Human Capitalists*

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Abstract

The widespread and growing practice of equity-based compensation has transformed high-skilled labor from a pure labor input into a class of "human capitalists". We show that high-skilled labor income in the form of equity claims to firms' future dividends and capital gains has dramatically increased since the 1980s. Indeed, in recent years, equity-based compensation represents almost 45% of total compensation to high-skilled labor. Ignoring such income results in incorrect measurement of the returns to high-skilled labor, with important implications for macroeconomics. Including equity-based compensation to high-skilled labor cuts the total decline in the labor share since the 1980's by over 60%, and completely reverses the decline in the high skilled labor share to an increase of almost 1%. Correctly measuring the return to high-skilled labor can thus resolve the puzzling lack of a skill premium in recent data, as well as the corresponding lack of evidence of complementarity between high-skilled labor and new-economy physical capital. Moreover, tackling the capital structure question of who owns firms' profits is necessary to provide a link between changing factor shares and changing income and wealth shares. We use an estimated model to understand the rise of human capitalists in an economy with declining capital goods prices. Finally, we present corroborating cross section and time series evidence for complementarity between high-skilled labor and physical capital using our corrected measure of the total return to human capitalists.

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1 Introduction

Human capitalists are corporate employees who receive significant equity-based compensation, for example in the form of equity 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. 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-skilled 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.

Equity-based compensation represents almost 45% of compensation to human capitalists. As such, correctly accounting for the total income earned by these skilled laborers has a dramatic effect on measured changes in labor shares over the modern era. Including equity-based compensation to high-skilled labor cuts the total decline in the labor share by over 60% in our sample since the 1980's, and completely reverses the decline in the high skilled labor share to an increase of 1%. Correctly measuring the return to high-skilled labor can thus resolve the puzzling lack of a skill premium in recent data, as well as the corresponding lack of evidence of complementarity between high-skilled labor and new-economy physical capital. Out of the total labor share, the high skill share jumps from one third to one half in recent years when equity-based compensation is included.

Our study thus contributes important new facts to the study of changing factor shares, and the implications for income and wealth, in the face of declining investment goods prices. Elsby, Hobijn, and Şahin (2013) and Karabarbounis and Neiman (2014) show that the labor share represented by wages has declined in the US corporate sector since the early 1980s. Indeed, wage growth has been anemic relative to that of corporate profits. While these facts seem to point to a secular shift of income away from households which provide labor and toward the owners of physical capital, tackling the capital structure question of who owns firms' profits is necessary to provide a concrete link between changing factor shares and changing income and wealth shares. We show that an important class of firm owners are human capitalists. In our sample, human capitalists' ownership share of public companies is 7%. The fact that this ownership share, as well as corporate valuations, have risen substantially since 1980 implies that, in recent years, human capitalists earn over $85 Billion annually in equity-based compensation from publicly traded firms.

We provide the first ownership-based 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.[1] 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 is 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.[2]

Following the observation that physical capital's share of value added has not kept pace with the profits of the corporate sector (Barkai (2017) and Rognlie (2015)), Karabarbounis and Neiman (2018) coined the term "factorless income", and showed measurement methods to reduce the share of income that is unaccounted for by observable factors. Since human capitalists own about 7% of firm equity, their flow equity compensation reduces factorless income by this amount. It is important to note that, over our sample, not only have firm profits grown, the ownership share of human capitalists grew even more.

We start by carefully documenting the stylized facts of the secular evolution of human capitalists' income share outlined above. The main measurement challenge is to gather information on equity-based compensation. The largest of component of this compensation is deferred, and hence does not appear in standard compensation measures based on W-2 tax data.[3] We construct two measures, both based on information from the SEC filings of the universe of publicly-traded US corporations to more accurately measure the total returns earned by owners of human capital. Our first measure

[1]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.

[2]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.

[3]See the BEA and BLS documentation.

uses data on the number of shares reserved for employees' unexercised stock options or restricted equity grants at both firm-level and industry-level from 1958 to 2005. Using the data on reserved shares, and its law of motion, we construct a measure of the annual flow of new equity-based compensation grants. To get a measure of total compensation, we add high-skill wages, adjusted for exercised grants, from a merged NBER CES-Compustat sample. Exercised grants (about 10% of the total) can be subject to taxation, and if so, they will be included in wage data based on W-2 filings. As a robustness check, we also construct a second measure of total payments to human capitalists based on a fraction of firms' Selling and General Administrative expense (SG&A). A large portion of SG&A expense is wages, salaries, and any capital gains from stock grants or exercised stock options. By either measure, human capitalists' share of income has risen over the last few decades. Importantly, we also confirm that, using our sample of firms, and our more comprehensive measure of the human capital share, that the total labor share has declined since the 1960s, while the physical capital share of value added has been flat.

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 goods 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, given the complementarity we estimate, 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, Rìos-Rull, and Violante (2000), who were the first to model and document the complementarity between high-skilled human capital and physical capital. Following their work, the wage-based skill premium declined, leading to a flat high-skilled labor share and a corresponding (and puzzling) lack of evidence for complementarity between high-skilled labor and new-economy IT capital. In addition to constructing a more comprehensive measure of high-skilled labor compensation, we modify their theoretical 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), but in contrast to estimates from their model using more recent compensation data based on wages only, our structural production parameter estimates imply greater complementarity between high-skilled human capital and physical capital, and more substitutability between physical capital and labor. It should be noted that our estimation specification is also novel, in the sense that it relies on variation in the growth of shares of income across industries rather than soley on aggregates.

To quantitatively explore the relation between investment goods prices and human capitalists' share of value added and income, we construct a core industry-level dataset for capital and labor shares for the 1958 to 2010 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 Karabarbounis and Neiman (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 goods prices.

We then use our model to get quantitative estimates of the degree of complementarity between physical and human capital. Our estimation indicates that there is a strong complementarity between physical and human capital. The elasticity of substitution between physical and human capital is 0.44 in our sample, while the elasticity of substitution between capital and unskilled labor is 1.79. Our finding on the capital – (unskilled) labor substitutability is broadly consistent with the estimates in the existing literature (e.g. Karabarbounis and Neiman (2014), Krusell et al. (2000)) while the high degree of complementarity between physical and human capital echos the findings by Krusell et al. (2000). We show that correcting the human capitalists' income by including equity-based compensation is crucial for identifying the complementarity between physical and human capital. In the counterfactual where we measure the human capital share using only high skilled human capitalists' wage income, we found significant substitutability between physical and skilled labor instead. This contrast finding is mainly driven by the fact that the relative share of physical capitalists' income and skilled labor wage income decreases without adjusting for the equity-based compensation.

Finally, we provide additional, robust regression-based evidence for complementarity between high-skilled labor and physical capital. Using the correctly measured total return to human capitalists, 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). 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 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 contributes 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), Karabarbounis and Neiman (2014), Lawrence (2015), Hartman-Glaser et al. (forthcoming), Autor et al. (2017)). This literature has focused on the total labor share. Very little is known about the total compensation to the intermediate levels of the income distribution represented by high-skilled laborers. And direct evidence on the relation between investment goods prices and factor shares is still limited (Acemoglu (2002)).

Our theoretical focus on 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. Our study also contributes to our understanding of who gains and who loses from investment-specific technological change.

Relatedly, our analysis has implications for the broader debate on the income distribution between capital and labor, and the concern regarding rising inequality (Piketty (2014), Caicedo et al. (2016), Gabaix 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 or founder level, where total compensation appears to have peaked around the year 2000.[4] Thus, our analysis is complementary to that of Smith et al. (2018), who show that the small business owners earn considerable capital income as compensation for their labor input.

Finally, a growing literature in macro and finance highlights the importance of a "missing factor", namely intangible capital embedded in, and partially owned by, human inputs, or organization capital (e.g., Eisfeldt and Papanikolaou (2014), Barkai (2017), Karabarbounis and Neiman (2018)). We bring new micro data to address the measurement challenges. Moreover, we examine the importance of the rents generated by organization capital from a national income accounting perspective, which has received so far limited (i.e. with the exception of Karabarbounis and Neiman (2018)) attention in this literature.

2 Empirical Facts

This section presents our measures of human capitalists' income. We construct two main measures of the total income to human capitalists, along with several robustness checks, and use these measures to examine the implications for the dynamics of factor shares over time. We document the link between declining investment goods prices and the rise of human capitalists' income, both as a share of value added and as an ownership share of firms. Specifically, we show that there is a negative relation between investment goods prices and the human capitalists' income 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.

2.1 Sample Construction

We construct our income and factor shares measures from micro data for a large sample of US corporations over the 1960 to 2010 period from Compustat, which covers the universe of publicly-

[4] See Frydman and Jenter (2010) for a summary of facts describing executive compensation.

traded US firms.[5] We exclude financial firms (SIC codes 6000-6999), and regulated utilities (SIC codes 4900-4999). Since Compustat does not have information on value added, payroll, and investment goods prices, we retrieve it at the 4-SIC industry level from the NBER-CES Manufacturing Industry Database, which is based largely on the Annual Survey of Manufacturing datasets (Becker, Gray and Marvakov, 2013).[6] 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 of the aggregate value of sales in the Compustat universe. Consumption goods prices are from St Louis FRED. The combined dataset for the 1960 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 of human capitalists consists of two pieces. The first piece is traditional compensation from wages to high-skilled human capitalists. The second piece, which is novel to our analysis, is compensation from restricted equity or stock option grants. In practice, equity-based compensation employees are promised equity grants which can only be exercised or vested after a certain period of time has elapsed. Because equity-based compensation is not immediately realized at the time it is granted, it is subject to special tax treatment. Indeed, many grants are made as employer retirement contributions. As a result, this component of income has been at best only partially accounted for so far in the literature. In order to construct a measure of the level of equity-based compensation that is as precise as possible, we construct our baseline measure based on widely-available data on shares reserved for employee compensation. We construct robustness checks on this measure using smaller samples of detailed data on option grants. Then, we use an expense-based measure of the fraction of high-skilled compensation that firms can expense as a comparison, and find very similar time series and cross section results using this measure. This measure is based on the Sales and General Administrative Expense (SG&A), which includes wages and any

[5] Compustat data are from 10-K statements filed with the Securities and Exchange Commission.

[6] 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.

equity-based compensation that may be expensed. We use these the grant-based and expense-based measures to quantify the macroeconomic importance of human capitalists.

Grant-Based Measure The main measurement challenge is to gather comprehensive information on the equity-based component of income, which comes from equity grants which come in the form of restricted stock or unvested stock options. Companies must reserve shares to offset outstanding equity compensation grants.[7] This item has the advantage of being widely available back to 1960.

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.

Compustat defines the reserved share variable as follows: "This item represents shares reserved for stock options outstanding as of year-end plus options that are available for future grants."[8] Because the process of reserving shares is lumpy, we must smooth the allocation of reserved shares allocated to grants over time. To do this, intuitively, we can use the stock of reserved shares, divided by the average time that a reserved share stays on the balance sheet before being granted as compensation, which we denote the "granting period", or gp. Appendix 6.4 uses the law of motion for reserved shares to formalize this intuition, and provides a precise derivation for our measure which accounts for exercise and expiration. We then use the Risk Metrics data from 1996 to 2005 to estimate the weighted-average ratio of compensation grants to reserved shares. This ratio reveals that the weighted-average granting period, gp is five. We then use the weighted-average granting period of five years to estimate the annual flow of equity-based compensation grants from the end of year stock of reserved shares. We call this annual flow of equity based compensation "new grants", or NG. In each year, we then aggregate the firm-level value of NG to the industry level by summing up over firms. We construct the industry-level share of income from equity-compensation as the ratio of industry-level NG to industry-level value added. Figure 1 reports the aggregate NG

[7]This item is typically under the treasury stock in the liability side of the balance sheet.

[8]It is our understanding that the reserved share variable also includes shares reserved for restricted stock grants, but, if not, our measure is conservative for that reason.

as share of aggregate value added. Income from equity-based compensation grows from less than 1% of value added before 1980 to as much as about 9% in the 2000s.

We also measure the share of total equity that human capitalists own. 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.[9] This share captures the employee-owned fraction of the firm value.

For robustness, we compare our reserved-share based measure of equity-based income to the value of newly granted stock options, and find that these two measures are highly correlated for the shorter sample when both are available. 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 added ratio for the rest of the sample. The correlation between BSSO to value added ratio and NG to value added ratio is 0.69. Figure 3 plots the aggregated BSSO share, which closely tracks our measure of NG 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 for NG.

Our grant-based approach to measuring equity-based compensation has two main advantages. First, reserved shares are not subject to changes in tax treatment and reporting requirements. For example, changes in accounting rules for expensing equity grants can shift firms' incentives between relying on stock options vs. restricted stocks as their preferred method of equity-based 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

[9]Scaling 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.

since 1996, and as a requirement since the introduction of the Financial Accounting Standards Board (FASB) new standard— FAS–123R—in 2004.[10] 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.[11] Hence, before 2004, firms could expense granted employee stock options at the fair-value-based method[12]. Reserved shares on the balance sheet are not impacted by changes in expensing practices.

Second, our approach using firm-level information from SEC filings allows for timely and comprehensive coverage of equity-based compensation. For example, for stock options, their value is not included in standard payroll measures when they are granted, but when they are exercised, and inclusion even when exercised is limited to "non-qualified" plans (which are taxed at the income rate), but excludes 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

[10] Most options are granted at the money, so firms can choose to expense them at their intrinsic value which is zero at the time of granting. Under the new accounting rule after 2004, firms are required to expense their option grants at the fair value.

[11] For 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.

[12] Since 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.

the employee on the W-2 form.[13] 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 fully capture the income to human capitalists.

We now turn to the human capitalists' total income share. We calculate the human capitalists' wage income share as the difference between the total labor (payroll) share of income and the production labor (payroll) share of income defined from the NBER-CES Manufacturing database. Since income from exercised options under "non-qualified" equity-based plans is at least partially included in the wage income share measure from NBER-CES, we take a conservative approach to avoid double counting. We use an estimate of the aggregate value of exercised stock options relative to the aggregate value of new grants, which is 30% in the IRRC data, and an estimate of the fraction of total new grants that are non-qualified, which is 2/3 in ExecuComp.[14] Thus, we subtract 20% of new grants from the high-skill wage income share to correct for potential double-counting. After adjusting for exercised options that may be taxed and hence may appear in CES wages, the CES high-skilled wage measure captures the *wage income share* of human capitalists. The time series of high-skilled wage is plotted in Figure 2. We note that the decline in the high-skill wage income share is pronounced, from 17% in 1960 to 12% in 2009. However, the wage measure is incomplete. Next, we compute, and plot in figure 2, the income share of *equity-based compensation* using our grant-based measure of reserved shares normalized by the weighted-average granting period. Finally, we sum the wage income share and equity-based compensation share to construct human capitalists' total income share, and plot it in figure 2. The increase in equity-based compensation more than offsets the decline in high-skill wage income, and, on average the total human capitalists share is increasing since 1980.

[13]See Hall and Murphy (2003) for a detailed discussion of the tax treatment of stock options and Lebow et al. (1999) and Moylan (2000) for details on BLS and BEA treatment of stock options.

[14]Specifically, in the IRRC data for the 1996-2005 period we calculate the aggregate annual vaue of new and exercised grants by summing over firms and use the average annual ratio of the aggregate value of exercised relative to new grants as our estimate. In the ExecuComp data for the 1992-2005 period, we use the stock grant table, which provides information on value and type for each stock option grant. In each year, we aggregate qualified and non-qualified grants by summing over firms and use the average annual ratio of qualified to total new grants as our estimate.

Expense-Based Measure Our second measure of human capitalists' income 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. An additional advantage of our primary measure based on reserved shares is that we can use it to validate this parametric assumption. Total human capital income based on reserved shares is, on average, 46.8% of SG&A in our sample, indicating that our choice of 0.3 is conservative. Our second measure of human capitalist income shares is constructed, in each year, by aggregating the firm-level 30% of SG&As to the industry level and then taking the ratio of industry-level 0.3×SG&A to industry-level value added (0.3×SG&A/VADD). The bottom left panel of Figure 3 plots the aggregate human capital income share based on SG&A. This share was 5.4% at the beginning of the sample period and more than doubled to 13.2% at the end of 2005.

Table 1 reports the summary statistics of the key variables for our analysis. The average total labor share is 41.8%, while the average skilled labor share is about 18%. Over the sample period from 1960 to 2010, both the the grant-based measure (NG) and the expense-based measure of human capital share (SG&A/VADD) experienced positive annual growth, while both the total labor share and investment goods prices declined. From the sample period (1996 to 2005), new grants of employee stock options are about 8% relative to vale added, and the majority of these grants, about 78%, goes to employees that are not the top-5 executives.

[Insert Table 1 Here]

2.3 The Evidence

Figures 1 and 2 show the time series of human capitalists' equity-based and total (wages+equity) compensation as a share of value added, respectively. Strikingly, the tenfold increase in the equity-based compensation relative to value added (roughly by about 9 percentage points from the 1960s to the 2000s) reverses the downward trend in high-skilled labor wage income. In fact, Figure 6 shows that the increase in equity-based compensation is strong enough to greatly dampen the decline in the overall labor wage share of value added. In line with these facts, the human capitalists' ownership share (Figure 5) – i.e., shares reserved for employee equity-based compensation relative to total equity shares outstanding – also displayed a pronounced upward trend, increasing from about 1% before the the 1980s to about 7% in the 2000s. The increase in the ownership share was not driven just by top executives' equity-based compensation, which was relatively stable around 2.2%, on average, in the 1990s and 2000s.

Figure 3 shows that the time-series evidence is not sensitive to the implementation details of our main proxy. Specifically, our second proxy based on SG&A and an alternative proxy based on the annual change in reserved shares adjusted for exercise and expiration also exhibit a pronounced upward trend. In addition, it is reassuring that our primary estimate of the value of equity-based compensation lines up closely with the actual Black-Scholes value of new grants in the 1996-2005 period, for which this more precise data is available.

Figure 4 shows that in the time-series there is a negative correlation between our grant-based and expense-based measures of human capitalists' income and investment goods prices (-0.76 and -0.48). For reference, we also plot aggregate capital and labor shares. Amid declining investment goods prices, 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 Karabarbounis and Neiman (2014).

[Insert Table 2 Here]

Cross-industry evidence is consistent with a substitution mechanism between human capital and labor, and complementarity between human capital and physical capital. Table 2 reports industry-level regressions of the human capitalists' share in a given year on the physical capital share and the unskilled labor share at the 4-SIC level of industry aggregation, respectively. Both the grant-based and the expense-based shares are significantly positively (negatively) correlated with physical capital share (unskilled labor share) within-industry over time.

Next, we use regression analysis to examine in more detail the cross-sectional relation between investment goods prices and equity-based compensation as well as income shares. To that end, we regress the human capitalists' income and ownership shares on investment goods 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 capitalists' income shares (Columns 1-3) as well as other industry-level measures including the unskilled labor share (Column 5) in a given year on investment goods prices. The coefficients on investment goods prices are robustly negative and strongly statistically significant for all measures of human capitalists' income shares. The estimates are also economically significant, as they imply that a one standard-deviation decline in investment goods prices is associated with up to about 13% of a standard-deviation increase in the human capitalists' income share. The negative correlation is robust to using either of our measures, grant-based (Column 1 and 2) or expense-based (Column 3). In Column 7, we show that declining investment goods prices lead to a chance in the structure of human capitalists' pay, which loads more heavily on equity-based compensation. Finally, Columns 4-5 show that there is a positive relation between the labor (payroll) share and investment goods prices across industries for both total and production workers' payroll, which is in line with the cross-country evidence in Karabarbounis and Neiman (2014).

Table 4 confirms the relation between investment goods prices and the human capitalists' income and ownership shares at the firm level, for specifications with industry (Panel A) and firm (Panel B) fixed effects, respectively. The coefficient estimate in Column (3) implies that a one standard-deviation decline in investment goods prices is associated with about 12% of a standard-deviation increase in the human capitalists' income share at the firm level. Columns (4-6) confirm the negative relation between the ownership share and investment goods prices. The relation between investment goods prices and the ownership share is also economically significant, with a one standard-deviation decline in investment goods prices being associated with about 7% of a standard-deviation increase in the human capitalists' ownership share at the firm level based on the estimate in Column 6. Columns (7-9) confirm the relation for the expense-based income share.

In all, regression analysis confirms the negative time-series relation between investment goods prices and the human capitalists' income and ownership shares, which also holds within-industry and within-firm.

[Insert Table 5 Here]

Next, we examine the growth of the human capitalists' share relative to the physical capital share as investment goods prices decline, which is an important finer prediction of our complementarity mechanism. Table 5 reports both industry-level (Column 1-3) and firm-level (Columns 4-5) regressions of the relative growth of human capitalists' share and physical capital share in a given year on investment goods prices. The coefficient estimates are negative and statistically significant. A one standard-deviation decline in investment goods prices is associated with 10% of a standard deviation (on average) faster growth of the human capitalists' share relative to the physical capital share. This feature is useful for identifying the complementarity at the core of our theory, a point on which we will expand in the model analysis below.

[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 goods prices should be stronger in industries that are more physical capital intensive. In line with this prediction, the coefficient estimate on investment goods prices is statistically and economically significant only in the sub-samples of capital-intensive industries (Columns 1-2, 5-6, and 9-10). Interestingly, the relation between the human capital share and investment goods prices also displays systematic heterogeneity by the degree of skill intensity, and it is much stronger in relatively higher skill-intensity sectors (Columns 3-4, 7-8, and 11-12). 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 confirm that our main results are robust to sharpening our measurement by using the more granular information on employee stock option grants that is available for the 1996-

2005 period. While our baseline measure has the advantage of being available for a wide cross-section of firms over a long time-series, the ideal measurement of equity-based compensation is the intrinsic value of newly granted options. For the 1996 to 2005 period, we have the detailed information that is needed to calculate this value and use it to corroborate the relation between equity-based compensation from granted stock options and investment goods prices. In Panel A of Table 7, we confirm that the negative relation with investment goods prices holds also for an alternative measure of human capitalists' equity-based compensation, the (Black-Scholes) value of their earnings from stock option grants relative to stock market capitalization, both at the industry and firm levels (Columns 1-2 and 3-4, respectively). Another concern is that our measures include the compensation of the very top executives and, as such, may be driven just by this relatively small sub-set of human capitalists. 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[15], indicating that our results reflect the impact on broad-based employee stock-based compensation.[16]

[Insert Table 8 Here]

Table 8 repeats our analysis for a broader measure of equity-based compensation based on the (Black-Scholes) value of employees' current and past stock option grants relative to stock market capitalization. This measure is broader because it captures not only new grants but also appreciation of past grants. The negative relation with investment goods prices holds also for this more comprehensive measure, which offers additional reassurance that our baseline estimates indeed reflect an economically important relation between investment goods prices and human capitalists' income.

3 The Model

In this section, we propose a simple framework building upon Krusell et al. (2000). We show that the stylized facts describing factor shares in both the time series and the cross section can be

[15]We take information on stock option grants for top-5 executives from ExecComp, which is a standard source.

[16]In Appendix Table A.2, we also confirm that the relation is robust to another set of alternative approaches to measuring the human capitalists' income share which are based on either firm estimates of diluted earnings from option exercise or the value of stock repurchases to offset expected dilution from option exercise or small issues of new stock that are primarily related to option exercise.

explained in a unified equilibrium model of the firm with technological complementarity between capital and high skilled labor. To match observed compensation patterns, our model includes both wages and equity based compensation to high skilled labor.

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 household sector, physical capitalists denoted by K, owns physical capital and provides low-skilled labor, while the other household sector, human capitalists H, produces human capital. There is no uncertainty in the economy, and we focus our analysis on comparing equilibrium outcomes across steady states as in Karabarbounis and Neiman (2014).

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

$$Y_t = \left[\int_0^1 y_{j,t}^{\frac{1}{\epsilon_t}} dj \right]^{\epsilon_t}, \tag{1}$$

where $\epsilon_t > 1$[17] is the elasticity of substitution between intermediate goods j. The intermediate goods 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 goods j:

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

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

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

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.[18] In this simple model, we assume that there are *no* adjustment costs associated either with physical capital investment or with adjusting unskilled labor n_t. The required rates of return for physical capital and human capital are R_t^k and w_t^h respectively. Labor is compensated with a per-period market-clearing wage, w_t. Firms produce intermediate good j using k, h, and n according to a constant-return-to-scale CES production function (Krusell et al., 2000):

$$y_{j,t} = f(z_t, k_t(j), h_t(j), n_t(j)) = z_t \left[\alpha_c \left((\alpha_k k_t(j)^\rho + (1-\alpha_k) h_t(j)^\rho\right)^{\frac{\sigma}{\rho}} + (1-\alpha_c) n_t(j)^\sigma\right]^{\frac{1}{\sigma}} \tag{3}$$

where z_t represents the level of factor-neutral productivity and $\alpha_i, i = k, c$ are distribution parameters. σ governs the elasticity of substitution ($\frac{1}{1-\sigma}$) between physical capital and labor, and the elasticity of substitution between human capital and labor. ρ governs the elasticity of substitution ($\frac{1}{1-\rho}$) between physical capital and human capital. If the value of σ or ρ is greater than zero, it indicates that substitutability is greater than that of a Cobb-Douglas production function.[19] 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. A residual fraction λ 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 the firms in the intermediate sector, subject to the participation constraint of human capitalists.

The profit-maximization problem $\mathcal{P}$ of the intermediate sector is:

$$V_t^k(j) = \max_{p_t(j), k_t(j), h_t(j), n_t(j), y_{j,t}, \lambda} \lambda \cdot \sum_t \beta^t \Pi_t(j) \tag{4}$$

[18] Alternatively, 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.

[19] If either σ or ρ is equal to zero, the production function is in Cobb-Douglas form. If either σ or ρ is equal to one, we have linear or perfect substitution in the production function.

subject to

$$\Pi_t(j) = p_t(j)y_{j,t} - R_t^k k_t(j) - w_t^h h_t(j) - w_t n_t(j) \quad (5)$$

$$y_{j,t} = p_t(j)^{\frac{\epsilon_t}{1-\epsilon}} Y_t \quad (6)$$

$$(1-\lambda)\Pi_t(j) + \beta\phi_{t+1}(j) \geq \mathcal{O}_t = \eta V_t(j) \quad (7)$$

where (6) is the demand for intermediate goods j from equation (2), and (7) is the participation constraint for human capitalists. $\phi_{t+1}(j) = \sum_{s=t+1} \beta^s (1-\lambda)\Pi_s(j)$ 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, $\phi_t + V_t^k = V_t$ for $\forall j$.

Equation (7) describes the participation constraint of human capitalists. If human capitalists stay with their present firm, they receive their flow wage $w_h h$, as well as their equity-based compensation $(1-\lambda)\Pi_t(j) + \beta\phi_{t+1}(j)$. Firm owners set equity based compensation by adjusting λ so that human capitalists' participation constraint is satisfied. This practice is very consistent with observed corporate behavior, by which firms retain talent by granting deferred compensation in the form of restricted equity or unvested options. If human capitalists leave to start a new firm, we assume that they will also receive their flow wage $w_h h$. In addition, at their new firm, they will accrue a fraction η of the new firm's value. Flow wages, which are received regardless of human capitalists' departure decision, cancel out, and we are left with the participation constraint in (7). Profit maximization by physical capitalists implies that (7) is always binding and $\lambda = 1 - \eta$.

Then, given η, the first order conditions (w.r.t. k, h, and n) of the profit-maximizing choice yield a simple markup over marginal cost under the constant returns to scale technology: $p_t(j)f_k(j) = \mu_t R_t^k$, $p_t(j)f_h(j) = \mu_t w_t^h$, $p_t(j)f_n(j) = \mu_t w_t$, where the markup over marginal cost is $\mu_t = \epsilon_t$. The marginal productivity of k is $f_k(j) = z\alpha_c\alpha_k \left(\frac{y(j)}{\Psi(j)}\right)^{1-\sigma} \left(\frac{\Psi(j)}{k(j)}\right)^{1-\rho}$, the marginal productivity of h is $f_h(j) = z\alpha_c(1-\alpha_k) \left(\frac{y(j)}{\Psi(j)}\right)^{1-\sigma} \left(\frac{\Psi(j)}{h(j)}\right)^{1-\rho}$ where $\Psi(j) = (\alpha_k k(j)^\rho + (1-\alpha_k)h(j)^\rho)^{\frac{1}{\rho}}$, and the marginal productivity of n is $f_n(j) = z(1-\alpha_c)\left(\frac{y(j)}{n(j)}\right)^{1-\sigma}$.

Agents The economy is populated with two sectors of households: A sector of physical capitalists, K, that supplies physical capital k and labor n, and a sector of human capitalists, H, who supply h.

Physical Capitalists own the production technology that produces physical capital k. We assume a linear technology in producing capital goods. Households can transfer final outputs to increase the physical capital stock k at prices determined by the level of investment-specific technological change.[20] The law of motion for physical capital is as follows:

$$k_{t+1} = (1-\delta_k)k_t + I_t^k,\ 0 < \delta_k < 1 \tag{8}$$

Every period, investment decisions I_t^k are made. The capital stock k depreciates at the rate δ_k. There is no adjustment cost associated with investing k. Define p_t^k as the relative price of physical capital investment goods over the numeraire. $\tilde{p}_t^k = \frac{p_t^k}{z_t^k}$ is the price of physical capital investment goods with z_t^k the investment-specific technological (IST) shock. Following Greenwood et al. (1997), $\tilde{p}_t^k$ represents the effective conversion of final outputs to equipment capital.

We assume that the physical capitalist sector owns the firms producing intermediate goods, and shares the positive marginal profits Π_t from this production. They also have access to risk-free assets f_t with interest rate R_t^f. The representative physical capitalist maximizes their life-time utility:

$$\max_{\{c_t, I_t^k\}_{t=0}^{\infty}} \sum \beta^t U^k(c_t^k, n_t)$$

subject to the budget constraint:

$$c_t^k + \tilde{p_t^k} I_t^k + f_{t+1} - (1+R_t^f)f_t = \int_0^1 R_t^k k_t(j)dj + \lambda \Pi_t + w_t n_t \tag{9}$$

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 the production technology that produces human capital h, with law of motion,

$$h_{t+1} = (1-\delta_h)h_t + I_t^h,\ 0 < \delta_h < 1. \tag{10}$$

Investment, I_t^h, can be interpreted as investing in obtaining skills or improving knowledge. The

[20]We can extend the current setup to a general environment as in Karabarbounis and Neiman (2014) where there is an intermediate goods sector for k.

representative human capitalist maximizes the expected life-time utility:

$$\max_{\{c_t, I_t^h\}_{t=0}^{\infty}} \sum \beta^t U^h(c_t^h)$$

subject to the budget constraint:

$$c_t^h + I_t^h + f_{t+1} - (1 + R_t^f) f_t = \int_0^1 w_t^h h_t(j) dj + \beta\phi_{t+1}(j) - \phi_t(j) \tag{11}$$

where $\beta\phi_{t+1}(j) - \phi_t(j) = \eta\Pi_t$ is the change in the present value of profits that accrues to human capitalists from t to $t+1$ in the steady state in which the firm grows at r_f.

Equilibrium We consider a symmetric competitive equilibrium. This 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 $\max_{\{c_t^i, I_t^i\}_{t=0}^{\infty}} \sum \beta^t U_t^i$ subject to the budget constraint (9) or (11); 2) The owner of the final consumption goods sector solves the maximization problem $\mathcal{P}$; 3) The equilibrium is symmetric: $p_t(j) = P_t = 1$, $k_t(j) = k_t$, $h_t(j) = h_t$ and $y_{j,t} = Y_t$; 4) The market clears: $Y_t = c_t^k + c_t^h + \tilde{p}_t^k I_t^k + I_t^h$.

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

$$1 + R_{t+1}^f = \frac{U_{c,t}^i}{\beta U_{c,t+1}^i}, \qquad i = k, h \tag{12}$$

$$R_{t+1}^k = \tilde{p}^k \frac{U_{c,t}^k}{\beta U_{c,t+1}^k} - \tilde{p}^k{}_{t+1}(1 - \delta_k) \tag{13}$$

$$w_{t+1}^h = \frac{U_{c,t}^h}{\beta U_{c,t+1}^h} - (1 - \delta_h) \tag{14}$$

$$w_t = \frac{U_{n,t}}{U_{c,t}}. \tag{15}$$

3.2 Factor Shares of Income

In this subsection, we discuss the factor shares of income in our baseline economy, and derive their properties. The final output is split three ways between physical capitalists, human capitalists, and labor (though for simplicity we assign the labor income to physical capitalists). Physical capitalists receive the rental income from physical capital, $R_t^k k_t$. Human capitalists receive their wages $w_t^h h_t$ and the share of profits that just satisfies their participation constraint, $(1-\lambda)\Pi_t$. Finally, labor receives wages, $w_t n_t$.

$$\begin{aligned} Y_t &= R_t^k k_t + w_t^h h_t + w_t n_t + \Pi_t \\ &= \underbrace{R_t^k k_t}_{\text{Physical Capitalists Income}} + \underbrace{w_t^h h_t + (1-\lambda)\Pi_t}_{\text{Human Capitalists Income}} + \underbrace{\lambda \Pi_t}_{\text{Profits}} + w_t n_t \end{aligned}$$

The share of human capital income is then $\frac{w_t^h h_t + (1-\lambda)\Pi_t}{Y_t}$, while the physical capitalists income share is $\frac{R_t^k k_t}{Y_t}$. The residual share of profits $\lambda \Pi_t$ is the profit share. We note that, while it is not our main focus, our model highlights the distinction between shares of value added, and shares of income. While shares of value added are based on current output and value added flows, shares of income can include compensation for contributions to firm value stemming from future output. Indeed, in a dynamic model with uncertainty, (e.g. Hartman-Glaser et al. (forthcoming)), ex-ante income shares need not align with ex-post shares of value added, and vice versa.

We now derive the relationship between the factor shares and the rate of return of each factor. Given that our analysis focuses on steady states, we 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 payments to h and k, and the composition of human capitalists' income.

$$\begin{aligned} \frac{s_k}{s_h} = \frac{R^k k + \lambda(\mu - 1)Y}{w^h h} &= \frac{R^k k}{w^h h} \frac{w^h h}{w^h h + (1-\lambda)(\mu-1)Y} \\ &= \frac{R^k k}{w^h h} \omega_R, \end{aligned} \tag{16}$$

where $\omega_R = \frac{w^h h}{w^h h + (1-\lambda)(\mu-1)Y}$ is the fraction of human capital income that is the rental payment paid as flow wages. The relative capital share of income is driven by two factors: first, the relative rental payment between h and k, $\mathbf{D} = \frac{R^k k}{w^h h}$; second, the composition of human capital income, ω_R. When human capitalists' outside option η is higher, human capitalists' income is driven more by profit sharing $1 - \omega_R$, since the participation constraint is always binding $1 - \lambda = \eta$. It is worth noting that the fraction of profits $(1-\lambda)\Pi$ is promised compensation, but may not necessarily be distributed (vested) in the current period. Current period promised profit sharing should be considered part of current period compensation since it is paid to satisfy the time t participation constraint.

To further understand the intuition for the relative rental payments, we can substitute out the ratio between physical capital and human capital $\frac{k}{h}$ using the function of the relative capital return as follows:

$$\mathbf{D} \equiv \frac{R^k k}{w^h h} = \frac{R^k}{w^h} \cdot \left[\frac{\alpha_k w^h}{(1-\alpha_k)R^k}\right]^{\frac{1}{1-\rho}} = \left(\frac{\alpha_k}{(1-\alpha_k)}\right)^{\frac{1}{1-\rho}} \left[\frac{w^h}{R^k}\right]^{\frac{\rho}{1-\rho}} \tag{17}$$

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 substitutes or complementary. If $\rho < 0$ (complementary), $\mathbf{D}$ is decreasing in $\frac{w^h}{R^k}$. The intuition is that, as physical capital becomes cheaper, more h is adopted in production, because of complementarity. Hence, the relative share of h to k is increasing. On the contrary, if $\rho > 0$ (substitutes), $\mathbf{D}$ is increasing in $\frac{w^h}{R^k}$. Hence, given the technology parameter ρ, the relative income share of h vs. k in equation (16) is driven by the relative price and the composition of human capitalists' income.

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

$$1 - s_n \quad = \quad \frac{1}{\mu}\alpha_c^{\frac{1}{1-\sigma}} \alpha_k^{\frac{\sigma}{1-\sigma}} \mathbf{C}^{\frac{\sigma(1-\rho)}{1-\sigma}} R^{k\,\frac{\sigma}{\sigma-1}} + 1 - \frac{1}{\mu} \tag{18}$$

where $\mathbf{C} = \left(\alpha_k + (1-\alpha_k)\left[\frac{(1-\alpha_k)R^k}{\alpha_k w^h}\right]^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}$.[21] 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 σ, 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 (13), (14), (16) and (18). We next confront the system with the data to estimate deep parameters in the production technology.

[21] See the derivation in Appendix 6.1.

4 Estimation

In this section, we combine our model with data to learn about the shape of the aggregate production technology. Specifically, we estimate the elasticity of substitution between k and h, ρ, and that between labor and capital, σ. We also examine a quantitative counterfactual where we exclude equity-based compensation from human capitalists' income.

4.1 The Elasticity of Substitution

We start with the system of first order conditions (16), (17) and (18) with i.i.d. error terms:

$$\frac{s_{k,t}}{s_{h,t}} = \left(\frac{\alpha_k}{1-\alpha_k}\right)^{\frac{1}{1-\rho}} \left[\frac{w_t^h}{R_t^k}\right]^{\frac{\rho}{1-\rho}} \omega_{R,t} + u_t \tag{19}$$

$$1 - s_{n,t} = \frac{1}{\mu}\alpha_c^{\frac{1}{1-\sigma}} \alpha_k^{\frac{\sigma}{1-\sigma}} \mathbf{C_t}^{\frac{\sigma(1-\rho)}{1-\sigma}} R_t^{k\,\frac{\sigma}{\sigma-1}} + 1 - \frac{1}{\mu} + \epsilon_t, \tag{20}$$

where the return to physical capitalists, R_t^k, and that to human capitalists, w_t^h, are determined by the households' intertemporal consumption and saving choices (13) and (14). The estimation focuses on matching the empirically observed trends in the relative capital share $\frac{s_{k,t}}{s_{h,t}}$ and the capital share $1 - s_{n,t}$ to those implied by our model. The estimation allows us to determine the set of parameters that characterize the shape of the aggregate production function. In particular, our interest is in understanding the elasticity of substitution between k and h, ρ, and that between unskilled labor and capital, σ.

Equation (19) is key to identifying parameter ρ. To see the intuition, we assume that ω_R is constant, the trend of marginal return of capital $\frac{w_t^h}{R_t^k}$ equals the difference between the growth in rental return to human capital investment w^h and the trend of investment good prices, scaled by $\frac{\rho}{1-\rho}$. As relative price of physical investment goods trends down, R^k declines faster than the return to human capital investment w^h, and $\rho < 1$, the relative share of physical capital compared to human capital $\frac{s_{k,t}}{s_{h,t}}$ can decline in $\tilde{p}^k$ only if $\rho < 0$, i.e. k and h are complementary. In other words, the dynamics of the relative capital share is crucial for understanding the degree of complementarity in the production function.

The correlation between the rental rate of capital k and the growth of total capital share drives the sign of σ. We can write down the log growth of total capital share $s_c = 1 - s_n$, obtained from equation (18): $\hat{s_c} \approx \frac{\sigma(1-\rho)}{1-\sigma}\hat{\mathbf{C}} + \frac{\sigma}{\sigma-1}\hat{R^k}$, where $\hat{x}$ denotes the growth of x. If capital and labor are substitutes, 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.

[Insert Table 9 Here]

We estimate our model to match the time series factor shares for the sample period from 1980 to 2005. The reason for focusing on the recent period is that the decline in investment goods prices p_t^k started in the early 1980s. The set of parameters that we estimate includes: physical capital's share (α_k), total capital share (α_c), the elasticity of substitution (EOS) between k and h (ρ), the elasticity of substitution (EOS) between capital and labor n (σ), and the depreciation rate of human capital δ_h. The parameters that govern the depreciation rate of physical capital δ_k and the markup μ are calibrated.

In the benchmark estimation, we calibrate the depreciation rate of capital δ_k at the average investment rate in our sample (0.09). We set the markup at a constant 1.3 throughout the sample period.[22] Given that we observe the equity-based component of human capitalists' income, we feed time varying $\omega_{R,t}$ into equation (19) and (20). ω_R is measured as the ratio of the human capitalists' wage income to total human capital income (grant-based measure), which declined from 0.96 in 1980 to 0.86 in 2005. The returns to capitalists are determined by equation (13) and (14), where R_f is set to the level of average real interest rate (1.51%) over the sample period.

Our estimation benefits from the measurement of the equity-based compensation. The unrealized equity component of compensation allows employees to share into firms' capital gains much like non employee capitalists, and captures the amount of human capital wealth beyond labor income. In the estimation, we correct the trend in skilled labor share using both the grant-based human capital share and expense-based human capital share. The estimated parameters are reported in Table 9.

Panel A of Table 9 shows our benchmark result using the grant-based measure of the human capitalists' income share. The decline in the relative capital share $\frac{s_{k,t}}{s_{h,t}}$ implies a negative ρ since

[22] De Loecker and Eeckhout (2017) estimated the average markup in the sample of publicly traded firms, and showed that the average markup has increased from 1.21 in the 1980s to 1.45 around mid 2000s. Karabarbounis and Neiman (2018) showed that the average increase in markup among the same sample is milder when including SG&A as variable costs.

returns to physical capital decreased over the same period. The elasticity of substitution between capital and labor is 1.79 while the elasticity of substitution between physical and human capital is 0.44, indicating a strong complementarity between the physical capital and the human capital. Our estimation of the elasticity of substitution between capital and labor, σ, is similar to the findings of the existing literature. Karabarbounis and Neiman (2014) estimated the EOS between capital and labor is 1.28 on average across countries, and Krusell et al. (2000) showed that EOS is 1.65 between capital and labor using the sample from 1963 to 1992. Our estimate on the elasticity of substitution between physical capital and human capital is closer to the findings in Krusell et al. (2000). We also obtain estimates of the depreciation rate of human capital, δ_h, in our benchmark estimation. In Panel A, $\delta_h = 0.272$ indicates a 3.7 years write-off of the human capital. Panel B of Table 9 reports the estimation result using our expense-based measure of the human capital income share, and estimates on ρ and σ are rather similar to Panel A.

Panel A of Figure 7 shows the behavior of the estimated benchmark model. The model prediction closely tracks the data time series. The decline in the return to physical capital over the sample period leads to an increase in the relative return $\frac{w^h}{R^k}$. Hence, complementarity (between k and h) provides a quantitative explanation for the decline in the relative capital share.

4.2 Counterfactual

While capital-labor substitution can explain the declining labor share (unskilled or total) since the 1980s, equity-based pay is key to account for the rise in the high-skill share and to generate complementarity between physical capital and high-skill labor. To highlight these point, we re-estimate the model under the counterfactual where the total human capitalists' share of income only includes high skilled wage income. The estimation result is reported in Table 10.

[Insert Table 10 Here]

The estimates in the counterfactual are now positive for both ρ and σ. A positive ρ implies the elasticity of substitution between physical and human capital is 1.35, while the elasticity of substitution between capital and labor (1.58) remains similar for σ to our benchmark estimation. The evidence of declining relative capital share is critical for identifying the elasticity of substitution between physical and human capital. Panel B in Figure 7 shows the behavior of the estimated counterfactual. The relative share of physical capital to human capitalists' wage income share decreased over the sample period from 1980 to 2005, and hence the elasticity of substitution between physical and human capital turns out to be greater than one even though they are less substitutative than capital and unskilled labor.

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 goods prices help to understand the quantitative rise of human capitalists in the share of US value-added and corporate income.

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6 Appendix

6.1 Derivation of Equation (18)

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

$$f_k = z\alpha_c\alpha_k\left(\frac{y}{\Psi}\right)^{1-\sigma}\left(\frac{\Psi}{k}\right)^{1-\rho} = \mu_t R^k \tag{21}$$

$$f_h = z\alpha_c(1-\alpha_k)\left(\frac{y}{\Psi}\right)^{1-\sigma}\left(\frac{\Psi}{h}\right)^{1-\rho} = \mu_t w^h \tag{22}$$

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

$$\frac{h}{k} = \left[\frac{(1-\alpha_k)R^k}{\alpha_k w^h}\right]^{\frac{1}{1-\rho}} \equiv \mathbf{B} \tag{23}$$

We can derive the total capital share $s_k + s_h$ as $1 - s_n$:

$$\begin{aligned} 1 - s_n &= s_k + s_h = \frac{(1-\alpha_k)\left(\frac{Y}{\Psi}\right)^{1-\sigma}\Psi^{1-\rho}[\alpha_k k^\rho + (1-\alpha_k)h^\rho]}{\mu Y} + 1 - \frac{1}{\mu} \\ &= \frac{\alpha_c\left(\frac{Y}{\Psi}\right)^{1-\sigma}\Psi^{1-\rho}\Psi^\rho}{\mu Y} + 1 - \frac{1}{\mu} = \frac{\alpha_c}{\mu}\left(\frac{Y}{\Psi}\right)^{-\sigma} + 1 - \frac{1}{\mu} \end{aligned}$$

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

$$\begin{aligned} h &= \mathbf{B}k \\ \Psi &= [\alpha_k k^\rho + (1-\alpha_k)\mathbf{B}^\rho k^\rho]^{\frac{1}{\rho}} = (\alpha_k + (1-\alpha_k)\mathbf{B}^\rho)^{\frac{1}{\rho}}\, k \equiv \mathbf{C}k \end{aligned} \tag{24}$$

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

$$\frac{Y}{\Psi} = \frac{Y}{\mathbf{C}k} = \left[\frac{R^k}{\alpha_c\alpha_k\mathbf{C}^{1-\rho}}\right]^{\frac{1}{1-\sigma}} \tag{25}$$

$$\begin{aligned} 1 - s_n &= \frac{\alpha_c}{\mu}\left[\frac{\alpha_c\alpha_k\mathbf{C}^{1-\rho}}{R^k}\right]^{\frac{\sigma}{1-\sigma}} + 1 - \frac{1}{\mu} \\ &= \frac{1}{\mu}\alpha_c^{\frac{1}{1-\sigma}}\alpha_k^{\frac{\sigma}{1-\sigma}}\mathbf{C}^{\frac{\sigma(1-\rho)}{1-\sigma}}R^{k\,\frac{\sigma}{\sigma-1}} + 1 - \frac{1}{\mu} \end{aligned} \tag{26}$$

6.2 Data Construction

6.2.1 Data Source

The sample for income shares and investment goods 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 goods 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.

The sample for reserved shares We obtain the data for reserved shares from three sources: 1) Compustat Fundamental Annual 1958-1995; 2) Risk Metrics 1996-2005 covering firms from the S&P 500, S&P midcap, and S&P smallcap indexes; 3) Hand collect from 10K 2009-2015.

6.3 Variables Definition and Construction

Reserved shares (RS). Common shares reserved for conversion of employee stock options, which are defined as follows:

1. 1958-1983: CSHR (common shares reserved for conversion total) – DCPSTK(preferred stocks and convertible debt) (Compustat Fundamental Annual)
2. 1984-1995: 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)

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. Grant-based measure. Total human capital income includes the wage income of high-skill human capitalists and the equity-based compensation. Sample period is from 1958 to 2005.
   - High-skill wage share: skilled workers payroll/value added (NBER-CES) - income from exercising equity-based compensation
   - Equity-based compensation share: NG = number of reserved shares × current stock prices/5yr. The human capital share of income = NG/value added
   - Industry-level: human capital share of income = high-skill wage share + equity-based compensation share of income
2. Expense-based measure (selling, general, and administrative expenses). Sample period is from 1958 to 2010.
   (a) Industry-level: 30% of SG&A (Compustat) divided by value added (NBER-CES).
   (b) Firm-level: 30% of SG&A (Compustat) divided by sales (Compustat).

Physical capital share. Investment (NBER-CES) 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

6.4 Constructing the Grant-Based Measure

In this section, we provide a formal derivation of our baseline measure for the annual flow of deferred compensation. Our baseline measure is a fraction of the shares reserved for employee compensation, since the stock of reserved shares is available for a wide cross section of firms, and a long time series of fifty-three years, from 1960 to 2010. We calibrate our measure to Risk Metrics data, which contains information on both reserved shares and share-based employee compensation grants for the period 1996-2005. We also perform several robustness checks on this measure. Our measure is conservative, in the sense that we do not include capital gains or losses on granted but not vested share-based compensation, and on average share values have increased substantially over our sample (see Hall and Liebman (1998).).

We start with the following law of motion for the stock of reserved shares,

$$RS_{t+1} = RS_t + NRS_t - EXC_t - EXP_t, \tag{27}$$

where RS_t denotes reserved shares at the beginning of period t, and RS_{t+1} is the stock of reserved shares at the beginning of period $t + 1$. As is standard for the law of motion of any stock, there is "investment" in the stock, and "depreciation". Here, investment, or growth in reserved shares, is denoted NRS_t. That is, NRS_t denotes newly authorized reserved shares. All newly authorized reserved shares are voted on by the board of directors, and should be reported to the SEC at least annually, however comprehensive data on new share authorizations are not reliably available electronically. The stock of reserved shares also depreciates, due to exercised stock options and vested restricted stock (denoted EXC_t), and expired options or retired restricted stock (denoted EXP_t).

In practice, the process of authorizing new reserved shares is lumpy. Similar to a plan for capital expenditures, firms construct a plan for new share issuances for compensation, warrants, secondary offerings, etc. When this plan is revised significantly, the firm authorizes a new block of reserved shares, NRS_t. These newly authorized shares will then be used to grant option and restricted stock compensation over the next gp years, where the granting period gp denotes the time between the shares being authorized, and being allocated to compensation grants. It should also be noted that, similar to the way firms manage their cash to have enough to satisfy liquidity needs, but not too much due to opportunity costs, firms also manage their stock of reserved shares. They are required to reserve enough shares to satisfy compensation grants that are likely to be exercised or vested. On the other hand, they do not want to reserve too many shares because investors know that any new shares from employee compensation will result in the dilution of existing shares. Thus, firms strive to authorize new shares in a way that balances these tradeoffs.

Assume that the average granting period of the initial stock of reserved shares at time t, RS_t, is gp_0, meaning that on average any previously authorized share is expected to remain on the balance sheet in the stock of RS_t before being granted for gp_0 years. We allow for the granting period to be different for any given block of newly authorized shares, NRS_t, and we denote the average granting period for NRS_t by gp_t. What will be important for determining the fraction of the stock of reserved shares which represents the current flow of employee compensation grants is a weighted average of the granting period for all reserved shares on the balance sheet. For parsimony, we assume that all newly authorized shares are evenly granted over the next gp_t periods.

$$NRS_t = \sum_{k=t}^{t+gp_t} \text{Annual Grants(AG)}_k = gp_t \cdot AG_t \tag{28}$$

For further simplification, we assume that

1) On average ,employees exercise stock options, or their stock vests, after $e \cdot gp_0$ periods:[23]

$$EXC_t = \frac{1}{e \cdot gp_0} \cdot RS_t \text{ where } e > 1 \tag{29}$$

2) On average, outstanding restricted stocks or stock options display a constant attrition rate c due to forfeiture or expiration, or

$$EXP_t = c \cdot RS_t \tag{30}$$

Using equations (28), (29), and (30), we can rewrite the law of motion (27):

$$\begin{aligned} RS_{t+1} &= (RS_t - EXC_t - EXP_t) + NRS_t \\ &= (\frac{gp_0 - \frac{1}{e}}{gp_0} - c)RS_t + gp_1 \cdot AG_t \end{aligned}$$

To correctly capture the annual share-based compensation granted to employees at time t, which we denote NG_t for "new grants", we need to include the following two components:

1. AG: annual grants from newly reserved shares, NRS_t
2. PG: annual grants from the stock of previously reserved shares, $\frac{RS_t}{gp_0}$

Note, we can rewrite the law of motion for RS_{t+1}:

$$RS_{t+1} = \underbrace{(gp_0 - \frac{1}{e} - c \cdot gp_0)}_{\substack{\text{average remaining granting period} \\ \text{after exercising and expiration}}} \frac{RS_t}{gp_0} + gp_1 \cdot AG_t$$

Dividing both sides by $\frac{RS_{t+1}}{\frac{(gp_0 - \frac{1}{e} - c \cdot gp_0)\frac{RS_t}{gp_0} + vp_1 \cdot AG_t}{AG_t + \frac{RS_t}{gp_0}}}$, and multiplying by $AG_t + \frac{RS_t}{gp_0}$, we obtain

$$\begin{aligned} NG_t = AG_t + \frac{RS_t}{gp_0} &= \frac{RS_{t+1}}{\frac{(gp_0 - \frac{1}{e} - c \cdot gp_0)\frac{RS_t}{gp_0} + gp_t \cdot AG_t}{AG_t + \frac{RS_t}{gp_0}}} \\ &= \frac{RS_{t+1}}{\underbrace{(gp_0 - \frac{1}{e} - c \cdot gp_0)\omega_0 + gp_t\omega_1}_{\text{weighted average granting period}}}, \end{aligned} \tag{31}$$

[23] We assume that one outstanding stock option has the right to purchase one common share of the firm, consistent with common practice.

where $\omega_0 = \frac{\frac{RS_t}{gp_0}}{AG_t + \frac{RS_t}{gp_0}}$ and $\omega_1 = \frac{AG_t}{AG_t + \frac{RS_t}{gp_0}}$.

Hence, the flow of share-based compensation at period t is $\frac{RS_{t+1}}{\overline{gp}}$, where $\overline{gp}$ denotes the average time that any existing or newly authorized reserved share remains on the balance sheet before being allocated to a compensation grant.

To match the theory to the data, we note that this derivation uses t to denote beginning of period values, as is standard in macroeconomic notation. However, since accounting data is recorded at the end of the period, we use the end of period data to measure the deferred compensation flow for the annual period ending at the date of the accounting entry. That is, we use a fraction of the stock of reserved shares recorded at the end of year t to measure the flow of new grants during year t. Our calibration using Risk Metrics data, in which we have both NG_t and RS_t for the period 1996-2005, implies that $\bar{gp}$ equals 5.

Table 1: Descriptive Statistics

This table reports descriptive statistics (means, medians, and standard deviations) for our 4-SIC industry-level sample between 1958 and 2010, which corresponds 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. We report statistics for two measures of the human capital share, both defined relative to value added. The first measure, the Skilled Labor Share, uses the sum of non-production workers payroll and the value of reserved shares. The second measure, the SG&A share, uses selling, general, and administrative expenses. We also report statistics for the structure of skilled labor pay structure, measured by the share of equity-based pay to total pay. The time period is 1958-2010. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

	Mean	Median	St.Dev
	(1)	(2)	(3)
Levels (pct.pt.):			
NG/VADD	1.7	0.4	4.3
Skilled Labor Share	18.1	16.4	8.3
Equity Pay/Total Skilled Workers Pay	13.5	2.6	14.2
SG&A/VADD	10.9	5.1	17.5
Physical Capital Share	6.3	5.3	4.0
Labor Share	41.8	43.2	12.7
Unskilled Labor Share	27.2	27.2	10.6
Investment Good Prices	96.6	98.3	15.3
Annual Changes (pct.pt.):			
NG/VADD	0.1	0.0	2.5
Skilled Labor Share	0.1	-0.0	5.5
Equity Pay/Total Skilled Workers Pay	0.6	0.0	8.3
SG&A/VADD	0.4	0.1	4.7
Physical Capital Share	0.0	0.0	2.5
Labor Share	-0.4	-0.3	4.0
Unskilled Labor Share	-0.3	-0.3	2.7
Investment Good Prices	-0.5	-0.4	1.8
Additional Measures (1996-2005, pct. pt.)			
(Employee Stock Options, Black-Scholes Value)/VADD	8.0	0.8	25.5
(Employee Wealth, Black-Scholes Value)/Stock Mkt Value	9.3	4.1	21.3
(Non-Executive Employee Options, Black-Scholes Value)/ (Employee Stock Options, Black-Scholes Value)	78.1	82.7	18.4
(Value of Exercised Options)/Stock Mkt Value	1.0	0.4	4.8
N. of Industries=459			
N. of obs=6,174			

Table 2: The Relation Among Factor Shares: Industry-Level Analysis

This table reports industry-level regressions of the human capital share in a given year on the physical capital share at the 4-SIC level of industry aggregation, respectively. New equity grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The first measure is defined as the sum of skilled wages and new equity grants relative to value added. The second is the SG&A share. The unskilled labor share refers to production workers wages relative to value added. 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 third column, a one standard-deviation change in the physical capital share is associated with about one third of a standard deviation change in the human capital 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. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

Industry & Time Fixed Effects Estimates for the Human Capital Share						
	Equity Comp Share= NG/VADD		(NBER CES Skilled Wages+NG)/VADD		SG&A/VADD	
	(1)	(2)	(3)	(4)	(5)	(6)
	logs	logs	logs	logs	logs	logs
	4-SIC	4-SIC	4-SIC	4-SIC	4-SIC	4-SIC
Physical Capital Share	0.191***	0.245***	0.382***	0.366***	0.307***	0.361***
	(0.027)	(0.028)	(0.016)	(0.064)	(0.018)	(0.018)
Unskilled Labor Share		-0.204***		0.063		-0.247***
		(0.027)		(0.070)		(0.019)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	4,565	4,565	4,565	4,565	6,174	6,174
R^2(%)	64.61	65.07	82.68	82.73	70.23	71.05

Table 3: The Human Capital Share of Income and Investment Goods Prices: Industry-Level Analysis

This table reports (4-SIC) industry-level regressions of the human capital share (Columns 1 to 3) in a given year on investment goods prices. New equity grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The first measure is defined as the sum of skilled wages and new equity grants relative to value added (Column 2). The second is the SG&A share (Column 3). The unskilled labor share refers to production workers' wages relative to value added and the skilled share refers to non-production workers. We also report results for the structure of skilled workers pay, measured by the share of equity-based pay to total pay (Column 7). 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, a one standard-deviation change in investment goods prices is associated with about 9% of a standard deviation change in the human capital 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. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

	Industry & Time Fixed Effects Estimates for the Human Capital Share and the Labor Share						
	NG/ VADD	(Total Skilled Workers Pay)/ VADD	SG&A/ VADD	Total Wages/ VADD	Production Workers Wages/ VADD	Skilled Workers Wages/ VADD	Equity Pay /Total Skilled Workers Pay
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	logs	logs	logs	logs	logs	logs	
	4-SIC	4-SIC	4-SIC	4-SIC	4-SIC	4-SIC	4-SIC
Inv. Goods Prices	-0.126***	-0.090***	-0.134***	0.013***	0.140***	-0.062***	-0.093***
	(0.012)	(0.008)	(0.009)	(0.005)	(0.004)	(0.006)	(0.011)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	4,565	4,565	6,174	23,759	23,759	4,565	4,565
R^2(%)	65.10	79.50	69.96	84.20	88.04	86.11	53.98

Table 4: The Human Capital Share, Stock Market Value, and Investment Goods Prices: Firm-Level Analysis

This table reports firm-level regressions of the human capital share in a given year on investment goods prices. New equity grants (NG) are estimated based on the value of reserved shares, skilled wages at the firm level are estimates using the total number of employees at the firm level and skilled payroll per employee and skilled workers intensity at the industry level from NBER CES (Columns 1 to 3). In addition, we report results for the ownership share (Columns 4 to 5) and for the SG&A based measure of the human capital share (Columns 7 to 9).The NG and SG&A share variables are defined relative to sales, while the value of reserved shares is scaled relative to stock market value. In Panel A, we report results for a specification with industry fixed effects, while in Panel B we report results for a specification with firm fixed effects. 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 of Panel A, a one standard-deviation change in investment goods prices is associated with about 12% of a standard deviation change in the NG share variable. The time period is 1958-2010. All specifications include time (year) effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

Panel A: Industry & Time Fixed Effects Estimates for the Human Capital Share									
	(Skilled Wages+NG)/ Sales			Value of Reserved Shares/ Stock Mkt Value			SG&A/ Sales		
	(1) No Controls	(2) +Firm Controls	(3) +Industry Controls	(4) No Controls	(5) +Firm Controls	(6) +Industry Controls	(7) No Controls	(8) +Firm Controls	(9) +Industry Controls
Inv. Goods Prices	-0.139***	-0.132***	-0.117***	-0.071***	-0.070***	-0.070***	-0.053***	-0.038***	-0.038***
	(0.008)	(0.007)	(0.008)	(0.009)	(0.010)	(0.010)	(0.005)	(0.004)	(0.004)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effects	No	No	No	No	No	No	No	No	No
N. of Firms	5,909	5,909	5,640	5,909	5,909	5,640	7,356	7,336	7,073
N. of obs.	41,125	39,443	39,443	63,376	56,561	56,561	87,513	82,617	82,617
R^2(%)	44.86	46.85	47.08	17.27	18.76	18.77	46.59	56.60	56.61

Panel B: Firm & Time Fixed Effects Estimates for the Human Capital Share									
Human Capital Share=	NG/ Sales			Value of Reserved Shares/ Stock Mkt Value			SG&A/ Sales		
	(1) No Controls	(2) +Firm Controls	(3) +Industry Controls	(4) No Controls	(5) +Firm Controls	(6) +Industry Controls	(7) No Controls	(8) +Firm Controls	(9) +Industry Controls
Inv. Goods Prices	-0.145***	-0.139***	-0.124***	-0.091***	-0.086***	-0.086***	-0.035***	-0.047***	-0.048***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)	(0.004)	(0.004)	(0.004)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	No	No	No	No	No	No	No	No
Firm Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of Firms	5,909	5,909	5,640	5,909	5,909	5,640	7,356	7,336	7,073
N. of obs.	40,294	38,943	38,943	63,376	56,561	56,561	87,513	82,617	82,617
R^2(%)	64.99	65.22	65.43	58.88	59.11	59.84	86.41	87.97	88.04

Table 5: The Relative Growth of The Physical Capital and The Human Capital Share and Investment Goods Prices

This table reports results of additional industry-level and firm-level regressions of the human capital share in a given year on investment goods prices. New equity grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The first measure is defined as the sum of skilled wages and new equity grants relative to value added. The second is the SG&A share. For each measure, we report results relative to the physical capital share. 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 1, a one standard-deviation change in investment goods prices is associated with about 10% of a standard deviation change in the NG share relative to the physical capital share. The time period is 1958-2010. 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. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

	Additional Industry- & Firm-Level Analysis of the Human Capital Share				
	ln(NG/VADD)-ln(rK/VADD)	ln(NBER CES Skilled Wages+ NG/VADD)-ln(rK/VADD)	ln(SG&A/VADD)-ln(rK/VADD)		
	(1)	(2)	(3)	(4)	(5)
	logs	logs	logs	logs	logs
	4-SIC	4-SIC	4-SIC	firm-level	firm-level
Inv. Goods Prices	-0.104***	-0.220***	-0.108***	-0.064***	-0.085***
	(0.012)	(0.018)	(0.009)	(0.005)	(0.004)
Time Effects	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	No
Firm Effects	No	No	No	No	Yes
N. of obs.	4,565	4,565	6,174	87,513	87,513
R^2(%)	65.75	71.01	71.01	31.53	85.93

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 goods prices at the 4-SIC industry level. New equity grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The first measure is defined as the sum of skilled wages and new equity grants relative to value added. The second is the SG&A share. 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 1, a one standard-deviation change in investment goods prices is associated with about 16% of a standard deviation change in the NG 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. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

	Complementarity and Skills Splits											
	NG/VADD				(NBER CES Skilled Wages+NG)/VADD				SG&A/VADD			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	By Capital Intensity		By Skill Share		By Capital Intensity		By Skill Share		By Capital Intensity		By Skill Share	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Inv. Goods Prices	-0.161***	-0.081*	-0.133***	-0.005	-0.045***	-0.027	-0.041***	-0.038	-0.123**	-0.106	-0.165***	0.130
	(0.025)	(0.045)	(0.016)	(0.101)	(0.015)	(0.027)	(0.010)	(0.058)	(0.049)	(0.102)	(0.059)	(0.126)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of obs.	1,120	1,197	1,196	1,186	1,120	1,197	1,196	1,186	1,665	1,250	1,516	1,542
R^2(%)	67.68	67.94	72.03	60.44	83.99	79.77	53.81	53.96	80.96	71.91	80.04	82.73

Table 7: Human Capital Earnings, Factor Share and Investment Goods Prices: Firm-Level Analysis

This table reports industry- and firm-level regressions of an alternative measure of the new grants share based the Black-Scholes value of new grants of stock options for all employees (Panel A), and excluding the top executives (Panel B) in a given year on investment goods prices, in turn. The Black-Scholes value of new grants is relative to value added at the industry level and sale at the firm level, respectively. 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 goods prices is associated with about 17% of a standard deviation change in the new grants share. The time period is 1996-2005. All specifications include time (year) and either industry or firm effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

Panel A: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Compensation								
	(Employee Stock Options, Black-Scholes Value)/ VADD				ln(Employee Stock Options B-S Value/Employees)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Industry-level		Firm-level		Industry-level		Firm-level	
Investment Goods Prices	-0.210***	-0.168**	-0.848***	-0.665***	-0.414***	-0.167*	-0.382***	-0.372***
	(0.020)	(0.075)	(0.221)	(0.223)	(0.032)	(0.094)	(0.127)	(0.135)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	Yes	No	No	No	Yes	No	No
Firm Effects	No	No	Yes	Yes	No	No	Yes	Yes
Firm Controls	No	No	No	Yes	No	No	No	Yes
N. of obs.	1,282	1,282	3,357	3,314	1,111	1,111	3,104	3,300
R^2(%)	8.99	51.51	80.62	81.44	14.21	70.64	72.80	73.42
Panel B: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Compensation Excluding Top Executives								
	(Non-Exec Employee Stock Options, B-S Value)/ VADD				Non-Exec Employee Stock Options Relative to CEOs			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Industry-level		Firm-level		Industry-level		Firm-level	
Investment Goods Prices	-0.205***	-0.171**	-0.841***	-0.677***	-0.040	-0.171	-0.629*	-0.478
	(0.020)	(0.074)	(0.240)	(0.244)	(0.035)	(0.174)	(0.333)	(0.332)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	Yes	No	No	No	Yes	No	No
Firm Effects	No	No	Yes	Yes	No	No	Yes	Yes
Firm Controls	No	No	No	Yes	No	No	No	Yes
N. of obs.	1,282	1,282	3,017	2,982	1,111	1,111	2,496	2,546
R^2(%)	8.97	51.20	80.73	81.10	1.17	14.47	19.72	22.71

Table 8: Human Capital Wealth, Factor Share and Investment Goods Prices: Firm-Level Analysis

This table reports industry- and firm-level regressions of an alternative measure of the human capital ownership share based on Black-Scholes value of 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 goods 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 first column of Panel A, a one standard-deviation change in investment goods prices is associated with about 10% of a standard deviation change in the human capital ownership share. The time period is 1996-2005. All specifications include time (year) and either industry or firm effects. Standard errors are robust, with ***, **, and * denoting significance at the 1%, 5%, and 10% level, respectively. See Section 2.2 and Appendix 6.3 for detailed variable definitions.

Panel A: Firm & Time Fixed Effects Estimates for Total Employee Stock Options Wealth								
	(Employee Wealth, Black-Scholes Value)/ Stock Mkt Value				ln(Employee Wealth B-S Value/Employees)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Industry-level		Firm-level		Industry-level		Firm-level	
Investment Goods Prices	-0.163***	-0.366***	-0.362**	-0.370**	-0.406***	-0.137	-0.580***	-0.353**
	(0.026)	(0.128)	(0.166)	(0.176)	(0.036)	(0.128)	(0.156)	(0.154)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	Yes	No	No	No	Yes	No	No
Firm Effects	No	No	Yes	Yes	No	No	Yes	Yes
Firm Controls	No	No	No	Yes	No	No	No	Yes
N. of obs.	1,111	1,111	2,506	2,714	1,111	1,111	2,498	2,659
R^2(%)	25.09	35.17	75.83	77.33	14.57	67.13	87.57	84.02
Panel B: Firm & Time Fixed Effects Estimates for Total Employee Stock Option Wealth Excluding CEO								
	(Non-Exec Employee Wealth, B-S Value)/ Stock Mkt Value				Non-Exec Employee Wealth Relative to CEOs			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Industry-level		Firm-level		firm FE, w/o controls		firm FE, with controls	
Investment Goods Prices	-0.394***	-0.290**	-0.568***	-0.510**	-0.022**	-0.017	-0.339	-0.373
	(0.034)	(0.096)	(0.209)	(0.223)	(0.011)	(0.055)	(0.246)	(0.259)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	Yes	No	No	No	Yes	No	No
Firm Effects	No	No	Yes	Yes	No	No	Yes	Yes
Firm Controls	No	No	No	Yes	No	No	No	Yes
N. of obs.	1,111	1,111	2,071	2,218	1,111	1,111	1,991	2,138
R^2(%)	13.77	59.50	78.22	78.62	1.00	75.56	68.06	68.43

Table 9: Benchmark Estimation

The table reports estimated parameters in the benchmark setting using MLE. We calibrated the following parameters: $\delta_k = 0.09$, $\mu = 1.3$, and R_f is the average real interest rate over the sample period, 1.51%. $\omega_{R,t}$ is the human capitalists' wage income to the total human capitalists' income (wage income + equity-based compensation) ratio over the sample period. Panel A reports the estimation results using the grant-based measure for the human capitalists' income share (wage income $+NG$). Panel B reports the estimation results using the expense-based measure for the human capitalists' income share (SG&A). Sample period is from 1980 to 2005. Standard errors are in parentheses.

Panel A: Benchmark Estimation (Grant-Based)				
α_k	α_c	ρ	σ	δ_h
0.283	0.568	-1.267	0.444	0.275
(0.043)	(0.139)	(0.005)	(0.026)	(0.049)

Panel B: Benchmark Estimation (Expense-Based))				
α_k	α_c	ρ	σ	δ_h
0.451	0.564	-1.385	0.374	0.232
(0.423)	(0.194)	(0.003)	(0.048)	(0.311)

Table 10: Estimation: Counterfactual

The table reports the estimated parameters using MLE in the counterfactual where the human capitalists' income does not include the equity-based compensation. The human capitalists' wage income share is defined as the difference between the total labor share of income and the production labor share of income from the NBER-CES Manufacturing database. We calibrated the following parameters: $\delta_k = 0.09$, $\mu = 1.3$, and R_f is the average real interest rate over the sample period, 1.51%. δ_h is set to 0.272 from the benchmark estimation. Sample period is from 1980 to 2005. Standard errors are in parentheses.

Counterfactual (Wage Income Share)			
α_k	α_c	ρ	σ
0.265	0.815	0.259	0.369
(0.000)	(0.007)	(0.001)	(0.032)

Figures

Figure 1: Equity-Based Compensation as a Fraction of Value Added

The plot reports the time series of our grant-based measure of human capitalists' equity-based income share. The annual flow of total reserved shares for employees' equity-based compensation, NG, is calculated as the aggregate value of outstanding reserved shares normalized by the average granting period of 5 years. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005).

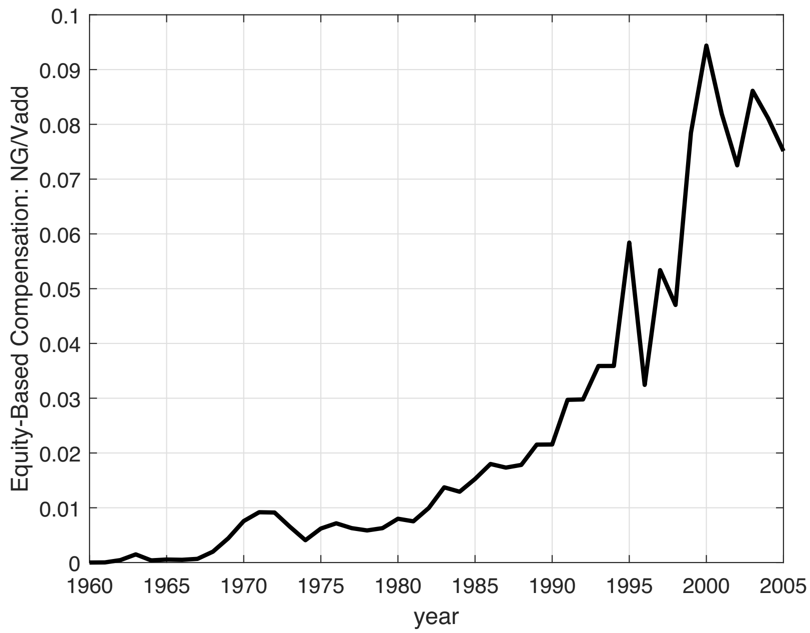


Figure 2: Human Capital Share of Income: Grant-Based Measure

The plot reports human capitalists' total income share and its composition. The blue dashed line is the human capitalists' flow wage income, calculated as the total labor income share minus the production labor income share (NBER-CES Manufacturing Industry Database), less an estimate of the total value of exercised employee stock options. The black dashed line is the equity-based compensation (NG) to value added ratio. The total human capitalists' income share is sum of the wage income share and the equity-based income share. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005), NBER-CES Manufacturing Industry Database (1960-2005).

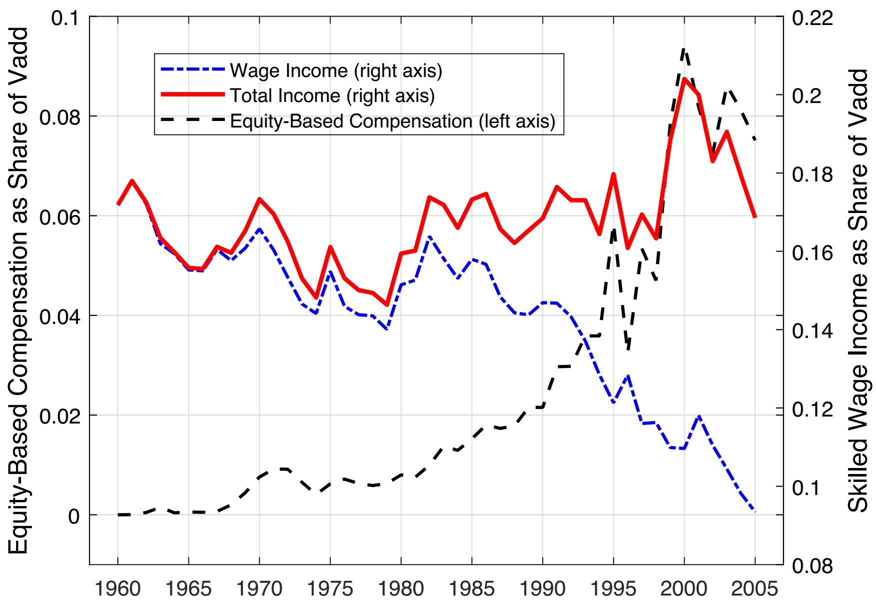


Figure 3: Measures of Equity-Based Compensation as a Fraction of Value Added

The plot reports the time series of our three grant-based measures and one expense-based measure of the aggregate equity-based compensation compensation to value added ratio. In the top left panel, the solid blue line reports the the annual flow of equity-based compensation measured as NG = RS/5, the aggregate value of reserved share by average 5 years. The equity-based compensation used for the dotted red line is the aggregate value of reserved share by the actual average remaining life of RS on the balanced sheets in the IRRC sample. In the top right panel, the annual flow is measured as the Black-Scholes value of the newly-granted stock options. 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. In the bottom right panel, the annual flow is calculated as the actual change of RS= $RS_{t+1} - RS_t$ in our sample. The blue dashed line is the Black-Scholes value of the newly granted employee stock options to value added ratio. In the bottom left panel, the annual flow of equity-based compensation is the expense-based measure $0.3SG\&A$. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005).

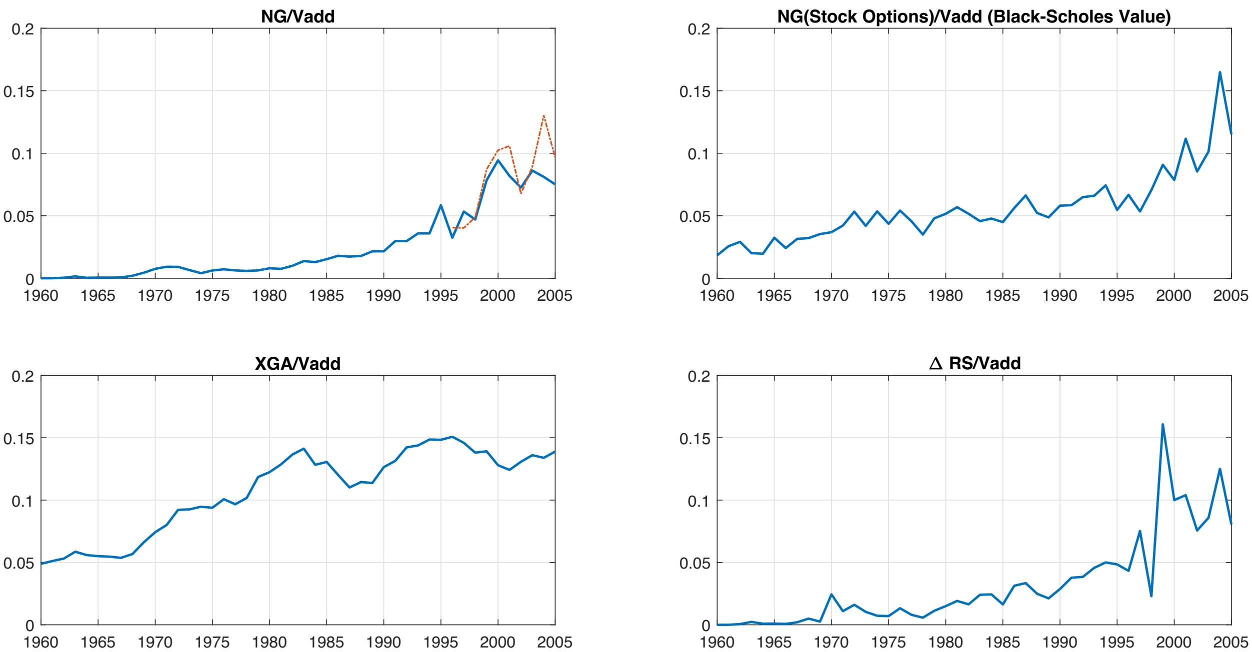


Figure 4: Human Capital Share of Income and Investment Goods Prices: Expense-Based Measure

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%S&GA 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 1960 to 2005.

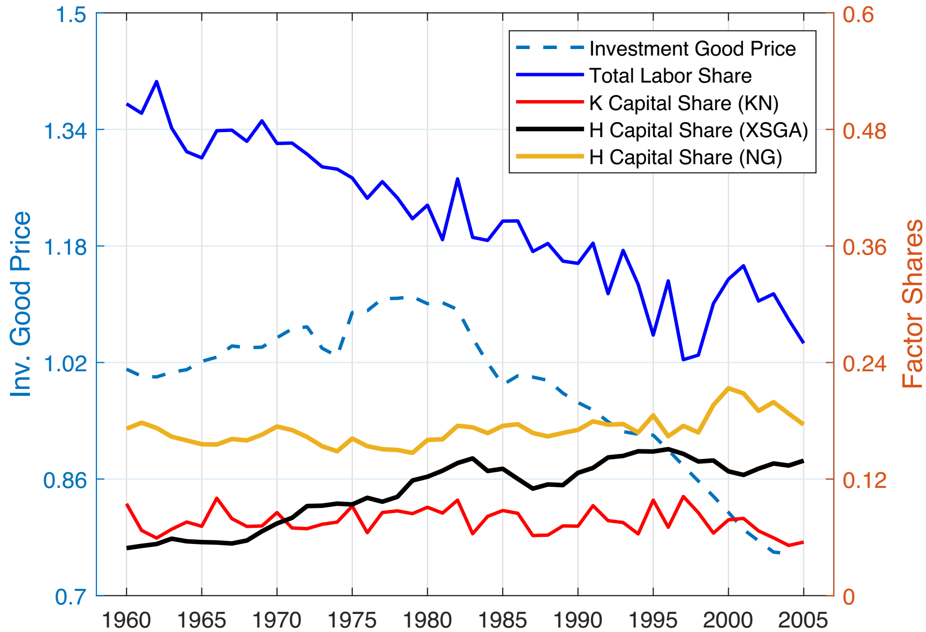


Figure 5: Ownership Share: Employee-Owned Fraction of Public Firms

The plot reports the time series of the ownership share: the ratio of the value of reserved shares for employee equity-based compensation to the stock market capitalization. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005).

Figure 6: Aggregate Labor Share

The plot reports the aggregate share before and after adjusting for the equity-based compensation. The blue dotted line is the aggregate wage income minus the estimate of the total value of exercised employee stock options. The black dashed line is the equity-based compensation (NG) to value added ratio. The total labor income share is sum of the wage income share and the equity-based income share. Source: Compustat Fundamental Annual (1960-1996), RiskMetrics (IRRC) (1996-2005), NBER-CES Manufacturing Industry Database (1960-2005).

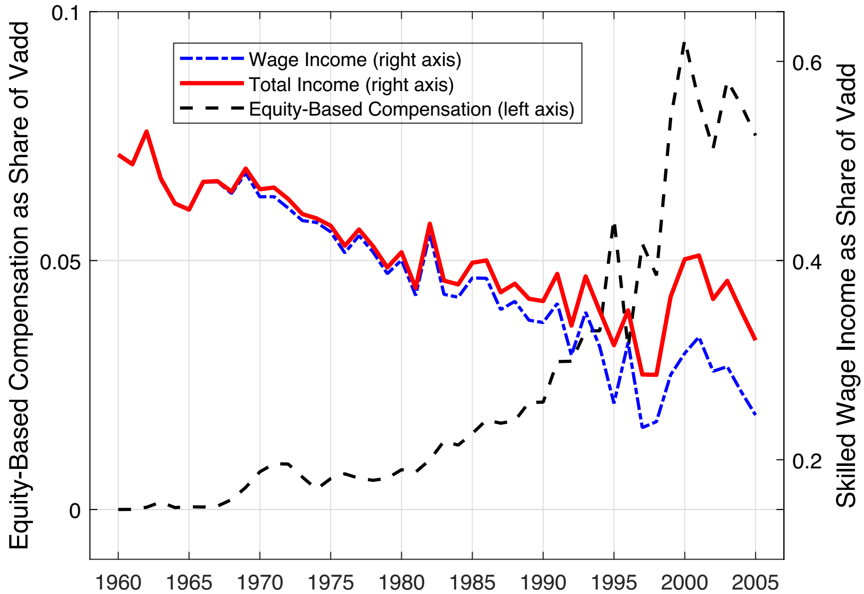
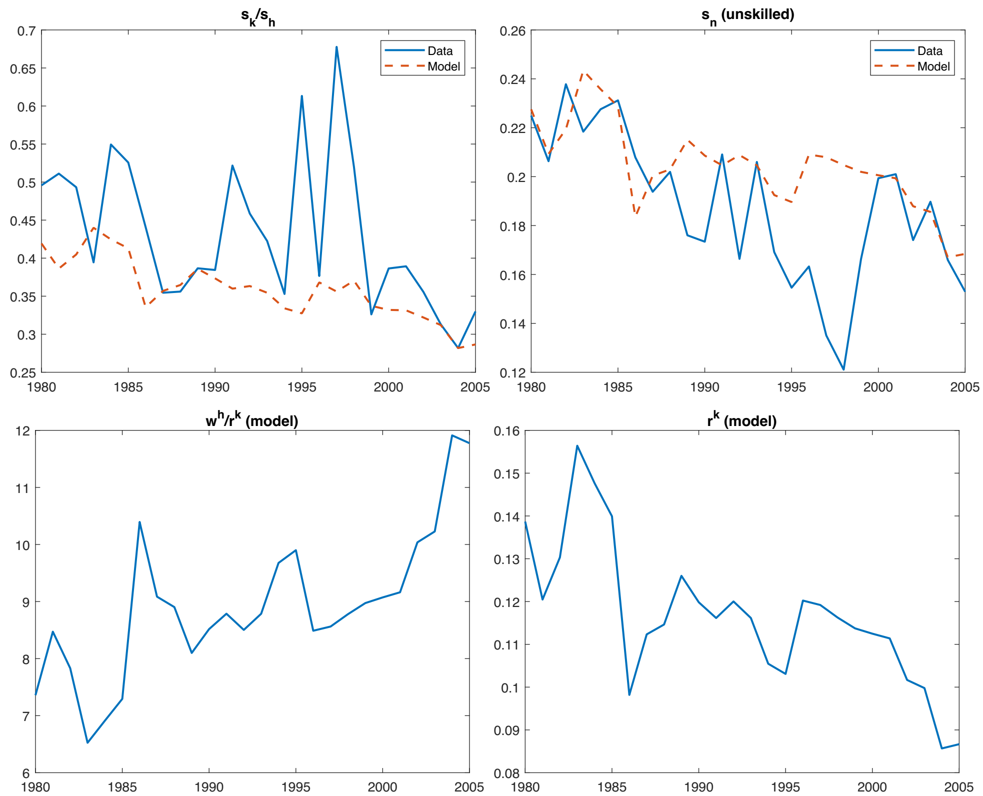


Figure 7: Model Fit: The Benchmark Model and The Counterfactual

The figures present the model-predicted time series of factor shares. Panel A reports the model-predicted relative capital share s_k/s_h and labor share s_n. The solid line is the actual data series and the dashed line is the prediction based on the benchmark estimation. Panel B reports the relative capital share s_k/s_h and labor share s_n predicted in the counterfactual. The solid line is the actual data series and the dashed line is the prediction based on the benchmark estimation. The sample period is from 1980 to 2005.

Panel A: The Benchmark Model



Panel B: The Counterfactual