods sector for } k.\)
Greenwood et al. (1997), $\tilde{p}_t^k$ represents the effective conversion of final outputs to equipment capital.

For now, we assume that the physical capitalists’ sector owns the production of intermediate goods and shares the positive marginal profits $\Pi_t$ from the production. They also have access to the risk-free assets $f_t$ with interest rate $R^f_t$. The physical capitalist maximizes the life-time utility:

$$\max \left\{ \left\{ c_t, I_t^k \right\}_{t=0}^{\infty} \right\} \sum_{t=0}^{\infty} \beta^t U^k(c_t^k, n_t) dt$$

subject to the budget constraint:

$$c^k_t + \tilde{p}_t^k I_t^k + f_{t+1} - (1 + R^f_t) f_t = \int_0^1 R^k_t k_t(j) dj + \lambda \Pi_t + w_t n_t$$

where $\Pi_t = \int_0^1 \Pi_t(j) dj = (\mu - 1) \int_0^1 p_t(j) y_{j,t} dj$.

**Human Capitalists** own production technology that produces human capital $h$.

$$h_{t+1} = (1 - \delta_h) h_t + I_t^h, \ 0 < \delta_h < 1$$

The investment $I_t^h$ can be interpreted as investment to obtain skills or to improve knowledge. The human capitalists maximize the expected life-time utility:

$$\max \left\{ \left\{ c_t, I_t^h \right\}_{t=0}^{\infty} \right\} \sum_{t=0}^{\infty} \beta^t U^h(c_t^h) dt$$

subject to the budget constraint:

$$c^h_t + I_t^h + f_{t+1} - (1 + R^f_t) f_t = \int_0^1 w_t^h h_t(j) dj + \beta \phi_{t+1}(j) - \phi_t(j)$$

where $\beta \phi_{t+1}(j) - \phi_t(j) = \eta(h) \Pi_t$ is the change of present value of profits that accrue to human capitalists from $t$ to $t + 1$. 

25
Equilibrium  We consider a symmetric competitive equilibrium. Equilibrium is defined as a sequence of prices \( \{p_t(j)\}_j \) and quantities such that:

1) Each household sector \( i = k, h \) maximizes their life-time utilities

\[
\max_{\{c_t^i, I_t^i\}_{t=0}^\infty} \sum \beta^t U_t^i dt
\]

subject to the budget constraint \((12)\) or \((14)\).

2) The owner of the final consumption goods sector solves the maximization problem \(P\).

3) The equilibrium is symmetric: \( p_t(j) = P_t = 1, \) \( k_t(j) = k_t, \) \( h_t(j) = h_t \) and \( y_{j,t} = Y_t \).

Hence, the market clearing conditions are written down as follows:

\[
Y_t = c_t^k + c_t^h + \tilde{p}_t^k I_t^k + I_t^h
\]  

(15)

Given the equilibrium definition, we obtain the standard inter-temporal Euler equations for consumption and investment:

\[
1 + R_{t+1}^f = \frac{U_{c,t}^i}{\beta U_{c,t+1}^i}, \quad i = k, h
\]  

(16)

\[
R_{t+1}^k = \frac{\tilde{p}_t^k U_{c,t}^k}{\beta U_{c,t+1}^k} - \tilde{p}_{t+1}^k (1 - \delta_k)
\]  

(17)

\[
w_{t+1}^h = \frac{U_{c,t}^h}{\beta U_{c,t+1}^h} - (1 - \delta_h - (1 - \eta'(h_{t+1}))\Pi_{t+1}^{18}
\]  

(18)

\[
w_t = \frac{U_{n,t}}{U_{c,t}}
\]  

(19)

\[18\] If we adopt an adjustment cost \( \Phi(\cdot) \) in \( h \) investment (without profit sharing), this Euler equation can be written as

\[
R_{t+1}^k = \frac{U_{c,t}^h}{\beta U_{c,t+1}^h} (1 + \Phi'(h_t, h_{t+1})) - (1 - \delta_h).
\]
3.2 Factor Shares of Income

In this subsection, we discuss the factor shares of income in our baseline economy and derive the properties of factor shares. The final output is split into four ways: rental income of physical capital, $R^k_t k_t$; labor income, $w_t n_t$; wages of human capitalists, $w^h_t h_t$, and the fraction of production profits that are promised to share with human capitalists, $(1 - \lambda)\Pi_t$, and the residual profits, $\lambda\Pi_t$.

$$Y_t = R^k_t k_t + w^h_t h_t + w_t n_t + \Pi_t$$

$$= R^k_t k_t + (w^h_t h_t + (1 - \lambda)\Pi_t) + w_t n_t + \lambda\Pi_t$$

The share of human capital income is then $\frac{w^h_t h_t + (1 - \lambda)\Pi_t}{Y_t}$, while the physical capitalists income share is $\frac{R^k_t k_t}{Y_t}$. We now derive the relationship between the factor shares and the rate of return of each factors. Given that our analysis focuses on the steady state, we will omit the subscription $t$ in the following context.

First, we characterize the relative factor shares of income $\frac{s_k}{s_h}$ which is determined by the relative rental payment between $h$ and $k$ and the composition of human capital income.

$$\frac{s_k}{s_h} = \frac{R^k_t k_t}{w^h h_t + (1 - \lambda)(\mu - 1)Y} = \frac{R^k_t k_t}{w^h h_t} \omega_R$$

(20)

where $\omega_R = \frac{w^h h_t}{w^h h_t + (1 - \lambda)(\mu - 1)Y}$ is the fraction of human capital income that is the rental payment. The relative capital share of income is driven by two factors: first, the relative rental payment between $h$ and $k$, $D = \frac{R^k_t k_t}{w^h h_t}$; second, the composition of human capital income, $\omega_R$. The second term is lower when human capitalists’ outside option $\lambda = \eta(h)$ is higher, e.g., human capitalists’ income is more significantly relying on profit sharing, since the participation constraint is always binding $\lambda = \eta(h)$. It is worth to note that the fraction of profit $(1 - \lambda)\Pi$ as part of compensation is promised but not necessarily distributed in the current period, but the fact that profit sharing exists in the compensation impacts the rental rate of
human capital $w^h$ as in (18). We will then make use of the information in the reserve shares to recover the rental rate of human capital at steady state.

To further understand the intuition of the relative rental payment, we can substitute the ratio between physical capital and human capital $k_h$ with the function of the relative capital return:\footnote{This is derived from first order conditions of the profit maximization problem.}

$$D \equiv \frac{R^k k}{w^h h} = \frac{R^k}{w^h} \cdot \left[ \frac{A_k w^h}{A_h R^k} \right]^{\frac{1}{1-\rho}} = \left( \frac{A_k}{A_h} \right)^{\frac{1}{1-\rho}} \left[ \frac{w^h}{R^k} \right]^{\frac{\rho}{1-\rho}} \quad (21)$$

The ratio $\frac{R^k k}{w^h h}$ as a function can be increasing or decreasing in the relative price, $\frac{w^h}{R^k}$, depending on whether $h$ and $k$ are substitutive or complementary. If $\rho < 0$ (complementary), $D$ is decreasing in $\frac{w^h}{R^k}$. The intuition is that, as physical capital becomes cheaper, more $h$ is adopted in the production because of complementarity. Hence, the relative share of $h$ to $k$ is increasing. On the contrary, if $\rho > 0$ (substitute), $D$ is increasing in $\frac{w^h}{R^k}$. Hence, given the technology parameter $\rho$, the relative income share of $h$ and $k$ (20) is driven by the relative price and the composition of human capitalists’ income:

$$\frac{s_k}{s_h} = \left( \frac{A_k}{A_h} \right)^{\frac{1}{1-\rho}} \left[ \frac{w^h}{R^k} \right]^{\frac{\rho}{1-\rho}} \omega_R \quad (22)$$

Next, we can derive the total capital share $s_k + s_h + s_\Pi$ as $1 - s_n$:

$$1 - s_n = \frac{1}{\mu} A_k^{1-\sigma} A_h^{\sigma} C^{\frac{\sigma}{1-\sigma}} R^k \frac{\sigma}{1-\sigma} + 1 - \frac{1}{\mu} \quad (23)$$

where $C = \left( A_k + A_h \left[ \frac{A_k R^k}{A_k w^h} \right]^{\frac{\rho}{1-\rho}} \right)^{\frac{1}{\rho}}$\footnote{See the derivation in Appendix 6.1.} The total capital share of income includes: profit share $1 - \frac{1}{\mu}$, and total rental payments to $h$ and $k$ as a function of $\sigma$, the capital-labor complementarity. In general, a declining rental rate of capital $R^k$ along with capital-labor substitutability $\sigma > 0$ leads to an increase in overall rental payments to capital.
The dynamics of factor shares of value added are captured by equations (17), (18), (22) and (23). We next confront the system with the data to estimate deep parameters in the production technology.

4 Estimation and Quantitative Implications

In this section, we estimate the production technology, elasticity of substitution between $k$ and $h$, $\rho$, and that between labor and capital, $\sigma$. In our benchmark estimation, we interpret the time series observations in the data as the steady-state-to-steady-state transition, and conduct estimation analyses for different industries. We then allow for the change in industry composition over time, and estimate the average elasticity of substitution in the full sample.

4.1 Benchmark Estimation and Transition Dynamics

Steady State We consider the transition dynamics of the steady states and define the percent change of variable $x$ between two periods (steady states) as $\hat{x} = \frac{x' - x}{x} - 1$. We assume that the factor-augmented productivity shocks $A_i$, time preference $\beta$, $\mu$, and depreciation rate of $k$ and $h$, $\delta_k, \delta_h$ are all constant over the sample period of our benchmark estimation.

If we consider $\hat{x}$ as the percentage change of the steady-state-to-steady-state transition, then we have $\hat{R}_{t,i}$ is a constant if $\beta$ is a constant. Keeping $\delta$ and $\mu$ constant along the transition dynamics, equation (17) and (18) imply that $\hat{R}_k = \hat{p}_k$ and $\hat{w}_h = \eta'(\hat{h})$.

Define $s_{k,h} = \frac{x'_k}{x'_h}$ the relative capital share, hence

$$s_{\hat{k},h} \approx \D \frac{\rho}{1 - \rho} (\hat{w}_h - \hat{R}_k) + \hat{\omega}_R$$

(24)

where $\D$ is the steady state relative ratio of rental payments.

Equation (24) is key to identifying parameter $\rho$. To see the intuition of identification, we assume that $\omega_\pi$ and $\omega_R$ are constant ($\hat{\omega}_R = 0$), the trend of marginal return of capital equals the difference between the growth in return to human capital investment $\hat{\omega}_h$ and the trend of
investment good prices, scaled by \(\frac{\rho}{1-\rho}\). As relative price of physical investment good trends downward, and the return to human capital investment increases over time, and \(\rho < 1\), the relative share of physical capital compared to human capital can decline in \(\hat{p}^k\) only if \(\rho < 0\), i.e. \(k\) and \(h\) are complementary.

We can also write down the steady state growth of total capital share: \(s_c = 1 - s_n\), obtained from equation (23):

\[
\hat{s}_c \approx \frac{\sigma(1 - \rho)}{1 - \sigma} \hat{C} + \frac{\sigma}{\sigma - 1} \hat{R}^k
\]  

(25)

The correlation between rental rate of capital \(k\) and the growth of total capital share drives the sign of \(\sigma\). If capital and labor are substitutive, a downward-trending rental rate of physical capital can drive up the total capital share, which can also be partially offset by the increasing demand of more expensive human capital \(h\).

**Benchmark Estimation** In the benchmark estimation, we estimate the production technology, elasticity of substitution between \(k\) and \(h\), \(\rho\), and that between \(n\) and capital, \(\sigma\) using the following system which we obtain from (24) and (25) with an i.i.d. error term:

\[
s_{k,h,j} = \frac{\rho}{1 - \rho}(\hat{w}^h_j - \hat{R}^k_j) + \hat{\omega}_{R,j} + u_j
\]

(26)

\[
s_{c,j} = \frac{\hat{C}^{\frac{\sigma(1 - \rho)}{1 - \sigma}}}{2s_c} \cdot \frac{\sigma}{1 - \sigma} (\hat{R}^k_j - \hat{w}^h_j) + \frac{\sigma}{\sigma - 1} \hat{R}^k_{j} + \epsilon_j
\]

(27)

where \(j\) denotes industries. All \(\hat{x}_j\) are industry-level trends.

[Insert Table 9 Here ]

We first focus on the trends in capital share, and the relative growth rate of physical capital share to the human capital share to identify the parameters of interest. Our estimation benefits from the measurement of the equity-based compensation. The unrealized equity component in the compensation allows employees to share into firms’ capital gains much like
non employee capitalists, and capture the amount of human capital wealth beyond labor income. In our estimation, we correct the trend in the rental rate of human capital $\hat{\eta}(h)$ using the growth rate of the relative reserve share as a fraction of total market capitalization.

We estimate our model to match the empirical moments for the full sample from 1980 to 1990. All the trend estimates span 10 years of data. The full sample estimation is reported in Table 9 along with the average moments from the data. Both $\sigma$ and $\rho$ are negative with $\sigma > \rho$, indicating a strong complementarity between the physical capital and the human capital.

We then quantify the explanatory power of our model by conducting out-of-sample analysis. We adopt our estimated parameters of elasticity of substitutions to project the path of relative equipment capital to human capital share over the next 15 years from 1990 to 2005. Figure 5 shows our out-of-sample trajectory of ration between the equipment capital (K) and human capital (H) share by feeding the level of investment good price and the rental rate of human capital investment $\eta'(h)$. The model-predicted time series of K/H shares explains 33% of the K/H share change in the data.

4.2 Cross-Industry Estimation

We next turn to the cross-industry estimation and show that the increasing technology complementarity is a between-industry rather than a within-industry phenomenon.

We focus on two major industries: manufacturing and consumer goods (traditional) and information, computer and technology (high-tech). The cross-industry estimation results are reported in Table 10. We find that high-tech industries experienced the most dramatic

\[\text{\footnotesize{We stop at 2005 because the overlapped sample of reserve share and investment good prices has the best quality before 2005.}}\]
increase in human capital share while also suffering the largest decline in the investment good prices. Manufacturing behaves very similarly to the full-sample estimation. We identify a large contrast between the elasticity of substitution between unskilled labor and capital, and that between human capital and physical capital in traditional industries, which is consistent with the fact that unskilled labor tend to conduct routine tasks that can be performed by machines over time.

Figure 6 shows our out-of-sample trajectory of the physical capital (K) to human capital (H) share. Using the estimated parameter from the traditional industries, we plot the model-predicted time series of K/H shares, which corresponds to 43% change of the K/H shares in the traditional industries over the time period from 1990 to 2005. However, we see the out-of-sample counterfactual performing better in high tech industries (Figure 7). The model predicts more than 53% changes in K/H shares in the data. This is due to the high complementarity between human capital and physical capital (ρ) in the high-tech industry.

[Insert Figure 6 Here]

[Insert Figure 7 Here]

4.3 Time Series Estimation

The cross-industry estimation motivates us to conduct a time-series estimation. Given that the degrees of the technological complementarity are heterogeneous cross industries, the technology of average firms is changing over time as the industry composition is varying dramatically. The estimation strategy is that we treat firms at each point in time as homogeneous, but the production technology (σ_t and ρ_t) is now time-varying.

[Insert Figure 8 Here]

[Insert Figure 9 Here]

[Insert Figure 10 Here]
We then estimate the average technology for each year \( t \) by matching the model to the growth rates of factor shares. We measure the growth rate of investment good prices of year \( t \) using data of all the past years till year \( t \). Empirical moments (growth rates for different years) are reported in Figure 8 and Figure 9. The (decreasing) growth rate of investment good prices has stabilized since 2000, while we see the steady increasing but stabilizing return of human capital \( R_h \) over time. Time series of \( \rho \) and \( \sigma \) estimated in Figure 10. Increasing in the labor-capital substitutability mostly happened in the late 80s, while the recent decline in K/H share indicates a sharper change in technological complementarity between human capital and physical capital. We interpret this result as a substantial increase in the market share of high-tech industries (ICT) which leads to more complementarity of representative firms in our sample.

[Insert Figure 11 Here]

Lastly, we conduct the counterfactual analysis to quantify the explanatory power of the model. In Figure 11 we predict the time series of \((s_k - s_h)\) using estimated year-by-year parameters while fitting the actual time series of investment good prices and \( \eta'(h) \) into the model. The model-implied \( s_k - s_h \) is relatively similar in the sample period from 1985 to 1995 driven by the stable \( \rho_t \) over the same period of time. However, we found the predicted \( s_k - s_h \) for the high-tech industry trended down and was lower than both manufacturing and health product industries. This is driven by both the increasing complementarity between \( k \) and \( h \) and the sharper decline in investment good prices in the high-tech industry.

5 Conclusion

Different from the downward trend of labor share in the US economy, the measured human capital share of income has risen dramatically. The equity-based component becomes an increasingly important part of human capitalists’ income over the last five decades. The greater participation of employees in firm’s ownership implies a larger mismeasured total
return to human capital. We provide the first comprehensive measurement of firm ownership by human capitalists and offer substantial evidence that human capitalists have increasingly benefited from firms’ growing profits as the technology progress leads to cheaper investment in physical capital. We proposed a story of complementarity between high-skill human capital and physical capital, which along with decreasing investment good prices help to understand the quantitative rise of human capitalists in the share of US value-added and corporate income.
References


6 Appendix

6.1 Derivation of Equation (23)

Under the symmetric equilibrium, the returns of physical capital and human capital can be derived from first order conditions of the profit maximization problem:

\[
f_k = A_c A_k \left(\frac{y}{\Psi}\right)^{1-\sigma}\left(\frac{\Psi}{k}\right)^{1-\rho} = \mu_t R_k^k \tag{28}
\]

\[
f_h = A_c A_h \left(\frac{y}{\Psi}\right)^{1-\sigma}\left(\frac{\Psi}{h}\right)^{1-\rho} = \mu_t w^h \tag{29}
\]

where \( \Psi = \left(\frac{A_k}{k} + \frac{A_h}{h}\right)^{\frac{1}{\rho}} \). From the above equations, the ratio between physical and human capital is a function of the relative capital return:

\[
\frac{h}{k} = \left[ \frac{A_h R_k^k}{A_k w^h} \right]^{\frac{1}{1-\rho}} \equiv B \tag{30}
\]

We can derive the total capital share \( s_k + s_h \) as \( 1 - s_n \):

\[
1 - s_n = s_k + s_h = \frac{A_c \left(\frac{Y}{\Psi}\right)^{1-\sigma} \Psi^{1-\rho} [A_k k^\rho + A_h h^\rho]}{\mu Y} + 1 - \frac{1}{\mu} = \frac{A_c \left(\frac{Y}{\Psi}\right)^{-\sigma}}{\mu Y} + 1 - \frac{1}{\mu}
\]

Find \( \frac{Y}{\Psi} \) as a function of prices:

\[
h = B k \\
\Psi = \left[ A_k k^\rho + A_h B^\rho k^\rho \right]^{\frac{1}{\rho}} = \left( A_k + A_h B^\rho \right)^{\frac{1}{\rho}} k \equiv C k \tag{31}
\]

Since \( \Psi \) is linear in \( k \), we obtain the expression of capital (non-labor) share in the function of prices:

\[
\frac{Y}{\Psi} = \frac{Y}{Ck} = \left[ \frac{R_k^k}{A_c A_k C^{1-\rho}} \right]^{\frac{1}{1-\sigma}} \tag{32}
\]

\[
1 - s_n = \frac{A_c}{\mu} \left[ \frac{A_c A_k C^{1-\rho}}{R_k^k} \right]^{\frac{\sigma}{1-\sigma}} + 1 - \frac{1}{\mu} = \frac{1}{\mu} A_c^{\frac{1-\sigma}{\sigma}} A_k^{\sigma (1-\rho)} C^{\frac{\sigma}{1-\sigma} R_k^{\rho - \sigma - 1}} + 1 - \frac{1}{\mu} \tag{33}
\]
6.2 Data Construction

6.2.1 Data Source

The sample for income shares and investment good prices  Our main source data for constructing factor shares is NBER-CES Manufacturing Industry Database. NBER-CES Manufacturing Industry Database covers SIC 4-digit industry level information from 1958 to 2010 on output, employment, payroll, investment good prices, and importantly value added. All variables are at an annual frequency.

For corporate income shares (physical capital share, profit share, SGA share) and other firm-level variables, we obtain the data from Compustat Fundamental Annual from 1958 to 2010. We exclude financial firms (SIC 6000-6999) and utility firms (SIC 4000-4999) from the universe of the publicly-traded firm sample.

Our main analyses are conducted in the merged sample of Compustat Fundamental Annual and NBER-CES Manufacturing Industry Database covering 7356 of firms, 459 of industries (SIC4) from 1958 to 2010.


6.3 Variables Definition and Construction

Reserved shares (RS).  Common shares reserved for conversion of employee stock options divided by number of common shares outstanding. The observations for RS exist at both the firm level and the industry level. The common shares reserved for employee stock options are obtained from the three data sources:

1. 1958-1983: CSHR (common shares reserved for conversion total) – DCPSTK(preferred stocks and convertible debt) (Compustat Fundamental Annual)
2. 1984-1996: CSHRO (common shares reserved for stock options conversion)
3. 1996-2005: total available shares for employee stock options conversion + total new shares reserved for employee stock options (Risk Metrics)
4. 2009- 2015: common shares reserved for employee stock options (hand collect from 10K directly).

Ownership share.  Employee-owned fraction of firms is calculated as the value of reserved shares (RS) divided by stock market capitalization.

Human capital share of income.  The total income to human capitalists as the share of value added.
1. Ownership-based measure. Total human capital income includes the wage income of high-skill human capitalists and the deferred compensation. Sample period is from 1958 to 2005.

- High-skill wage share: skilled workers payroll/value added (NBER-CES)
- Deferred compensation share: $\Delta RS = 0.9 \times \text{number of reserved shares} \times \text{current stock prices}/5\text{yr}$. The human capital share of income = $\Delta RS$/value added
- Industry-level: human capital share of income = high-skill wage share + deferred compensation share of income

2. Expense-based measure (selling, general, and administrative expenses). Sample period is from 1958 to 2010.

- Industry-level: 30% of XSGA (Compustat) divided by value added (NBER-CES).
- Firm-level: 30% of XSGA (Compustat) divided by sales (Compustat).

Physical capital share. CAPX (Compustat) divided by value added (NBER-CES). The variable is at the industry level. Sample period is from 1958 to 2010.

Labor share. The variable is at the industry level. Sample period is from 1958 to 2010.

1. Unskilled labor share: production labor payroll/value added (NBER-CES)
2. Labor share = skilled labor share + unskilled labor share
Table 1: Descriptive Statistics

This table reports descriptive statistics (means, medians, and standard deviations) for our 4-SIC industry-level sample, which consists of up to 6174 industry-year observations for between 1958 and 2010 corresponding to industries in the NBER-CES dataset for which information on their SG&A expenditures and/or reserved shares is available in Compustat and RiskMetrics. The dataset includes 459 (140) unique industries at the 4-SIC (3-SIC) level.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>St.Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td><strong>Levels (pct.pt.):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SG&amp;A/VADD</td>
<td>10.9</td>
<td>5.1</td>
<td>17.5</td>
</tr>
<tr>
<td>(Value of Reserved Shares)/Stock Mkt Value</td>
<td>6.2</td>
<td>1.7</td>
<td>13.1</td>
</tr>
<tr>
<td>Physical Capital Share</td>
<td>6.3</td>
<td>5.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Labor Share</td>
<td>41.8</td>
<td>43.2</td>
<td>12.7</td>
</tr>
<tr>
<td>Unskilled Labor Share</td>
<td>27.2</td>
<td>27.2</td>
<td>10.6</td>
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<tr>
<td>Investment Good Prices</td>
<td>96.6</td>
<td>98.3</td>
<td>15.3</td>
</tr>
<tr>
<td><strong>Annual Changes (pct.pt.):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SG&amp;A/VADD</td>
<td>0.4</td>
<td>0.1</td>
<td>4.7</td>
</tr>
<tr>
<td>(Value of Reserved Shares)/Stock Mkt Value</td>
<td>0.5</td>
<td>0.0</td>
<td>6.1</td>
</tr>
<tr>
<td>Physical Capital Share</td>
<td>0.0</td>
<td>0.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Labor Share</td>
<td>-0.4</td>
<td>-0.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Unskilled Labor Share</td>
<td>-0.3</td>
<td>-0.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Investment Good Prices</td>
<td>-0.5</td>
<td>-0.4</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Additional Measures (1996-2005, pct. pt.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Employee Stock Options, Black-Scholes Value)/Stock Mkt Value</td>
<td>2.2</td>
<td>0.7</td>
<td>9.1</td>
</tr>
<tr>
<td>(Employee Wealth, Black-Scholes Value)/Stock Mkt Value</td>
<td>9.3</td>
<td>4.1</td>
<td>21.3</td>
</tr>
<tr>
<td>(Value of Exercised Options)/Stock Mkt Value</td>
<td>1.0</td>
<td>0.4</td>
<td>4.8</td>
</tr>
</tbody>
</table>

N. of Industries=459
N. of obs=6,174
This table reports industry-level regressions of the human capital share in a given year on the physical capital share and the labor share at the 4-SIC level of industry aggregation, respectively. The SG&A share variable is defined relative to value added, while reserved shares are relative to shares outstanding. The unskilled labor share refers to production workers. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the first column, a one standard-deviation change in the physical capital share is associated with about one third of a standard deviation change in the SG&A share. The time period is 1958-2010. The NBER-CES dataset includes 459 (140) unique industries at the 4-SIC (3-SIC) level. All specifications include time (year) and industry effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

<table>
<thead>
<tr>
<th>Industry &amp; Time Fixed Effects Estimates for the Human Capital Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>SG&amp;A/VADD (Value of Reserved Shares)/Stock Mkt Value</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>logs</td>
</tr>
<tr>
<td>4-SIC</td>
</tr>
<tr>
<td>Physical Capital Share</td>
</tr>
<tr>
<td>Labor Share</td>
</tr>
<tr>
<td>Unskilled Labor Share</td>
</tr>
<tr>
<td>Time Effects</td>
</tr>
<tr>
<td>Industry Effects</td>
</tr>
<tr>
<td>N. of Industries</td>
</tr>
<tr>
<td>N. of obs.</td>
</tr>
<tr>
<td>R²(%)</td>
</tr>
</tbody>
</table>
Table 3: The Human Capital Share of Income and Investment Good Prices: Industry-Level Analysis

This table reports (4-SIC) industry-level regressions of the human capital share (Columns 1 and 6) and the labor share (Columns 3-4) in a given year on investment good prices. We report results for two measures of the human capital share, both defined relative to value added. The first measure, the SG&A share, uses selling, general, and administrative expenses (Column 1). The second measure, the skilled workers share, uses the sum of non-production workers payroll and the value of reserved shares (Column 6). We also report results for the components of high-skill workers compensation, measured by the share of deferred compensation to total compensation (Column 7), and for the value of reserved shares relative to shares outstanding (Column 3). To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the first column, a one standard-deviation change in investment good prices is associated with about 15% of a standard deviation change in the SG&A share. The time period is 1958-2010. All specifications include time (year) and industry effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

| Industry & Time Fixed Effects Estimates for the Human Capital Share and the Labor Share |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| SG&A/ (Value of Reserved Shares)/ Stock Mkt Value | Total Payroll/ VADD | Production Workers Payroll/ VADD | Skilled Workers Payroll/ VADD | (Human Capital Total Income)/ VADD | Deferred Compensation/ Total Pay |
| Inv. Good Prices | -0.134*** (0.009) | -0.100*** (0.015) | 0.013*** (0.005) | 0.140*** (0.004) | -0.068*** (0.005) | -0.094*** (0.008) | -0.091*** (0.011) |
| Time Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| N. of Industries | 459 | 209 | 459 | 459 | 459 | 459 | 209 | 209 |
| N. of obs. | 6,174 | 3,671 | 23,759 | 23,759 | 23,759 | 6,174 | 3,671 | 3,671 |
| R²(%) | 69.02 | 66.66 | 83.85 | 87.77 | 79.43 | 78.69 | 54.95 |
This table reports firm-level regressions of the human capital share in a given year on investment good prices. The SG&A share variable is defined relative to sales, while reserved shares are relative to shares outstanding. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in Column 3 (4) of Panel B, a one standard-deviation change in investment good prices is associated with about 5% (10%) of a standard deviation change in the SG&A share (reserved shares) variable. The time period is 1958-2010. All specifications include time (year) effects, and otherwise differ based on whether they also include industry (4-SIC) or firm fixed effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

### Panel A: Industry & Time Fixed Effects Estimates for the Human Capital Share

<table>
<thead>
<tr>
<th>Human Capital Share</th>
<th>SG&amp;A/ Sales (Value of Reserved Shares)/ Stock Mkt Value (Value of Shares Reserved for Stock Options)/ Stock Mkt Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>-0.053***</td>
<td>-0.053***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
</tbody>
</table>

### Panel B: Firm & Time Fixed Effects Estimates for the Human Capital Share

<table>
<thead>
<tr>
<th>Human Capital Share</th>
<th>SG&amp;A/ Sales (Value of Reserved Shares)/ Stock Mkt Value (Value of Shares Reserved for Stock Options)/ Stock Mkt Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>-0.035***</td>
<td>-0.035***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
</tbody>
</table>

**Panel A & B Notes:**
- **N. of Firms:** 7,356, 7,336, 7,073, 5,909, 5,909, 5,640, 4,685, 4,685, 4,538
- **N. of Industries:** 209, 209, 209, 209, 209, 209, 209, 209, 209
- **N. of obs.:** 87,513, 87,513, 82,617, 63,376, 63,088, 56,561, 29,072, 29,062, 27,862
- **R^2 (%):** 46.59, 46.45, 56.61, 17.27, 18.06, 18.56, 14.41, 14.41, 17.84
- Control variables include:
  - Industry Effects
  - Firm Effects
  - Time Effects
Table 5: The Relative Growth of The Physical Capital and The Human Capital Share and Investment Good Prices

This table reports results of additional industry-level and firm-level regressions of the relative growth of human capital share and physical capital share in a given year on investment good prices. Columns 1-3 report results for the human capital share relative to the physical capital share. The human capital share is defined using the SG&A share variable relative to value added for the industry-level analysis and relative to sales for the firm-level analysis. The time period is 1958-2010. Columns 4-6 report results for an alternative measure of the human capital share, which is defined using the exercise value of employee stock options. This value is equal to $n \ast (p - K)$, where $n$ denotes the number of exercised employee stock options, $p$ is the stock price and $K$ is the weighted-average exercise (strike) price of exercised options. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the first column, a one standard-deviation change in investment good prices is associated with about 7% of a standard deviation change in the SG&A share relative to the physical capital share. The time period is 1996-2005. All specifications include time (year) and/or industry or firm effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

| Panel A: Additional Industry- & Firm-Level Analysis of the Human Capital Share | (Value of Exercised Options)/Sales |
|---|---|---|---|
| ln(SG&A/VADD)-ln(rK/VADD) | (Value of Exercised Options)/Sales |
| (1) | (2) | (3) | (4) | (5) | (6) |
| logs | logs | logs | logs | logs | logs |
| 4-SIC | firm-level | firm-level | 4-SIC | firm-level | firm-level |
| Investment Good Prices | -0.071*** | -0.064*** | -0.085*** | -0.250*** | -0.302*** | -0.256*** |
| (0.015) | (0.005) | (0.004) | (0.037) | (0.099) | (0.089) |
| Time Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Effects | Yes | Yes | No | Yes | Yes | No |
| Firm Effects | No | No | Yes | No | No | Yes |
| N. of obs. | 6,171 | 87,513 | 87,513 | 1,567 | 3,530 | 3,530 |
| R²(%) | 49.54 | 31.53 | 85.93 | 59.49 | 18.72 | 49.62 |
Table 6: Corroborating the Complementarity Mechanism: Industry-Level Sub-Sample Analysis

This table reports sample split regression analysis of the human capital share in a given year on investment good prices at the 4-SIC industry level. The SG&A share variable is defined relative to value added, while reserved shares are relative to shares outstanding. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the first column, a one standard-deviation change in investment good prices is associated with about 12% of a standard deviation change in the SG&A share. The time period is 1958-2010. The NBER-CES dataset includes 459 (140) unique industries at the 4-SIC (3-SIC) level. All specifications include time (year) and industry effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

<table>
<thead>
<tr>
<th>Human Capital Share=</th>
<th>Complementarity and Skills Splits</th>
<th>(Value of Reserved Shares)/Stock Mkt Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Capital Intensity</td>
<td>SG&amp;A/VADD</td>
<td>By Skill Share</td>
</tr>
<tr>
<td>High</td>
<td>(1)</td>
<td>(3)</td>
</tr>
<tr>
<td>Low</td>
<td>(2)</td>
<td>(4)</td>
</tr>
<tr>
<td>Inv. Good Prices</td>
<td>-0.123**</td>
<td>-0.159*</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>Time Effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry Effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N. of Industries</td>
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<td>66</td>
</tr>
<tr>
<td>N. of obs.</td>
<td>1,665</td>
<td>1,516</td>
</tr>
<tr>
<td>R²(%)</td>
<td>79.20</td>
<td>73.25</td>
</tr>
</tbody>
</table>

(continued)
Table 7: Human Capital Earnings, Factor Share and Investment Good Prices: Firm-Level Analysis

This table reports industry- and firm-level regressions of the Black-Scholes value of human capital earnings from new grants of stock options for all employees (Panel A), and excluding the top executives (Panel B) in a given year on investment good prices, in turn. The Black-Scholes value is relative to stock market capitalization. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the second column of Panel A, a one standard-deviation change in investment good prices is associated with about one third of a standard deviation change in the Black-Scholes value of employee stock options. The time period is 1996-2005. All specifications include time (year) and firm effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

Panel A: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Compensation

<table>
<thead>
<tr>
<th>Stock Mkt Value</th>
<th>(Employee Stock Options, Black-Scholes Value)/ln(Employee Stock Options B-S Value/Employees)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industry-level</td>
</tr>
<tr>
<td>Investment Good Prices</td>
<td>-0.138***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td>Time Effects</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry Effects</td>
<td>No</td>
</tr>
<tr>
<td>Firm Effects</td>
<td>No</td>
</tr>
<tr>
<td>Firm Controls</td>
<td>No</td>
</tr>
<tr>
<td>N. of Industries</td>
<td>108</td>
</tr>
<tr>
<td>N. of obs.</td>
<td>1,111</td>
</tr>
<tr>
<td>$R^2$ (%)</td>
<td>19.67</td>
</tr>
</tbody>
</table>

Panel B: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Compensation Excluding Top Executives

<table>
<thead>
<tr>
<th>Stock Mkt Value</th>
<th>(Non-Exec Employee Stock Options, B-S Value)/Non-Exec Employee Stock Options Relative to CEOs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industry-level</td>
</tr>
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<td>Investment Good Prices</td>
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<tr>
<td></td>
<td>(0.033)</td>
</tr>
<tr>
<td>Time Effects</td>
<td>Yes</td>
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<tr>
<td>Industry Effects</td>
<td>No</td>
</tr>
<tr>
<td>Firm Effects</td>
<td>No</td>
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<tr>
<td>Firm Controls</td>
<td>No</td>
</tr>
<tr>
<td>N. of Industries</td>
<td>108</td>
</tr>
<tr>
<td>N. of obs.</td>
<td>1,111</td>
</tr>
<tr>
<td>$R^2$ (%)</td>
<td>14.17</td>
</tr>
</tbody>
</table>
This table reports industry- and firm-level regressions of the Black-Scholes value of human capital earnings from past unexpired grant and new grants of stock options for all employees (Panel A), and excluding top executives (Panel B) in a given year on investment good prices, in turn. To ease interpretation, all variables are expressed in standard deviation units. The interpretation of each reported coefficient is the change in standard deviations of the dependent variable associated with a one standard-deviation change in the explanatory variable. For example, in the second column of Panel A, a one standard-deviation change in investment good prices is associated with about half of a standard deviation change in the Black-Scholes value of options outstanding. The time period is 1996-2005. All specifications include time (year) and firm effects. Standard errors are robust, with ***; **, and * denoting significance at the 1%, 5%, and 10% level, respectively.

**Panel A: Firm & Time Fixed Effects Estimates for Total Employee Stock Options Wealth**

<table>
<thead>
<tr>
<th></th>
<th>(Employee Wealth, Black-Scholes Value)/ln(Employee Wealth B-S Value/Employees)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stock Mkt Value</td>
<td>ln(Employee Wealth B-S Value/Employees)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1) Industry-level</td>
<td>(2) Firm-level</td>
<td>(3) Industry-level</td>
<td>(4) Firm-level</td>
</tr>
<tr>
<td>Investment Good Prices</td>
<td>-0.163*** (0.026)</td>
<td>-0.366*** (0.128)</td>
<td>-0.362** (0.166)</td>
<td>-0.370** (0.176)</td>
</tr>
<tr>
<td>Time Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry Effects</td>
<td>No No</td>
<td>Yes No</td>
<td>No No</td>
<td>No No</td>
</tr>
<tr>
<td>Firm Effects</td>
<td>No No</td>
<td>Yes No</td>
<td>No Yes</td>
<td>No Yes</td>
</tr>
<tr>
<td>Firm Controls</td>
<td>No No</td>
<td>No No</td>
<td>No Yes</td>
<td>No Yes</td>
</tr>
<tr>
<td>N. of obs.</td>
<td>1,111 2,506</td>
<td>2,714 1,678</td>
<td>1,111 2,498</td>
<td>2,659 2,138</td>
</tr>
<tr>
<td>R^2(%)</td>
<td>25.09 75.83</td>
<td>77.33 77.33</td>
<td>87.57 84.02</td>
<td></td>
</tr>
</tbody>
</table>

**Panel B: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Wealth Excluding CEO**

<table>
<thead>
<tr>
<th></th>
<th>(Non-Exec Employee Wealth, B-S Value)/ln(Non-Exec Employee Wealth Relative to CEOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stock Mkt Value</td>
</tr>
<tr>
<td></td>
<td>(1) Industry-level</td>
</tr>
<tr>
<td>Investment Good Prices</td>
<td>-0.394*** (0.034)</td>
</tr>
<tr>
<td>Time Effects</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry Effects</td>
<td>No No</td>
</tr>
<tr>
<td>Firm Effects</td>
<td>No No</td>
</tr>
<tr>
<td>Firm Controls</td>
<td>No No</td>
</tr>
<tr>
<td>N. of obs.</td>
<td>1,111 1,678</td>
</tr>
<tr>
<td>R^2(%)</td>
<td>13.77 78.22</td>
</tr>
</tbody>
</table>
The table reports our benchmark GMM estimates of $\sigma$ and $\rho$. All variables with ‘hat’ notation represents the average growth rate over the sample period 1980-1990. $\delta_h = 0.15$, $\delta_k = 0.1$. $\omega_\pi = \lambda \times OIBDP/0.3XSGA$. $\lambda$ is proxied by the value of reserve share over market capitalization. $h$ is the accumulated $XSGA$. The average growth of $\lambda = \eta'(h)$ is estimated as the coefficient of the interaction between year and the stock of human capital $h$. Industries are defined using 3-digit SIC. Standard errors are in parentheses.

Panel A: Average Moments (Data) 1980-1990

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{s}_n$</td>
<td>-0.0057</td>
<td>Trend of $s_n$</td>
</tr>
<tr>
<td>$\hat{s}_k - \hat{s}_h$</td>
<td>-0.0034</td>
<td>Trend of $s_k/s_h$</td>
</tr>
<tr>
<td>$\hat{p}_k$</td>
<td>-0.0198</td>
<td>Trend of $p_k$</td>
</tr>
<tr>
<td>$\hat{R}_h$</td>
<td>-0.0006</td>
<td>Trend of $\lambda$</td>
</tr>
</tbody>
</table>

Panel B: Calibrated/Pre-set Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$</td>
<td>1.05</td>
</tr>
<tr>
<td>$\omega_\pi$</td>
<td>0.219</td>
</tr>
</tbody>
</table>

Panel C: Estimated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>0.2617 (0.016)</td>
<td></td>
</tr>
<tr>
<td>$\rho$</td>
<td>-0.2159 (0.273)</td>
<td></td>
</tr>
</tbody>
</table>
Table 10: Cross Industries Estimation

The table reports our GMM estimates of $\sigma$ and $\rho$ for two different industries: traditional and high-tech industries. All variables with ‘hat’ notation represent the average growth rate over the sample period 1980-1990. $\delta_h = 0.15$, $\delta_k = 0.1$, $\mu = 1.05$. $\omega_n = \lambda \times OIBDP/0.3XSGA$. $\lambda$ is proxied by the value of reserve share over market capitalization. $h$ is the accumulated $XSGA$. The average growth of $\lambda = \eta'(h)$ is estimated as the coefficient of the interaction between year and the stock of human capital $h$. Industries are defined using 3-digit SIC. Standard errors are in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Traditional</th>
<th>Tech</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Factor Share Moments 1980-1990</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\hat{s}_n$</td>
<td>-0.0020</td>
<td>-0.0108</td>
</tr>
<tr>
<td>$\hat{s}_k - \hat{s}_h$</td>
<td>-0.0035</td>
<td>-0.0060</td>
</tr>
<tr>
<td>$\hat{\rho}_k$</td>
<td>-0.0198</td>
<td>-0.0198</td>
</tr>
<tr>
<td>$\hat{R}_h$</td>
<td>0.0039</td>
<td>0.0081</td>
</tr>
<tr>
<td><strong>Panel B: Calibrated Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\omega_n$</td>
<td>0.107</td>
<td>0.163</td>
</tr>
<tr>
<td><strong>Panel C: Estimated Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.1039</td>
<td>0.4070</td>
</tr>
<tr>
<td>$\rho$</td>
<td>-0.2794</td>
<td>-0.4198</td>
</tr>
</tbody>
</table>
Figures

Figure 3: Deferred Compensation as a Fraction of Value Added

The plot reports our two measures of aggregate deferred compensation to value added ratio. The black line is the annualized value of reserved shares for employees equity-based compensation. $\Delta RS$ is calculated as the aggregate value of reserved share by average 5 years of vesting periods. The blue dashed line is the Black-Scholes value of the newly granted employee stock options to value added ratio. From 1996 to 2005, we calculate the value of newly granted stock options to value added ratio using RiskMetrics (IRRC). For the period from 1960 to 1995 and from 2006 to 2009, we obtain the aggregated BS value of stock options to value added ratio by multiplying the aggregate value added by the average ratio from 1996 to 2005. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005).
Figure 4: Human Capital Share of Income and Investment Good Prices: Expense-Based Measure

Physical capital share is physical capital investment divided by value added. Human capital share is the flow income share of human capital, defined as 30%XSGA by value added. Total labor share is labor income by value added. Profit share is operating profits (OIBDP) by value added. Source: NBER-CES manufacturing industry database merged with Compustat Fundamental Annual. Sample period is from 1958 to 2010.
Figure 5: Out-of-Sample Transition Dynamics

This figure shows our out-of-sample trajectory of the equipment capital (K) to human capital (H) share and that of the investment good prices. We calibrate the level of \( s_k - s_h \) predicted by the model to match the observed difference between \( s_k - s_h \) in the data at the year 1990. Then we obtain the model predicted time series of \( s_k - s_h \) by fitting the growth of \( R_k \) and \( R_h \) over the period from 1991 to 2005 while keeping the estimated parameters \( \rho \) and \( \sigma \) the same. The solid line reports the model predicted time series of \( s_k - s_h \). The dashed line is time series \( s_k - s_h \) from 1990-2005.
Figure 6: Out-of-Sample Transition Dynamics: Traditional Industries

This figure shows our out-of-sample trajectory of the equipment capital (K) to human capital (H) share and that of the investment good prices. We calibrate the level of $s_k - s_h$ predicted by the model to match the observed difference between $s_k - s_h$ in the data at the year 1990 for the sample of traditional industries. Then we obtain the model predicted time series of $s_k - s_h$ by fitting the growth of $R_k$ and $R_h$ over the period from 1991 to 2005 while keeping the estimated parameters $\rho$ and $\sigma$ the same. The solid line reports the model predicted time series of $s_k - s_h$. The dashed line is time series $s_k - s_h$ from 1990-2005.
Figure 7: Out-of-Sample Transition Dynamics: High Tech Industries

This figure shows our out-of-sample trajectory of $s_k - s_h$ and that of the investment good prices. We calibrate the level of $s_k - s_h$ predicted by the model to match the observed difference between $s_k - s_h$ in the data at the year 1990 for the sample of traditional industries. Then we obtain the model predicted time series of $s_k - s_h$ by fitting the growth of $R_k$ and $R_h$ over the period from 1991 to 2005 while keeping the estimated parameters $\rho$ and $\sigma$ the same. The solid line reports the model predicted time series of $s_k - s_h$. The dashed line is time series $s_k - s_h$ from 1990-2005.
Figure 8: Growth Rates of Factor Shares

The figure reports the average growth rate of $1 - s_n$ and that of $s_k - s_h$ for each given year in the sample. The growth rate of $1 - s_n$ is estimated from the following regression:

$$1 - s_{n,i,t} = a_{\tau} + b^n_{\tau} \times t + \epsilon_{i,t} \text{ for } t = 1, 2, \ldots, \tau$$

where $i$ denotes industry $i$ and $b^n_{\tau}$ for $\tau = 5, \ldots, 25$ are plotted in Panel (1). The growth rate of $s_k - s_h$ is estimated from the following regression:

$$s_{k,i,t} - s_{h,i,t} = a_{\tau} + b^{kh}_{\tau} \times t + \epsilon_{i,t} \text{ for } t = 1, 2, \ldots, \tau$$

$b^{kh}_{\tau}$ for $\tau = 5, \ldots, 25$ are plotted in Panel (2). In the time series estimation, the model is estimated to match these two moments year by year. Sample period: 1980-2005.
Figure 9: Growth Rates of Investment Good Prices and Reserved Shares

The figure reports the average growth rate of investment good prices and that of the growth rate of incremental reserve share relative to $h$. The growth rate of $R_k$ is estimated from the following regression:

$$p_{k,i,t} = a_\tau + c_k^{i} \times t + \epsilon_{i,t}$$ for $t = 1, 2, ... \tau$

where $i$ denotes industry $i$ and $c_k^{i}$ for $\tau = 5, ... 25$ are plotted in Panel (1). The growth rate of $R(h)$ is estimated from the following regression:

$$\frac{RS}{MKT}_{i,t} = a_\tau + c_h^{i} \cdot (h_{i,t} \times t) + d_r h_{i,t} + f_{\tau} t + \epsilon_{i,t}$$ for $t = 1, 2, ... \tau$

$c_h^{i}$ for $\tau = 5, ... 25$ are plotted in Panel (2). In the year-by-year time series estimation, we preset the $\hat{R}_k$ and $\hat{R}_h$ to these two moments.
Figure 10: Time Series of $\sigma$ and $\rho$

This figure reports the time series estimation of average $\sigma_t$ and $\rho_t$. $\sigma_t$ and $\rho_t$ are obtained by matching the model-implied growth rates of factor shares to the data. The estimates are obtained by matching the model-predicted moments and the empirical moments period by period.
Figure 11: Counterfactual: Industry K share - H share

This figure reports the predicted paths of $s_k - s_h$ for manufacturing, high-tech and health product industries. The projected $s_k - s_h$ path for industry $i$ is calculated using the time series of $\sigma_t$ and $\rho_t$ along with the industry investment good prices and $\eta'(h)$.