Human Capitalists*

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

Abstract

The widespread and growing use of equity-based compensation has transformed high-skilled labor from a pure labor input to a class of "human capitalists." We show that high-skilled labor earns substantial income in the form of equity claims to firms' future dividends and capital gains. Equity-based compensation has dramatically increased since the 1980s, representing almost 45% of total compensation to high-skilled labor in recent years. Ignoring equity income causes incorrect measurement of the returns to high-skilled labor, with substantial effects on macroeconomic trends. In our sample, including equity-based compensation in high-skilled labor income reduces the total decline in labor's share of income relative to total value added since the 1980s by over 60%. The inclusion of equity-based compensation also reverses the otherwise declining share of high-skilled labor. Our structural estimation using total income supports complementarity between high-skilled labor and physical capital. We also provide additional regression evidence of such complementarity.

Keywords: Human Capital, Labor Share, Equity Compensation, Factor Shares, Inequality

*We thank the seminar and conference participants at the NBER Summer Institute Micro Data and Macro Models Workshop, the Society of Economic Dynamics Annual Meeting, the MIT Junior Finance Conference, ASU Sonoran Winter Finance Conference, the Macro Finance Society Biannual Meeting, Texas Finance Festival, WUSTL the Macroeconomics of Inequality Mini-Conference, Boston University, Columbia University, the University of Minnesota, the University of Illinois Urbana-Champaign, the London School of Economics, the University of Texas at Austin, MIT, Stanford, UC Davis, Northwestern University, the University of Chicago, Carnegie Mellon University and Georgetown University for their helpful comments. Xiaolan gratefully acknowledges the financial support from the faculty excellence research grant from the McCombs School of Business at the University of Texas at Austin.

†UCLA Anderson School of Management and NBER, Email: andrea.eisfeldt@anderson.ucla.edu

‡Federal Reserve Board, Email: antonio.falato@frb.gov

§Department of Finance, University of Texas at Austin, Email: mindy.xiaolan@mccombs.utexas.edu

1 Introduction

Human capitalists are corporate employees who receive significant equity-based compensation. Two examples of this type of compensation are equity grants and stock options. These employees are partial owners of US firms, and 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 that 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. We use a structural model that features complementarity between high-skilled human capital and physical capital, and we set forth a unified, technology-based explanation of the quantitative rise of human capitalists as a 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. We include equity-based compensation in our sample, and this inclusion reduces the decline in labor income's share of value added since the 1980s by over 60%. For high-skilled labor, the inclusion of equity-based compensation completely reverses the decline and reveals an increase of 1%. Thus, correctly measuring the return to high-skilled labor can resolve the otherwise puzzling lack of evidence of complementarity between high-skilled labor and new-economy physical capital. Indeed, the high-skill share of total labor income increases from one third to one half in recent years when equity-based compensation is included. Importantly, we show that equity-based compensation is widely used beyond the much-studied C-suite. In fact, recent data show that 78% of equity-based compensation went to employees outside the C-suite.

Our study contributes important new facts to the study of changing factor shares, and the implications for the study of 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 the growth of corporate profits. These facts seem to indicate a secular shift of income away from the providers of labor to the owners of physical capital. However,

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 human capitalists are an important class of firm owners. And, firms appear to have substituted away from wages towards equity-based compensation, especially in the last three decades.

We use our sample of firms and our more comprehensive measure of the human capital share to confirm that the total labor share has declined since the 1960s, while the physical capital share of value added has been flat. Since physical capital's share of value added has not kept pace with the profits of the corporate sector (see Barkai (2017) and Rognlie (2015)), Karabarbounis and Neiman (2018) coined the term "factorless income" and documented measurement methods to reduce the share of income that is unaccounted for by observable factors. We provide an additional way to reduce factorless income by allocating profits to human capitalists. In our sample, human capitalists' ownership share of public companies is 7%. Thus, their flow equity compensation reduces factorless income by this amount. 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 in our sample, and this excludes capital gains from prior grants. It is important to note that, over our sample period, 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. Our main measurement challenge is to gather information on equity-based compensation. The largest component of this compensation is deferred, hence it does not appear in standard compensation measures based on W-2 tax data. Indeed, even on the employee side, equity-based pay is reported on different forms depending on its tax treatment.[1] To surpass these measurement challenges, we use firm data on the value of shares reserved for compensation. By law, firms must reserve shares against compensation grants in order to disclose the resulting dilution to shareholders. Data on shares reserved for employees' unexercised stock options or restricted equity grants are available annually for the universe of publicly traded US corporations via their SEC filings from 1958–2005. Using data on the stock of reserved shares, along with its law of motion, we construct a measure of the annual flow of new equity-based compensation grants

[1]See the Appendix for a detailed discussion. BEA and BLS data include only the (small) fraction of equity-based compensation that is non-qualified under the tax law governing incentive pay and is both exercised and unrestricted. In our calculations, we net the included fraction out of wages.

each year. We then aggregate to the industry level and add high-skilled wages from a merged NBER-CES-Compustat sample to obtain a measure of total compensation to high-skilled labor. Since exercised grants (about 10% of the total) can be subject to taxation and can be included in wage data based on W-2 filings, we net the value of exercised grants out of these wage data. Our merged NBER-CES-Compustat data set covers a very broad set of manufacturing firms and contains a reliable measure of value added.[2]

We perform several robustness checks on the resulting time series of equity-based compensation, including using more detailed data on compensation grants from RiskMetrics for the period 1996–2005 as well as using an expensed-based measure of total payments to human capitalists that we construct using a fraction of firms' Selling and General Administrative expense (SG&A). A large portion of SG&A expenses consists of wages, salaries, and any capital gains from stock grants or exercised stock options. By all measures, human capitalists' share of income is substantial, and it has risen dramatically over the last few decades.

A rising share of human capitalist income, along with the observed declining investment goods prices, is consistent with technological complementarity between human and physical capital. We explore this potential complementarity in two ways. First, we provide robust regression-based evidence for complementarity between high-skilled labor and physical capital. Second, we conduct a structural estimation that highlights the importance of equity-based compensation when evaluating evidence of complementarity between human capital and physical capital.

Our panel regressions first document a negative relationship within firms and within industries over time between investment goods prices and high-skilled human capital owners' earnings and wealth. Human capitalists' income has increased more in industries and firms that have experienced larger declines in investment goods prices. Thus, the evidence suggests that human capitalists have benefited disproportionately from declining investment goods prices. Next, we use the correctly measured total return to human capitalists to show that within industries and over time, there is a positive relation between the human capital share and the physical capital share (which is consistent with complementarity). By contrast, and consistent with the cross-country evidence in Karabarbounis and Neiman (2014), we find a negative relation between the wage-based low-skilled

[2]We show in the Online Appendix that the factor shares (excluding equity-based compensation) in our merged sample are nearly identical to those in the broader NBER-CES data set.

labor share and capital shares (which is consistent with substitutability).

We develop and study a parsimonious model and then estimate its key parameters (a) to provide structure for the facts that describe the rise of human capitalists and (b) to understand its implications for shares of value added and income. Our model builds on the model described in Krusell, Ohanian, Rìos-Rull, and Violante (2000), who were the first to model and document the complementarity between high-skilled labor and physical capital. However, their sample ends in 1992, before the decline in the wage income of human capitalists accelerated in the 1990s. The subsequent steep decline in the high-skilled wage shares implies a puzzling lack of evidence for complementarity between high-skilled labor and the coincident introduction of 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. First, we treat high-skilled human capital as as a stock that can be accumulated through investment rather than as a flow labor input. Second, in our framework, this stock of human capital earns an equilibrium return that can depend not only on its current marginal product but also on its outside option (e.g., Eisfeldt and Papanikolaou (2013), Hartman-Glaser et al. (2019)).

Our model employs a CES production function with three inputs, physical capital, human capital, and (unskilled) labor. Technological progress occurs via a standard shock to (physical) investment goods prices (see Greenwood et al. (1997), Papanikolaou (2011), and Kogan and Papanikolaou (2014)). We use our model to obtain quantitative estimates of the degree of complementarity between physical and human capital. We find that correcting human capitalists' income by including equity-based compensation is crucial for identifying complementarity between physical and human capital. Importantly, we show that only a small fraction of equity-based pay must be assigned to human capitalists' marginal product in order to generate a degree of complementarity between physical and human capital that is larger than the complementarity implied by Cobb–Douglas. Our estimate of the elasticity of substitution between capital and unskilled labor is 1.33, and is not sensitive to the fraction of equity-based pay assigned to marginal product. This finding on the substitutability between capital and unskilled labor is broadly consistent with the estimates in the existing literature (e.g., Karabarbounis and Neiman (2014), Krusell et al. (2000)).

In order to determine the fraction of equity-based pay that is in fact attributable to human capitalists' marginal product, we incorporate an estimate of the elasticity of substitution between

physical and human capital from the cross section of industries over the same time period. The cross section evidence indicates strong complementarity (an elasticity of substitution equal to 0.21). This estimate, combined with our time series estimation, implies that 95% of equity-based compensation is attributable to human capitalists' marginal product. This makes sense, as it seems likely that firms substituted wages for equity pay, rather than considerably increasing pay overall. Overall, in response to a reduction in investment goods prices, our model with correctly measured income shares is able to replicate the full set of stylized facts we document.

Our paper contributes to the following related areas of the literature. First, there is an ongoing discussion on the secular evolution of factor shares in the macroeconomic literature (e.g., Elsby et al. (2013), Karabarbounis and Neiman (2014), Lawrence (2015), Koh et al. (2016), Autor, Dorn, Katz, Patterson, and Reenen (2017), Hartman-Glaser et al. (2019)). This literature has established the decline of the aggregate labor share measured using standard sources of realized income (mainly wages). While we confirm their main finding, we contribute important new facts that help make progress on the evolution of total income share dynamics for workers of different skill levels. We note that under standard measurement procedures, measures of value added are based on current output flows, but the income used to proxy for factor shares can include compensation for contributions to firm value based on past or future output. Hartman-Glaser et al. (2019) is among the first studies of the implications of equilibrium long-term compensation contracts on factor share dynamics. We also provide an ownership-based link between changes of factor shares in value added and in measured income. Barkai (2017) and Autor, Dorn, Katz, Patterson, and Reenen (2017) emphasize rising concentration and corporate profits. We identify one segment of the labor force that may have benefitted from this, through shared firm ownership.

Our 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)). Despite this growing literature, there is still a limited amount of direct cross-sectional evidence on the relation between investment goods prices and factor shares (Acemoglu (2002)). We broaden this literature by examining its implications for factor shares and by 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.[3]

Our analysis has related implications for the broader debate on the income distribution between capital and labor, and the concern regarding rising inequality (e.g., 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)). Given the data limitations, very little was previously known about the total compensation to the intermediate levels of the income distribution represented by high-skilled laborers. Our analysis highlights the importance of equity compensation paid to employees below the very top executive or founder level. Whereas total compensation at the C-suite level appears to have peaked around the year 2000, equity-based compensation to a broader set of high-skilled labor continues to rise.[4] Our analysis is complementary to that of Smith, Yagan, Zidar, and Zwick (2018), who show that small private 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," and in particular intangible capital embedded in, and partially owned by, human inputs or organization capital (e.g., Eisfeldt and Papanikolaou (2014), Koh et al. (2016), Barkai (2017), Karabarbounis and Neiman (2018), Benzell and Brynjolfsson (2019)). We bring new micro data to address the measurement of human inputs. Moreover, we examine the importance of the rents generated by organizational capital from a national income accounting perspective, which so far has received limited attention in this literature.[5]

2 Empirical Facts

This section presents our measures of human capitalists' income. We construct our main measure of the total income to human capitalists using data on reserved shares from Compustat, and data on high-skilled labor wages from the NBER-CES manufacturing data set. We perform several

[3]See also the recent study Jaimovich et al. (Forthcoming), who argue that incorporating the quality of goods produced is crucial for measuring the interaction between skill-biased technical change and the skill premium.

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

[5]For exceptions, see Karabarbounis and Neiman (2018) and Barkai (2017) who disucss the potential magnitude of organization capital in explaining "factorless income" or reducing the profit share using aggregate data. See also Koh et al. (2016), who examine the impact of the capitalization of intellectual property products (IPP) on the total labor share in BEA accounts. IPP is distinct from our notion of human capital.

robustness checks, and we use these measures to examine the implications for the dynamics of factor shares over time. We also document the cross-sectional link between declining investment goods prices and the rise of human capitalists' income, both as a share of value added and as a share of firm ownership. Specifically, we show a negative relation between investment goods prices and human capitalists' income shares, which holds in the time series in the cross-section of industries, as well as within firms over time. Finally, we also provide evidence on the relation between investment goods prices and human capitalist wealth. Our main findings highlight the large magnitude of human capitalists' equity based compensation, and its importance for understanding the degree of complementarity of human and physical capital.

2.1 Sample Construction

We construct our income and factor share measures from micro data for a large sample of US corporations over the period 1958–2010 from Compustat. This data set covers the universe of publicly traded US firms.[6] We exclude financial firms (SIC codes 6000–6999) and regulated utilities (SIC codes 4900–4999). Since Compustat lacks information on value added, payroll, and investment goods prices, we retrieve these at the 4-SIC industry level from the NBER-CES Manufacturing Industry Database, which is based largely on the Annual Survey of Manufacturing data sets (Becker et al. (2013)).[7] The merged Compustat-NBER-CES data set covers all firms in the manufacturing and health sectors, as well as roughly half of the firms in the consumer goods and high-tech sectors. The covered sectors represent over 40% of the aggregate value of sales in the Compustat universe, and the Online Appendix shows factor shares dynamics using wage data only are nearly identical to those in our sample. Investment goods prices are taken from St. Louis FRED. The combined data set for the 1958-2010 period is composed of 6,174 industry–year observations for 459 4-SIC industries and 86,940 firm–year observations for 7,356 firms.

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

[7] The NBER-CES data set includes 459 (140) unique industries at the 4-SIC (3-SIC) level. Most of the variables in the NBER-CES are taken from the Annual Surveys of Manufacturing, while 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.

2.2 Human Capital Share of Income

The income of human capitalists consists of two parts. The first is traditional compensation to high-skilled human capitalists in the form of wages. The second part, which is novel to our analysis, is compensation from restricted equity or stock option grants. In practice, employees receiving equity-based compensation 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, the IRS allows firms to classify most equity grants as "qualified", or incentive-based, and these typically do not appear in W2 earnings. Other grants constitute employer retirement contributions. As a result, this component of income has been, at best, only partially accounted for so far in the literature. To surpass the challenges faced by standard data sources using employer or employee tax data, we construct our baseline measure of equity-based compensation using widely available firm-level data on shares reserved for employee compensation. The Appendix Section 6.1 provides a detailed discussion of the measurement challenges and the shortfalls of standard data sources. We also construct robustness checks on our measure of equity based compensation based on reserved share data using a smaller sample of detailed data on option grants from Risk Metrics.

To construct our measure of total compensation, we combine our reserve-share based measure of equity compensation with NBER-CES data on high skilled wages. Importantly, we adjust that wage data downward by netting out the value of exercised, non-qualified, options. The exercised value of non-qualified options represents the small fraction of equity-based compensation which appears in W2 data. Below, we estimate the fraction of equity grants which have flowed through to W2 earnings to be 20%, and we net this value out of our measure of wages. To provide a robustness check on total human capitalist compensation, we use an expense-based measure of the fraction of high-skilled compensation that firms can expense as a comparison, and we find very similar time-series and cross-sectional results using this measure. This measure is based on the Selling and General Administrative Expense (SG&A), which includes wages not expensed as cost of goods sold (i.e. wages that are associated with headquarters vs. production lines), as well as equity-based compensation that is expensed.

Constructing an Annual Flow Measure of Equity-Based Compensation Our main measurement challenge is to gather comprehensive information on the equity-based component of income, which comes from equity grants in the form of restricted stock or unvested stock options. We take advantage of securities law, which requires firms to disclose shares reserved for compensation, in order to disclose the potential dilution to existing shareholders. By law, companies must reserve shares to offset their outstanding equity compensation grants. Each year, the board of directors authorizes reserved shares, and the shares reserved for compensation appear under treasury stock on the liability side of the balance sheet.

We obtain the reserved shares data (RS) as follows. RS data are available from Compustat from 1958–1996. We extend the time window past 1996 using information from RiskMetrics for the 1996–2005 period. RiskMetrics (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 the Appendix.

Compustat defines the *reserved share* (RS) variable as the item that "... 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 stock of reserved shares allocated to grants over time. Intuitively, we can accomplish this using the stock of reserved shares divided by the average time that a reserved share remains on the balance sheet before it is granted as compensation. We denote this as the *granting period*, or gp. We provide a formal derivation of this flow measure of equity-based compensation, *new grants*, or, $NG = RS/gp$, in Appendix 6.3 using a law of motion for reserved shares which accounts for authorization, exercise, and expiration. We then use the RiskMetrics data from 1996–2005 to estimate the weighted-average ratio of compensation grants to reserved shares. During this period, the weighted-average granting period, gp, is five years. 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. For 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 as a share

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

of aggregate value added in our sample. Income from equity-based compensation grows from less than 1% of value added before 1980 to as much as 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 (i.e., RS) to the stock market capitalization of the firm (see Figure 2).[9] This share captures the fraction of firm value which is employee-owned.

We emphasize that the institutional features and tax treatment of equity-based compensation are complex and lead to measurement challenges with standard income data sources. The Appendix 6.1 provides a detailed summary of the treatment of equity-based compensation in the data that has been previously employed in the literature. The main challenge is that payroll-based measures of wages entirely exclude or significantly underestimate the value of equity-based employee pay. This type of compensation is generally part of a variety of compensation plans, such as stock option plans, restricted stock, restricted stock unit (RSU) plans, employee stock purchase plans (ESPPs), stock ownership plans (ESOPs), 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 the measurement of income accrual. In addition, for tax purposes, earnings from equity-based compensation may be treated either as income or as capital gains, depending on whether they are derived from non-qualified or qualified plans, respectively. As a result of these complications, the standard measures of payroll used in the literature (e.g., the BLS Employment Cost Index (ECI)) do not include any type of equity-based pay. Other measures include the BLS nonfarm compensation per hour (CPH) or the Census Bureau and NIPA/BEA estimates of wages and salaries. However, these measures include only payments to employees under plans that are taxed at the personal income tax rate and are either (a) reported as payroll by the employer on IRS Form 941 or (b) reported as wage income by the employee on his or her W-2 form.[10] For context, the value of exercised options in our data 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 1). Hence, accounting for the granted but not yet exercised portion

[9]Scaling the value of reserved shares by the stock market valuation helps alleviate the potential concern of market timing. Companies may issue more equity-based compensation when stock prices are high.

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

of stock and stock option grants is crucial to fully capture the income to human capitalists. This is especially important given the rapid growth in grants in recent decades.

In summary, using firm-level information from SEC filings allows for timely and comprehensive coverage of equity-based compensation. The value of stock options is included in standard payroll measures not when they are granted but rather when they are exercised. And, even when exercised, their inclusion is limited to *non-qualified* plans, which are taxed at the income tax rate. All other plans (i.e., qualified plans or plans that are a part of retirement accounts) are excluded and are taxed as capital gains.

Constructing an Annual Flow Measure of Equity-Based Compensation: Robustness We present several robustness checks to our main measure of the annual flow of equity-based compensation, $NG = \frac{RS}{gp}$, in Figure 4. The top left panel of Figure 4 shows that using firms' actual granting periods from 1996 to 2005 from Risk Metrics data yields very similar dynamics to our measure using a constant five year weighted average granting period.[11]

Next, we construct a measure of new grants to value added using the aggregate (Black–Scholes) value of newly granted stock options (BS) from Risk Metrics for the period 1996–2005. The top right panel of Figure 4 plots the aggregated BS value relative to value added, along with our baseline measure including shares reserved for both options and restricted stock grants. As is apparent in the Figure, these two measures are highly correlated for the shorter sample when both are available. The time series correlation between the ratio of BS to value added and the ratio of NG to value added is 0.79.[12] There are a few reasons why, particularly in the last three years of data, the BS share of value added is somewhat lower than our measure. The main reason is that there is convincing evidence (see Aboody et al. (2006)) that once firms were required to expense option grants, they began to significantly understate their value. Another reason that the BS share is lower is that it does not include restricted stock grants, which became more popular relative to options after the severe downturns in equity valuations in 2000 and 2008.[13] Possibly reflective of these issues, in the 1996–2005 period, the ratio of aggregate reserved shares to value added more closely

[11] for the shorter time period, we also have information on whether a firm discloses all available reserved shares in its 10-K filing. This is the case for 80% of the firms, further supporting the accuracy of our estimate for NG.

[12] In pooled time series cross section data using 4-digit SIC industry-level observations, we find that the correlation between the ratio of BS to value added and the ratio of NG to value added is 0.92.

[13] Bachelder (2014) estimates that in recent years about half of equity-based compensation is in the form of restricted stock.

tracks the ratio of total outstanding stock options to value added, with a time-series correlation of 0.93.[14]

Finally, we show that using the raw change $\Delta \text{RS} = \text{RS}_{t+1} - \text{RS}_t$. in reserved shares yields a similar upward and accelerating trend as our main measure. The bottom left panel of Figure 4 shows the time series pattern of ΔRS to value added ratio also closely tracks the NG share, with a correlation coefficient of 0.93.

Total Human Capitalist Compensation: Wages plus Equity We now turn to the human capitalists' total income measurement, that is, equity-based compensation plus wages. We calculate the human capitalists' wage income 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. Income from exercised options under non-qualified equity-based plans is at least partially included in the wage income share measure from NBER-CES, so 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. We also use an estimate of the fraction of total new grants that are non-qualified, which is two thirds in ExecuComp.[15] Thus, we subtract 20% of the value of new grants from the high-skilled 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, our CES high-skilled wage measure captures the *wage income* of human capitalists. The time series of high-skilled wages as a share of value added is plotted in Figure 3. Note the pronounced decline in the high-skilled wage income share, from 17% in 1960 to 9.4% in 2005.[16] However, the wage measure is incomplete. Next, we compute the income share of *equity-based compensation* using our grant-based measure of reserved shares normalized by the weighted-average granting period, NG. Finally, we sum the wage income share

[14] In pooled time series cross section data using 4-digit SIC industry-level observations, the correlation between the ratio of reserved shares to value added and the ratio of the value of total outstanding stock options to value added is 0.87.

[15] Specifically, in the IRRC data for the 1996–2005 period, we calculate the aggregate annual value of new and exercised grants by summing over firms. Then, we use the average annual ratio of the aggregate value of exercised grants 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 the value and type for each stock option grant. For each year, we aggregate qualified and non-qualified grants by summing over firms, and we use the average annual ratio of qualified grants to total new grants as our estimate.

[16] The decline in the skilled labor share using unadjusted wages from the NBER-CES similar in magnitude, from 17% in 1960 to 10.8% in 2005. Thus, the dramatic decrease in the skilled wage income share is not driven by netting out a fraction of the growing equity-based compensation.

and equity-based compensation share to construct human capitalists' total income share. We plot the time series of both the equity-based income share and the total income share in Figure 3. The increase in equity-based compensation more than offsets the decline in high-skilled wage income, and, on average, the total human capitalists' share is slightly increasing since 1980.

Note that, because our data are generated by firm-level data and not worker-level data, we cannot identify the precise recipients of equity-based compensation. Auxiliary data sources, such as levels.fyi, suggest that equity-based compensation is used heavily for engineers and for a broad set of managers. Using ExecuComp, we show that most equity-based compensation (78% in recent years) goes to workers outside the C-suite. We assume that equity-based pay goes to workers who are not classified as production workers by the NBER-CES (i.e., those workers whom the literature has classified as higher skilled). We use an expense-based measure below, to provide additional evidence that total compensation to white-collar workers has increased from 1980–2005.

We also show additional evidence that our merged Compustat-NBER-CES sample presents a high degree of similarity to the overall NBER-CES universe in the Online Appendix. Both the levels and trends of all the wage share measures in the merged sample are very similar to those in the NBER-CES universe, suggesting that our main facts are not just a by-product of limiting the sample to publicly traded firms in Compustat. In addition, the figure shows that Compustat coverage improved slightly over the first decade (1960s), but remained stable afterward. This indicates that the upward trend in the human capitalist share is not mechanically driven by a decline in the share of private firms, which would lead to a secular upward trend in Compustat coverage.

Finally, we note that, in the cross section, the increase in equity-based compensation is even more pronounced for small firms.[17] Although our sample focuses primarily on publicly traded firms, the fact that human capitalists in smaller firms receive more equity-based compensation as a share of total sales than those of larger firms indicates that our time series for the share of NG relative to value added could be an underestimate for the whole US economy. This increase in equity-based compensation among smaller firms also enhances the divergence between the average and the aggregate total labor share, which is consistent with the evidence in Hartman-Glaser et al.

[17]See the Online Appendix. Using the sample for which we have full Compustat coverage (1970–1995), we show that smaller firms (i.e., firms in the bottom quintile of the size distribution) offer 10% more equity-based compensation to employees relative to firms in the top quintile.

(2019).

Total Human Capitalist Compensation: Robustness Our final robustness check compares our main approach to measuring total human capitalist compensation as the sum of equity-based compensation from reserved share data, and high-skilled wage data from CES to an expensed-based measure of the total compensation to human capitalists. Specifically, we compare our measure of total income to a measure based on accumulating the widely available accounting variable *selling, general, and administrative expenses* (SG&A). As detailed in Eisfeldt and Papanikolaou (2013) and the associated Online Appendix, this variable typically includes the salaries, wages, and bonuses of firms' white-collar workers and managers. However, since SG&A includes other expenses unrelated to employee compensation, we follow the standard approach in the literature (e.g., Eisfeldt and Papanikolaou (2014)) and scale the variable by 0.3. Our primary measure, which is based on reserved shares, has an additional advantage because we can use it to validate this parametric assumption. Total human capital income based on reserved shares plus high-skilled wages is, on average, 46.3% of SG&A in our sample. This indicates that our choice of 0.3 is conservative. Our second measure of human capitalist income shares is then constructed in each year by aggregating the firm-level observations of 30% of SG&A to the industry level and then computing 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 4 plots the aggregate human capital income share based on SG&A. This share was 5.4% at the beginning of the sample period, then it more than doubled to 13.2% at the end of 2005. As expected, given that wages have trended downward while equity compensation increased substantially, the SG&A based measure increases from 1980 to 2005, but not as dramatically as the measures of equity compensation only.

Our approach to measuring equity-based compensation using reserved share data has an important advantage over the expense-based measure. In particular, reserved shares are not affected by changes in expensing practices for stock options that occurred over our sample period. Equity-based compensation can be used effectively for retention and incentive purposes, but historically, purely accounting-based motivations have played a role. In particular, historically, equity-based pay was not always expensed, or was expensed at a low value, thereby boosting profits. The Appendix 6.1 contains further details. The fact that reserved shares on the balance sheet are not impacted by

changes in expensing practices leads us to use this measure as our baseline measure, with support from the expense-based measure.

2.3 Time Series Evidence: Main Facts

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 1958–2010, both 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 RiskMetrics sample period (1996–2005), new grants of employee stock options are about 5% relative to the value added, and the majority of these grants (78%) goes to employees who are not the top five executives.

Figures 1 and 3 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 equity-based compensation relative to value added (i.e., a roughly 9 percentage point increase from the 1960s to the 2000s) completely reverses the downward trend in high-skilled labor's wage income share. 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 2) (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 1980s to about 7% in the 2000s. The increase in the ownership share was not driven only by top executives' equity-based compensation, which was relatively stable at around 2.2% on average in the 1990s and 2000s.

Figure 5 shows that, in the aggregate time series, there is a negative correlation between our grant-based measures and our expense-based measures of human capitalists' income and investment goods prices (-0.59 and -0.49). For reference, we also plot aggregate physical capital and total labor shares from the NBER-CES database. Amid declining investment goods prices, the physical capital share has been relatively flat in the U.S. since the 1960s (dashed red line), while the labor share has declined steadily (solid blue line). This finding aligns with the cross-country evidence of Karabarbounis and Neiman (2014).

We show that cross-industry evidence is consistent with (a) a substitution mechanism between

human capital and labor and (b) complementarity between human capital and physical capital. Table 2 reports industry-level multivariate regressions of the human capitalists' share in a given year on both the physical capital share and the unskilled labor share at the 4-SIC level of industry aggregation. 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.

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 regressions of 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 shares (Columns 1 and 2) or expense-based shares (Column 3). In Column 7, we show that declining investment goods prices are correlated with a change in the structure of human capitalists' pay, with equity-based compensation increasing in importance. Finally, Columns 4–5 show a positive relation between the labor (payroll) share and investment goods prices across industries for both the total payroll and production workers' payroll, which aligns 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 fixed effects (Panel A) and firm fixed effects (Panel B). The coefficient estimate in Column (3) implies that a one standard deviation decline in investment goods prices is associated with an increase of about 12% of a standard deviation 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. We observe that a one standard deviation decline in investment goods prices is associated with an increase of about 7% of a standard deviation 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, the regression analysis confirms the negative time-series relation between investment goods prices and human capitalists' income and ownership shares. This relation holds both within-industry and within-firm.

Next, we examine the growth of the human capitalists' share relative to the physical capital share as investment goods prices decline. This is an important motivation for complementarity between physical and human capital. Table 5 reports both industry-level regressions (Column 1–3) and firm-level regressions (Columns 4–5) of the relative growth of human capitalists' share in a given year and the physical capital share 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 faster growth (on average) of the human capitalists' share relative to the physical capital share. These changes in relative shares drive the identification in our structural analysis below.

In Table 6, we use sample-split analysis to further corroborate 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 skill intensive. In line with this prediction, and robustly across our measures, the relation between the human capital share and investment goods prices displays systematic heterogeneity by the degree of skill intensity. This heterogeneity is much stronger in relatively higher skill-intensity sectors (Columns 1, 3, and 5). Overall, the evidence of stronger complementarity in sectors that rely more heavily on skilled workers supports the unique economic mechanism at the heart of our model.

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. Our baseline measure has the advantage of being available for a wide cross section of firms

over a long time series. However, the ideal measurement of equity-based compensation is the value of newly granted options and unrestricted stock. For the 1996–2005 period, we have the detailed information required to calculate this value, and we use this information 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 also holds for an alternative measure of human capitalists' equity-based compensation: the (Black–Scholes) value of their earnings from stock option grants relative to the value added (sales) at the industry level (firm level) (Columns 1–2 and 3–4, respectively). Another concern is that our measures include the compensation of the very top executives and, as such, our results may be driven solely by this relatively small subset 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 five executives. This means that the relation between declining investment goods prices and equity-based compensation is stronger for employees outside the C-suite.[18] This indicates that our results reflect the impact of broad-based employee stock-based compensation.

Additional robustness checks appear in the Online Appendix. In particular, employee stock compensation plans lead to the dilution of existing shareholders in the absence of a parallel repurchase plan. In the Online Appendix, we show that the same relationships as in our main tables holds for alternative measures of dilution. We also show that our results on ownership shares are robust to expanding the sample to the entire Compustat universe by including the non-manufacturing sectors, for which we do not have value added data.

Table 8 repeats this 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 the stock market capitalization. This measure is broader because it captures not only new grants but also the capital appreciation of past grants. Thus, it is a proxy for the stock of equity compensation or human capitalists' compensation wealth. The negative relation with investment goods prices also holds 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.

[18] We take information on stock option grants for a firm's top five executives from ExecComp, which is a standard source.

3 The Model

In this section, we propose a simple framework to show that the stylized facts that describe factor shares in both the time series and in the cross section can be explained by a unified equilibrium macroeconomic model. The model features declining investment goods prices as a driving force, and, at estimated parameters, features technological complementarity between physical and human capital, as well as declining investment goods prices. Human capital's participation constraint accounts for the fact that human capital may earn more than its marginal product in an economy with profits to be shared and outside options to be met. This section describes the model, and the following section discusses its estimation.

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*, denoted by 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 Final goods are produced using a continuum of intermediate goods, j, as our unit of 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 $\epsilon_t > 1$[19] 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, hence we obtain the standard demand function

[19] 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.

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 good is the numeraire, and it has a price $P_t^Y = 1$.

Intermediate Goods Production Production of intermediate goods requires both types of capital, k and h, and also (unskilled) labor, n, supplied by the households in the K sector.[20] In this simple model, we assume that there are no adjustment costs associated either with physical capital investment or with adjusting labor. The required rates of return for physical capital and human capital are R_t^k and R_t^h, respectively. Labor is compensated with a per-period market-clearing wage, w_t. Firms produce intermediate goods j using k , h, and n according to a constant-return-to-scale CES production function (Krusell et al., 2000):

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

where z_t represents the level of factor-neutral productivity and $\alpha_i, i = k, c$ are share parameters. The variable σ governs both the elasticity of substitution ($\frac{1}{1-\sigma}$) between physical capital and labor, and the elasticity of substitution between human capital and labor. The variable ρ governs the elasticity of substitution ($\frac{1}{1-\rho}$) between physical capital and human capital. A zero value for σ or ρ indicates the same degree of complementarity as Cobb–Douglas, and a value of 1 for σ or ρ indicates perfect substitution. A $\sigma > \rho$ indicates that physical capital is more complementary with human capital than with unskilled labor, and a negative ρ indicates that the complementarity is greater than that of Cobb–Douglas.

The profit-maximizing intermediate goods sector is owned by both physical capitalists and human capitalists. We assume that physical capitalists operate the firms in the intermediate sector. They maximize their share of firm value $V^k(j)$ subject to the participation constraint of human capitalists. A residual fraction λ of profits $\Pi_t(j)$ is owned by these physical capitalists. This fraction represents the remaining profits available for distribution after the necessary profit-sharing with

[20] Alternatively, we can assume that labor is supplied either by the human capitalist or by both household sectors. This assumption does 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.

human capitalists.

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

$$V_t^k(j) = \max_{p_t(j),k_t(j),h_t(j),n_t(j),y_{j,t},\lambda} \lambda \cdot \sum_t \beta^t \Pi_t(j) = \lambda \cdot \Pi_t(j) + \beta \cdot V_{t+1}^k(j), \tag{4}$$

subject to

$$\begin{aligned} \Pi_t(j) &= p_t(j)y_{j,t} - R_t^k k_t(j) - R_t^h h_t(j) - w_t n_t(j) && (5) \\ y_{j,t} &= p_t(j)^{\frac{\epsilon_t}{1-\epsilon}} Y_t && (6) \\ R_t^h h_t + (1-\lambda)V_t(j) &\geq \mathcal{O}_t = R_t^h h_t + \eta V_t(j), && (7) \end{aligned}$$

where (6) is the demand for intermediate goods j from Equation (2), and (7) is the participation constraint for human capitalists. The total firm value is $V_t(j) = \sum_{s=t+1} \beta^s \Pi_s(j)$, which is the accumulated present value of the residual profits after the marginal products of capital and labor are paid. The fraction of firm value shared with human capitalists can be expressed as $V_t^h(j) = (1-\lambda)V_t(j)$, which is the accumulated present value of profit-sharing that physical capitalists promised to human capitalists before production. Hence, $V_t^h(j) + V_t^k(j) = V_t(j)$ for $\forall j$.

Equation (7) describes the participation constraint for human capitalists. If human capitalists remain with their present firm, they receive their marginal product $R^h h$ as well as some promised share of the firm $(1-\lambda)V_t^h(j)$. Firm owners set the latter component by adjusting λ so that human capitalists' participation constraint is satisfied. This practice is consistent with observed corporate behavior, in 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 they will still receive their marginal product $R^h h$. Note that this marginal product can be paid with wages or with equity-based compensation. In addition, at their new firm, they will accrue a fraction η of the new firm's value. Marginal products, which are the same regardless of whether the human capitalist remains with her existing firm or moves to a new firm, cancel out from both sides. Profit maximization by physical capitalists implies that (7) is always binding, and $\lambda = 1 - \eta$.

Note that the participation constraint (7) is expressed in terms of *total* firm value shared with human capitalists, so V_t^h does not represent the flow compensation for human capitalists at period

t. The share of firm value $1-\lambda$ is promised to human capitalists at period t, but the income of human capitalists due to retention motives should count only for the incremental part (i.e., the flow) of the firm shares at period t. For measurement, it is useful to note that the change in the share of the firm owned by human capitalists is $\Delta V_t^h(j) \equiv \Delta(1-\lambda)V^t(j) \equiv \beta V_{t+1}^h(j) - V_t^h(j)$. Note that in a steady state, the change in shares of the firm value $\Delta(1-\lambda)V_t$ is simply the fraction of current profit $(1-\lambda)\Pi_t$, given the definition of V_t.

At this point, we take no stand on what fraction of human capitalists' marginal product is compensated using wages versus equity-based compensation. Equation (7) simply states that the *total* value allocated to human capitalists equals human capitalists' marginal product plus any additional shares of firm value needed to satisfy human capitalists' outside option and the participation constraint. In theory, both wages and equity-based compensation can be used for either the marginal product or the retention components of compensation. In practice, there are both accounting motivations and tax motivations for using equity-based pay, as well as retention and incentive reasons. To keep notation consistent, we denote the total flow of equity-based compensation as E^h, of which a fraction θ of E^h is used to compensate human capitalists' marginal product, and $(1-\theta)E^h = \Delta(1-\lambda)V_t$ is then used for retention purposes. The marginal product $R^h h$ is the sum of the flow wage payment w^h and the relevant fraction of equity-based compensation θE^h. In our structural estimation, we show that only a small fraction of equity-based compensation must be assigned as compensation to human capitalists for their marginal product in order to generate complementarity between physical and human capital in the production function. Then, we show that evidence from factor share dynamics in the cross section of industries suggests that, in fact, most all equity compensation is attributable to human capitalists' marginal product.

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: $p_t(j)f_k(j) = \mu_t R_t^k$, $p_t(j)f_h(j) = \mu_t R_t^h$, $p_t(j)f_n(j) = \mu_t w_t$, where the markup over marginal cost is $\mu_t = \epsilon_t$. The marginal product 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 product 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 product of n is $f_n(j) = z(1-\alpha_c)\left(\frac{y(j)}{n(j)}\right)^{1-\sigma}$.

Agents This section describes the objective functions of the 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 for producing capital goods. Households can invest final output goods in order to increase the physical capital stock k at prices determined by the level of investment-specific technological change.[21] The law of motion for physical capital is

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

Investment decisions I_t^k are made each period. The capital stock k depreciates at the rate δ_k. Define p_t^k as the relative price of physical capital investment goods over the numeraire. The price of physical capital investment goods is $\tilde{p_t^k} = \frac{p_t^k}{z_t^k}$, and z_t^k represents the investment-specific technological (IST) shock. Following Greenwood et al. (1997), $\tilde{p}_t^k$ represents the effective conversion of final output goods to equipment capital.

We assume that the physical capitalist sector owns the firms that produce intermediate goods, and it shares ownership of the profits Π_t from this production. The physical capitalist sector also has access to risk-free assets f_t with an interest rate of R_t^f. The representative physical capitalist maximizes her lifetime utility, defined as

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

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 the

[21] We can extend the current setup to a general environment, as in Karabarbounis and Neiman (2014), which includes an intermediate goods sector for k.

law of motion,

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

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

The representative human capitalist maximizes expected lifetime utility, defined as

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

subject to the budget constraint:

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

where the right-hand side states the sources of income of human capitalists. The marginal product of human capital is $R_t^h h_t$, and $\Delta(1-\lambda)V_t \equiv \beta V_{t+1}^h(j) - V_t^h(j) = (1-\lambda)\Pi_t$ is the change in the share of the firm value that accrues to human capitalists from t to $t+1$ in the steady state, in which the firm grows at the risk free rate. The change in the share of firm value accruing to human capitalists is implied by the participation constraint at consecutive dates.

Equilibrium We consider a symmetric competitive equilibrium defined as follows:

Definition 1 *A **Competitive Equilibrium** in this economy is a sequence of prices $\{p_t(j)\}_j$ and quantities such that the following optimality and market clearing conditions hold: (a) Each household sector $i = k, h$ maximizes its lifetime 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)*. (b) The owner of the final consumption goods sector solves the maximization problem $\mathcal{P}$. (c) The equilibrium is symmetric: $p_t(j) = P_t = 1$, $k_t(j) = k_t$, $h_t(j) = h_t$ and $y_{j,t} = Y_t$. And, (d) 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 intertemporal Euler equations for

consumption, investment, and labor supply:

$$1 + R^f_{t+1} = \frac{U^i_{c,t}}{\beta U^i_{c,t+1}}, \qquad i = k, h \tag{12}$$

$$R^k_{t+1} = \tilde{p^k_t}\frac{U^k_{c,t}}{\beta U^k_{c,t+1}} - \tilde{p^k}_{t+1}(1-\delta_k), \tag{13}$$

$$R^h_{t+1} = \frac{U^h_{c,t}}{\beta U^h_{c,t+1}} - (1-\delta_h), \tag{14}$$

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

3.2 Factor Shares of Income

In this subsection, we discuss the factor shares of income in our economy. The final output is distributed among three sectors: physical capitalists, human capitalists, and labor. Physical capitalists receive the rental income from physical capital, $R^k_t k_t$. Human capitalists receive compensation equal to their marginal product plus any additional compensation necessary to satisfy their participation constraint. The sum of wages plus equity compensation is $R^h_t h_t + \Delta(1-\lambda)V_t$, though one cannot equate $R^h_t h_t$ to wages alone as equity can also be used to compensate marginal product. Finally, labor receives wages, $w_t n_t$.

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

The share of human capital income is then $\frac{R^h_t h_t + \Delta(1-\lambda)V_t}{Y_t}$, while the physical capitalists' income share is $\frac{R^k_t k_t}{Y_t}$. 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. (2019)), 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 share of capital income $\frac{s_k}{s_h}$:

$$\frac{s_k}{s_h} = \frac{R^k k}{R^h h + \Delta(1-\lambda)V} = \frac{R^k k}{R^h h}\frac{R^h h}{R^h h + \Delta(1-\lambda)V} = \frac{R^k k}{R^h h}\omega_R, \tag{16}$$

where $\omega_R = \frac{R^h h}{R^h h + \Delta(1-\lambda)V}$ is the fraction of human capital income that is the marginal product. The relative capital share of income is driven by two factors: the relative rental payment between h and k, $\mathbf{D} = \frac{R^k k}{R^h h}$, and the composition of human capital income, ω_R. When human capitalists' outside option η is higher, human capitalists' income is driven more by the participation constraint, $1 - \omega_R$.

The elasticity of substitution between k and h is crucial for the dynamics of relative rental payments and hence the relative share of capital income. To further understand the mechanism, we can substitute out the ratio between physical capital and human capital $\frac{k}{h}$ using the function of the relative capital return as

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

The ratio $\frac{R^k k}{R^h h}$ as a function can be increasing or decreasing in the relative price, $\frac{R^h}{R^k}$, depending on whether h and k are substitutes or complementary. If $\rho < 0$ (complementary), $\mathbf{D}$ is decreasing in $\frac{R^h}{R^k}$. The intuition is that, as physical capital becomes cheaper, more h is adopted in production due to complementarity. Hence, the relative share of h to k is increasing. On the contrary, if $\rho > 0$ (substitutes), $\mathbf{D}$ is increasing in $\frac{R^h}{R^k}$. Hence, given the technology parameter ρ and ω_R, the relative income share of h versus k in Equation (16) is driven by the relative price and the composition of human capitalists' income.

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

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

where $\mathbf{C} = \left(\alpha_k + (1-\alpha_k)\left[\frac{(1-\alpha_k)R^k}{\alpha_k R^h}\right]^{\frac{\rho}{1-\rho}}\right)^{\frac{1}{\rho}}$.[22] 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 this system with the data to estimate the deep parameters in the production technology.

4 Estimation

In this section, we combine our model with the data to learn about the shape of the aggregate production technology. Specifically, we estimate the elasticity of substitution between k and h, ρ, as well as the elasticity of substitution between labor and capital, σ.

4.1 Measurement Equations

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

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

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

where the return to physical capitalists, R_t^k, and the return to human capitalists, R_t^h, are determined by the households' intertemporal consumption and saving choices (13) and (14). We estimate this system via maximum likelihood, assuming normally distributed error terms. This 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 the trends 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 the elasticity of substitution between unskilled labor and capital, σ.

[22] See the derivation in Appendix 6.4.

Equation (19) is key to identifying the parameter ρ. Dividing both sides by ω_R yields:

$$\frac{s_k}{s_h \cdot \omega_R} = \frac{R^k k}{R^h h} = \left(\frac{\alpha_k}{1-\alpha_k}\right)^{\frac{1}{1-\rho}} \left(\frac{R^h}{R^k}\right)^{\frac{\rho}{1-\rho}}. \tag{21}$$

The difference between the trends of rental payments to physical capital $R^k k$ and human capital $R^h h$ identifies the parameter ρ. To see the intuition, we apply the log difference to the right-hand side of Equation (21). The trend in the marginal return of capital $\frac{R^h_t}{R^k_t}$ equals the difference between the growth in the rental return to human capital investment R^h and the trend of investment goods prices, scaled by $\frac{\rho}{1-\rho}$. As the relative price of physical investment goods trends downward, R^k declines faster than the return to human capital investment R^h. Given that $\rho < 1$, the relative share of physical capital compared to human capital $\frac{s_{k,t}}{s_{h,t}\omega_R}$ can decline in $\tilde{p^k}$ only if $\rho < 0$ (i.e., only if 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 estimation requires data on the marginal product of human capital $R^h h$ as an input to the left-hand side of Equation (21). In practice, what is observed is total human capitalists' income, which is composed of wages w^h and equity-based compensation E^h. Each of these components may include both compensation for the marginal product $R^h h$ and any additional compensation required to satisfy human capitalists' outside option $\Delta(1-\lambda)V$. To account for this, we assume, as in the existing literature, that all wage compensation is due to human capitalists' marginal product. For equity-based compensation, we perform a series of estimations, assigning all values between 0% and 100% for the fraction of equity-based pay attributable to human capitalists' marginal product. We show that the structural estimation implies more complementarity than Cobb–Douglas between physical and human capital for all but very small values of the fraction of equity-based pay that is used to compensate high-skilled labor for their marginal product.

Note that we are being conservative by not assigning all equity-based pay to human capitalists' marginal product. A reasonable baseline assumption would be that equity pay has simply replaced wages, but not increased overall pay. There are several reasons why firms might substitute away from wages and towards equity grants. First, equity-based pay is tax advantaged because qualified grants can avoid being taxed at income taxes. Second, before 1996, companies could use equity-based compensation without fully expensing it, thus boosting earnings. Third, equity-based

compensation is approved by the IRS as a justification for replacing dividends (taxed at the income tax rate) with repurchases (taxed at the capital gains rate). Finally, we note that equity-based compensation can be used to substitute equity-based compensation for wages due to incentive alignment, retention motives, and relaxation of financial constraints by delaying a fraction of pay.

Rather than taking as a baseline that one hundred percent of equity based pay is simply a substitute for wages, and used to compensate marginal product, we instead acknowledge that some reasons for using equity-based pay may break the relationship between compensation and the marginal product. To assess the importance of the attribution of equity-based pay to marginal product, we designate a fraction θ of equity-based compensation to represent compensation due to human capitalists' marginal product, and we vary this fraction in our estimation. The relative capital share on the left-hand side of Equation (21) can then be represented as follows:

$$\frac{s_k}{s_h \omega_R} = \frac{R^k k}{R^h h} = \frac{R^k k}{w^h + \theta E^h}.$$

In the denominator, w^h is the measured flow wage income in the data, which represents only part of high-skilled labor's marginal product. The remainder of the marginal product is compensated with equity θE^h, where E^h is the observed equity-based compensation, and hence $R^h h = w^h + \theta E^h$ and $(1-\theta)E^h$ is any additional compensation, beyond the marginal product, necessary to satisfy human capitalists' outside option $\Delta(1-\lambda)V$. Our estimation strategy is then proceeds in two steps: First, we perform our estimation for $\theta \in [0,1]$, and we show its impact on the degree of complementarity between physical capital and human capital. Then, we exploit the cross-industry data to infer the value of θ.

The correlation between the rental rate of capital k and the growth of the total capital share drives the sign of σ. To gain intuition, we can express the log growth of the total capital share as $s_c = 1 - s_n$, 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.[23] 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 an increasing demand for (more expensive) human capital h.

[23] $\hat{x}$ is the change of x across steady states. This expression is obtained by assuming α_k, α_c and δ to be constant.

4.2 Estimation Results

Equity-based compensation is critical when accounting for the rise in human capitalists' income share and when investigating the elasticity of substitution between physical capital and human capital. In this section, we first estimate our model using the time series data to show that it is crucial to include equity-based compensation for the identification of the complementarity between physical and human capital. When only a very small fraction of equity-based compensation is included, we find greater complementarity between physical and human capital than that implied by Cobb-Douglas. However, if equity compensation is ignored completely, we find instead greater substitutability. In the final estimation step, we use cross sectional data to estimate the elasticity of substitution between physical and human capital, and then we use that elasticity to pin down the fraction of equity pay that is due to human capitalists' marginal product.

We estimate our model to match the time series of factor shares for the sample period from 1980–2005. The reason for focusing on the recent period is that the decline in investment goods prices p_t^k started in the early 1980s. Since our identification is driven by the relative trends of prices in the data and the share series are noisy, we apply a 2-year moving average to the target moments. 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), and the elasticity of substitution (EOS) between capital and labor n, (σ). The parameters that govern the depreciation rate of capital δ_k and δ_h and the markup μ are calibrated.

For the calibrated parameters, we set the depreciation rate of capital δ_k to the average investment rate in our sample (0.08). The variable δ_h is set to 0.15, which is equal to the depreciation rate used by the BEA in its estimation of R&D capital in 2006 (Eisfeldt and Papanikolaou (2013)). We set the markup at a constant 1.3 throughout the sample period.[24] The returns to human and physical capitalists are determined by Equations (13) and (14), where the interest rate R_f is the time series of real rates over the sample period.

Recall that ρ measures the degree of substitutability or complementarity between physical capital and human capital, while σ measures the degree of substitutability or complementarity

[24] 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 the 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.

between physical capital and labor. Estimates below zero indicate more complementarity than Cobb–Douglas, while positive estimates indicate a greater degree of substitutability than Cobb–Douglas. Estimates of 1 indicate perfect substitutability. The top panel of Figure 7 displays the results for the estimate of ρ.

Our estimation shows that the parameter ρ is highly sensitive to including even a very small fraction of equity-based pay in the marginal product of human capitalists. When equity-based compensation is completely ignored ($\theta = 0$), the estimated parameter ρ is positive, 0.09, which implies more substitution between human capital and physical capital in the aggregate production function than Cobb–Douglas (the EOS is 1.09). As θ increases, the estimates of the elasticity of substitution parameter ρ drop sharply. When only 8.98% of equity-based compensation is allocated to human capitalists' marginal product, the estimated elasticity of substitution ρ becomes negative.[25] In other words, omitting a very small fraction of equity-based compensation in the human capital income share leads to an for ρ with the "wrong" sign. In addition, the decline in the estimate of ρ accelerates quickly as θ increases.

By contrast, estimates of σ do not vary significantly over different values of θ, as seen in the bottom panel of Figure 7, which plots the estimates of the elasticity of substitution between labor and capital. The average of estimate for σ is 0.24, which implies a strong degree of substitutability between capital and labor (an EOS of 1.32). Our estimation of the elasticity of substitution between capital and labor, σ, is similar to the findings in the existing literature. Karabarbounis and Neiman (2014) estimate that the EOS between capital and labor is 1.28, on average, across countries. Krusell et al. (2000) shows that the EOS is 1.65 between capital and labor, using the sample from 1963–1992. While capital–labor substitution can explain the declining labor share (unskilled or total) since the 1980s, equity-based compensation is crucial for understanding the elasticity of substitution between physical capital and human capital in the last thirty years.

Thus far, we have remained relatively agnostic about what fraction, θ, of equity-based compensation is attributable to compensation for human capitalists' marginal product. Our next estimation exercise exploits the cross section data to pin down our estimate of ρ, the degree of complementarity between physical and human capital. By using the estimate of ρ from the cross section, we are then

[25] This threshold is 15.51% when we apply a 5-year moving average to the relative share of physical capital to human capital. Without applying any moving average to the target moments, the threshold is 0.82%.

able to provide an estimate of θ in our study of the time series. Our identification strategy is as follows: Recall the first-order condition (19), which captures the dynamics of the relative income shares of physical vs. human capital for each industry at each year. We take this equation to the data by taking logs on both sides and adding an i.i.d. error term:

$$\log s_{h,j,t} - \log s_{k,j,t} = \frac{1}{1-\rho}\log\left(\frac{1-\alpha_k}{\alpha_k}\right) + \frac{\rho}{1-\rho}\log R^k_{j,t} - \frac{\rho}{1-\rho}\log R^h_j + \log\frac{1}{\omega_{R,t}} + \epsilon_{j,t} \quad (22)$$

where j stands for industry j. Since both $\omega_{R,t}$ and R^h_j are unobservable, we need to assume that some variables are fixed across time, or across industries in order to identify ρ from the coefficient on $\log R^k_{j,t}$. Accordingly, we assume that 1) $R^h_{j,t}$ is different across industries but identical over time; and 2) $\omega_{R,t}$ is identical across industries, but varies over time. Hence, R^h_j and $\omega_{R,j}$ are absorbed by industry fixed effect and year fixed effect respectively.

We estimate (22) using the 4-SIC industry-level data for the sample period from 1980 to 2005.[26] We find evidence of a strong degree of complementarity between physical and human capital in this cross section regression, consistent with our findings in Section 2.3. The estimated coefficient on $\log R^k_{j,t}$ is -0.79 and is highly significant (t-statistic of 5.21). This estimate implies that $\rho = -3.76$, and that the elasticity of substitution between physical capital and human capital is 0.21. We note that our estimate of the elasticity of substitution between physical capital and human capital, using data including equity-based compensation and more recent data, is even smaller (indicating greater complementarity) than that reported in Krusell et al. (2000) using wages only in data up to 1992.

Using this estimate of ρ, we can back out the fraction of equity-based compensation allocated to human capitalists' marginal product, θ, from the estimation results in Figure 7. As can be seen in the figure, the estimate of ρ from the cross section of -3.76 implies that θ is 95%. We argue that this estimate is intuitive. It seems reasonable that, rather than increasing pay overall, firms have substituted equity-based pay for wages due to its desirable tax, accounting, incentive, and retention characteristics. Table 9 presents the estimation results.

[26] This empirical specification is the same as in Table 5 but with a different sample period. We do not use the longer sample for our estimate of ρ in aggregate, since, as shown in Figure 5, investment goods prices were increasing in our sample prior to 1980. It is the start of the IT revolution around the time investment goods prices began declining that we argue drives complementarity between physical and human capital. For reference, the estimate of ρ implied by the regression using data back to 1958 is -0.58.

5 Conclusion

Including equity-based compensation in human capitalists' total labor income is critical for accurately measuring human capitalists' contribution to economic activity as well as their share of income. In recent data, 45% of compensation to high-skilled labor appears in the form of equity-based pay. Standard data sources severely understate this compensation, due to its tax treatment at both the firm level and the individual level. Using only wages to measure the high-skilled labor share leads to a puzzling lack of complementarity between declining capital goods prices, mainly driven by e-capital, and high-skilled labor. A comprehensive measure of human capitalists income completely reverses an otherwise declining trend in the high-skilled labor share and reduces the decline in the overall labor share by 60%.

References

Aboody, D., Barth, M. E., Kasznik, R., 2006. Do firms understate stock option-based compensation expense disclosed under sfas 123? Review of Accounting Studies 11, 429–461.

Acemoglu, D., 2002. Technical Change, Inequality, and the Labor Market. Journal of Economic Literature 40, 7–72.

Autor, D., Dorn, D., Katz, L. F., Patterson, C., Reenen, J. V., 2017. Concentrating on the fall of the labor share. Working Paper 23108, National Bureau of Economic Research.

Bachelder, J. E., 2014. What has happened to stock options? Harvard Law School Forum on Corporate Governance and Financial Regulation .

Barkai, S., 2017. Declining labor and capital shares, *W*orking Paper, University of Chicago.

Becker, R., Gray, W., Marvakov, J., 2013. Nber-ces manufacturing industry database. Working paper, National Bureau of Economic Research.

Benzell, S. G., Brynjolfsson, E., 2019. Digital abundance and scarce genius: Implications for wages, interest rates, and growth. Working Paper 25585, National Bureau of Economic Research.

Caicedo, S., Robert E. Lucas, J., Rossi-Hansberg, E., 2016. Learning, career paths, and the distribution of wages. Working Paper 22151, National Bureau of Economic Research.

De Loecker, J., Eeckhout, J., 2017. The rise of market power and the macroeconomic implications. Working Paper 23687, National Bureau of Economic Research.

Eisfeldt, A. L., Papanikolaou, D., 2013. Organization capital and the cross-section of expected returns. The Journal of Finance 68, 1365 – 1406.

Eisfeldt, A. L., Papanikolaou, D., 2014. The value and ownership of intangible capital. American Economic Review 104, 189–94.

Elsby, M. W., Hobijn, B., Şahin, A., 2013. The decline of the us labor share. Brookings Papers on Economic Activity 2013, 1–63.

Frydman, C., Jenter, D., 2010. Ceo compensation. Working Paper 16585, National Bureau of Economic Research.

Frydman, C., Papanikolaou, D., 2015. In search of ideas: Technological innovation and executive pay inequality. NBER Working Papers 21795, National Bureau of Economic Research, Inc.

Frydman, C., Saks, R. E., 2010. Executive compensation: A new view from a long-term perspective, 1936–2005. The Review of Financial Studies 23, 2099–2138.

Gabaix, X., Landier, A., 2008. Why has ceo pay increased so much?*. The Quarterly Journal of Economics 123, 49–100.

Gabaix, X., Lasry, J.-M., Lions, P.-L., Moll, B., 2016. The dynamics of inequality. Econometrica 84, 2071–2111.

Greenwood, J., Hercowitz, Z., Krusell, P., 1997. Long-Run Implications of Investment-Specific Technological Change. American Economic Review 87, 342–62.

Hall, B. J., Liebman, J. B., 1998. Are ceos really paid like bureaucrats? The Quarterly Journal of Economics 113, 653–691.

Hall, B. J., Murphy, K. J., 2003. The trouble with stock options. Journal of Economic Perspectives 17, 49–70.

Hartman-Glaser, B., Lustig, H., Xiaolan, M. Z., 2019. Capital share dynamics when firms insure workers. The Journal of Finance 74, 1707–1751.

Jaimovich, N., Rebelo, S., Wong, A., Zhang, M. B., Forthcoming. Trading up and the skill premium. NBER Macroannual .

Kaplan, S. N., Rauh, J., 2010. Wall street and main street: What contributes to the rise in the highest incomes? The Review of Financial Studies 23, 1004–1050.

Karabarbounis, L., Neiman, B., 2014. The global decline of the labor share. The Quarterly Journal of Economics 129, 61–103.

Karabarbounis, L., Neiman, B., 2018. Accounting for factorless income. Working Paper 24404, National Bureau of Economic Research.

Kogan, L., Papanikolaou, D., 2014. Growth opportunities, technology shocks, and asset prices. The Journal of Finance 69, 675–718.

Koh, D., Santaeulàlia-Llopis, R., Zheng, Y., 2016. Labor Share Decline and Intellectual Property Products Capital. Working Papers 927, Barcelona Graduate School of Economics.

Krusell, P., Ohanian, L. E., Rìos-Rull, J.-V., Violante, G. L., 2000. Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis. Econometrica 68, 1029–1054.

Lawrence, R. Z., 2015. Recent declines in labor's share in us income: A preliminary neoclassical account. Working Paper 21296, National Bureau of Economic Research.

Lebow, D. E., Sheiner, L., Slifman, L., Starr-McCluer, M., 1999. Recent trends in compensation practices. Finance and Economics Discussion Series 1999-32, Board of Governors of the Federal Reserve System (US).

Moylan, C., 2000. Treatment of employee stock options in the u.s. national economic accounts. Bea papers, Bureau of Economic Analysis.

Papanikolaou, D., 2011. Investment shocks and asset prices. Journal of Political Economy 119, 639–685.

Piketty, T., 2014. Capital in the 21st century. Cambridge: Harvard University .

Rognlie, M., 2015. Deciphering the fall and rise in the net capital share: Accumulation or scarcity? Brookings Papers on Economic Activity pp. 1–54.

Smith, M., Yagan, D., Zidar, O., Zwick, E., 2018. Capitalists in the twenty-first century. NBER Working Paper 25442 .

Stokey, N. L., 2016. Technology, skill and the wage structure. Working Paper 22176, National Bureau of Economic Research.

6 Appendix

6.1 Discussion of Equity-Based Compensation in the Data and Literature

In this section, we establish the following two facts about the measurement of equity-based compensation: First, existing data sources (based on BEA and BLS statistics) previously employed in the literature to measure the labor share include only a small fraction of equity-based compensation; namely, they include only equity-based compensation which is either exercised or unrestricted (i.e., not deferred) and non-qualified for tax purposes. Second, we document that the CES wages used in this paper also include only this same small fraction.

Specifically, two main sources of payroll information are used in the literature to measure the labor share: BEA-NIPA (e.g., Karabarbounis and Neiman (2014)) and the BLS Quarterly Census of Employment and Wages (QCEW) (e.g., Elsby, Hobijn, and Şahin (2013)). For measures of the labor share based on BEA-NIPA, the BEA technical methodology [27] details that "wages and salaries in cash... includes employee gains from exercising non-qualified stock options (NSOs)... NSOs are regarded as additional, taxable, income at the time they are exercised; in contrast, incentive stock options do not require the reporting of additional income and are taxed as long-term capital gains when sold. The detailed data required for treating NSOs as compensation of employees when the options are granted (as the System of National Accounts (SNA) recommends) are not currently available. Instead, NSOs are valued at the time that they are exercised, and the difference between the market price at the time of the exercise and the price paid by the employee at the time of the exercise is recorded as wages and salaries." For a discussion of the SNA recommendations and the BEA's research on NSOs, see Moylan (2000).

For measures of the labor share based on employer payroll records from the BLS (QCEW), as detailed at the BLS website (`https://www.bls.gov/opub/hom/cew/data.htm`), the QCEW comes from the administrative tax records of state unemployment insurance (UI) programs. It is similar to NIPA and only includes taxable wages. As such, it includes only the exercise value of non-qualified stock options (NSOs). In addition, as discussed in further detail in the BEA technical note, and in the related paper by Moylan (2000), internal BLS surveys indicate that UI records are likely to underestimate even the exercise value of NSOs. That reference states, at the top of page 3, that "In addition, although it appears that large technology firms are reporting as wages the exercise of employee stock options, it is not clear that all firms are doing so. Because the annual tax base for UI wages and salaries is capped at $7,000 per employee, states may have little incentive to follow up with firms to ensure correct reporting of special compensation items."

Finally, two other measures of wages from the BLS have also been used in the macroeconomic literature on the labor share; namely, the *employment cost index* (ECI) and nonfarm *compensation per hour* (CPH). The former excludes stock options altogether. The latter includes only exercised NSOs, as detailed in Table 1 of the FRB technical note Lebow et al. (1999). Similarly, the data source for wages in this paper, NBER-CES, includes only the exercise value of a subset of stock options (i.e., NSOs). For reference, see the technical documentation of their ultimate data source for employer payroll, ASM/CMF (`https://www2.census.gov/programs-surveys/asm/technical-documentation/questionnaire/2016/instructions/MA-10000(L)%20Instruction%20Sheet.pdf`). This documentation confirms, on page 9 (item B), that payroll includes only the "spread on stock options that are taxable to employees as wages."

The reason for the incomplete measurement of equity-based compensation in existing sources is that such pay is reported in different ways depending on the allowed tax treatment. NSOs

[27] see "Ch 10 compensation of employees," p. 2–3 of `https://apps.bea.gov/national/pdf/chapter10.pdf`.

are taxable at the time they are exercised, and the taxable amount is reported on workers' W-2 forms, but NSOs are only a fraction of total equity-based pay because equity-based pay can also be qualified as incentive pay, and thus treated differently under the tax code. Qualifying dispositions, or those held by a retained employee for a sufficient time period, are reported on Schedule D and Form 8949.

The advantage of the reserved share measure of equity-based pay over an expense-based measure is that it is not affected by changes in accounting rules. In particular, publicly traded firms did not generally expense stock options before 1996, and they started doing so by reporting the intrinsic value of restricted stock and stock option grants. This occurred voluntarily after 1996, and it became a requirement after the introduction of the Financial Accounting Standards Board (FASB) new standard— FAS–123R—in 2004.[28] The value of employee stock options is reported on financial reports using an intrinsic-value-based method at the time they are granted as a compensation expense over the period of vesting.[29] Hence, before 2004, firms could expense granted employee stock options using the fair-value-based method[30].

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 the NBER-CES Manufacturing Industry Database. The NBER-CES Manufacturing Industry Database covers SIC 4-digit industry level information from 1958–2010 on output, employment, payroll, investment goods prices, and value added. All variables are defined at an annual frequency.

For corporate income shares (e.g., physical capital share, profit share, SGA share) and other firm-level variables, we obtain the data from Compustat Fundamental Annual from 1958–2010. 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 the Compustat Fundamental Annual and the NBER-CES Manufacturing Industry Database. This merged sample covers 7,356 firms and 459 of industries (4-SIC) from 1958–2010.

The sample for reserved shares We obtain the data for reserved shares from three sources: (a) the Compustat Fundamental Annual 1958–1995, (b) RiskMetrics 1996–2005, which covers firms from the S&P 500, S&P midcap, and S&P smallcap indices.

We then create the merged sample with the NBER-CES database, the Compustat Fundamental Annual, and the RiskMetrics database. Since we only observe value added at the industry level, we exclude industries (4-SIC) which only has one firm in the NBER-CES-Compustat merged sample for time series aggregation.

[28] 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.

[29] For example, if the vesting period is three years, one third of the value calculated at the time of the grant is expensed for each of the next three years.

[30] Since most employee stock options are granted at the money, firms favored employee stock options as part of their compensation scheme because the fair value of at the money options is zero.

6.2.2 Variable Definitions 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 (RiskMetrics)

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

Human capital share. 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-skilled human capitalists and their equity-based compensation. Sample period is 1958–2005.
   - High-skilled wage share: skilled workers' payroll/value added (NBER-CES) minus income from exercising equity-based compensation
   - Equity-based compensation share: NG = number of reserved shares × current stock prices/5yr. Equity-based compensation share = NG/value added
   - Industry level: human capital share = high-skilled wage share + equity-based compensation share of income
2. Expense-based measure (i.e., selling, general, and administrative expenses). Sample period is 1958–2010.
   (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 1958–2010.

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

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

6.3 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 53 years from 1958–2010. We calibrate our measure to RiskMetrics data, which contain 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 share-based compensation that is granted but not vested, and share values have increased substantially, on average, over our sample (see Hall and Liebman (1998)).

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

$$RS_{t+1} = RS_t + NRS_t - EXC_t - EXP_t, \tag{23}$$

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 both "investment" in the stock as well as "depreciation." Here, investment, or growth in reserved shares, is denoted by 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 they 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 also due to expired options or retired restricted stock (denoted by 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 (e.g., for compensation, warrants, secondary offerings). When this plan is revised significantly, the firm authorizes a new block of reserved shares, NRS_t. These newly authorized shares are then used to grant options 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 be noted that firms also manage their stock of reserved shares, similar to the way firms manage their cash to ensure a sufficient supply to satisfy liquidity needs but no more than this, due to opportunity costs. They are required to reserve enough shares to satisfy compensation grants that are likely to be exercised or vested. On the other hand, firms avoid reserving 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. This means 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 differ 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 that 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:

$$NRS_t = \sum_{k=t}^{t+gp_t} \text{Annual Grants(AG)}_k = gp_t \cdot AG_t. \tag{24}$$

For further simplification, we assume that

1) On average, employees exercise stock options, or their stock vests, after $e \cdot gp_0$ periods[31]

$$EXC_t = \frac{1}{e \cdot gp_0} \cdot RS_t \text{ where } e > 1 \tag{25}$$

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

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

$$EXP_t = c \cdot RS_t. \tag{26}$$

Using Equations (24), (25), and (26), we can rewrite the law of motion (23) as

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

To correctly capture the annual share-based compensation granted to employees at time t (denoted by NG_t) for "new grants," we must 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} as

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

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

$$\begin{aligned} NG_t = AG_t + \frac{RS_t}{gp_0} &= \frac{RS_{t+1}}{\frac{(gp_0 - \frac{1}{e} - c \cdot gp_0)\frac{RS_t}{gp_0} + gp_t \cdot AG_t}{AG_t + \frac{RS_t}{gp_0}}} \\ &= \frac{RS_{t+1}}{\underbrace{(gp_0 - \frac{1}{e} - c \cdot gp_0)\omega_0 + gp_t\omega_1}_{\text{weighted average granting period}}}, \end{aligned} \tag{27}$$

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 values at the beginning of each period, as is standard in macroeconomic notation. However, since accounting data are recorded at the end of each 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 RiskMetrics data, in which we have both NG_t and RS_t for the period 1996–2005, implies that $\bar{gp}$ equals 5.

6.4 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:

$$f_k = z\alpha_c\alpha_k \left(\frac{y}{\Psi}\right)^{1-\sigma} \left(\frac{\Psi}{k}\right)^{1-\rho} = \mu_t R^k \tag{28}$$

$$f_h = z\alpha_c(1-\alpha_k) \left(\frac{y}{\Psi}\right)^{1-\sigma} \left(\frac{\Psi}{h}\right)^{1-\rho} = \mu_t R^h, \tag{29}$$

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:

$$\frac{h}{k} = \left[\frac{(1-\alpha_k)R^k}{\alpha_k R^h}\right]^{\frac{1}{1-\rho}} \equiv \mathbf{B}. \tag{30}$$

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

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

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

$$\begin{aligned} h &= \mathbf{B}k \\ \Psi &= [\alpha_k k^\rho + (1-\alpha_k)\mathbf{B}^\rho k^\rho]^{\frac{1}{\rho}} = (\alpha_k + (1-\alpha_k)\mathbf{B}^\rho)^{\frac{1}{\rho}} k \equiv \mathbf{C}k. \end{aligned} \tag{31}$$

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

$$\frac{Y}{\Psi} = \frac{Y}{\mathbf{C}k} = \left[\frac{R^k}{\alpha_c\alpha_k\mathbf{C}^{1-\rho}}\right]^{\frac{1}{1-\sigma}} \tag{32}$$

$$\begin{aligned} 1 - s_n &= \frac{\alpha_c}{\mu}\left[\frac{\alpha_c\alpha_k\mathbf{C}^{1-\rho}}{R^k}\right]^{\frac{\sigma}{1-\sigma}} + 1 - \frac{1}{\mu} \\ &= \frac{1}{\mu}\alpha_c^{\frac{1}{1-\sigma}}\alpha_k^{\frac{\sigma}{1-\sigma}}\mathbf{C}^{\frac{\sigma(1-\rho)}{1-\sigma}}R^{k\frac{\sigma}{\sigma-1}} + 1 - \frac{1}{\mu}. \end{aligned} \tag{33}$$

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, measured by the ratio 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. New grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The main measure is defined as the sum of skilled wages and new grants relative to value added. The second is the expense-based 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% levels, 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 grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The main measure is defined as the sum of skilled wages and new grants relative to value added (Column 2). The second is the expense-based 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 compensation, measured by the share of equity-based compensation to total skilled workers compensation (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% levels, 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	(Skilled Wages +NG)/ VADD	SG&A/ VADD	Total Wages/ VADD	Production Workers Wages/ VADD	Skilled Workers Wages/ VADD	Equity Comp /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
Investment Good Prices	-0.126***	-0.090***	-0.134***	0.018***	0.131***	-0.062***	-0.093***
	(0.012)	(0.008)	(0.009)	(0.007)	(0.007)	(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	4,565	4,565	4,565	4,565
R^2(%)	65.10	79.50	69.96	86.10	90.63	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 expense-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% levels, 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=	(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	-0.145***	-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 grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The main measure is defined as the sum of skilled wages and new grants relative to value added. The second measure is the expense-based 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% levels, 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(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 Heterogeneity Analysis

This table reports cross-industry heterogeneity analysis of the human capital share in a given year on investment goods prices at the 4-SIC industry level. We test for cross-industry heterogeneity by including in the specification an interaction term between investment goods prices and a dummy equal to one for high-skill intensity industries, which is measured based on the top quartile of the ratio of skilled workers to total workers. New grants (NG) are estimated based on the value of reserved shares. We report results for two measures of the human capital share. The main measure is defined as the sum of skilled wages and new equity grants relative to value added. The second is the expense-based measure using 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 15% of a standard deviation larger change in the NG share for high skill intensity industries relative to low skill intensity industries. 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 either time(year) or 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 6.2 for detailed variable definitions.

	Complementarity and Skills Splits					
	NG/VADD		(Skilled Wages+NG)/VADD		SG&A/VADD	
	(1)	(2)	(3)	(4)	(5)	(6)
	High-Low Skill Intensity		High-Low Skill Intensity		High-Low Skill Intensity	
Inv. Good Prices* $I^{\text{High Skill Ind.}}$	-0.146***	-0.099***	-0.087***	-0.028***	-0.202***	-0.114***
	(0.027)	(0.011)	(0.019)	(0.006)	(0.021)	(0.008)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Effects	No	Yes	No	Yes	No	Yes
N. of obs.	4,565	4,565	4,565	4,565	6,174	6,174
R^2(%)	19.70	64.92	33.03	85.92	10.92	70.16

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 sales at the firm level. 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% levels, 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 the 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% levels, 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: Two-Step Estimation

The table reports estimated parameters from the two-step estimation. As the first step, we estimate the first-order condition (22):

$$\log s_{h,j,t} - \log s_{k,j,t} \quad = \quad \frac{1}{1-\rho}\log\left(\frac{1-\alpha_k}{\alpha_k}\right) + \frac{\rho}{1-\rho}\log R^k_{j,t} - \frac{\rho}{1-\rho}\log R^h_j + \log\frac{1}{\omega_{R,t}} + \epsilon_{j,t},$$

where j stands for 4-SIC industry j. We perform a panel regression with industry and year fixed effect. We identify ρ from the coefficient of $\log R^k_{j,t}$, and then infer θ, the fraction of equity-based compensation due to human capitalists' marginal product given the mapping between ρ and θ plotted in Figure 7. Second, given the value of θ, we perform the standard MLE estimation for the system of equations (19) and (20) using the time series data. The table below reports the estimated parameters from the second estimation. We calibrated the following parameters: $\delta_k = 0.08$, $\delta_h = 0.15$, $\mu = 1.3$, and R_f is the time series of the real interest rate over the sample period. Human capitalists' income share is measured as the ratio of wage income $+NG$ to value added in this estimation. The sample period is from 1980 – 2005. Standard errors are in parentheses. Implied elasticities between human and physical capital, and between all capital and labor, respecitively, are given in the last row.

θ	ρ	α_k	α_c	σ
0.95	-3.76	0.12	0.55	0.25
—	(0.76)	(0.03)	(0.04)	(0.10)
	$\frac{1}{1-\rho}$=0.21			$\frac{1}{1-\sigma}$=1.33

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 compensation 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. Data source: Compustat Fundamental Annual (1960–1996) and RiskMetrics (IRRC) (1996–2005), and NBER-CES Manufacturing Industry Database (1960–2005). The sample period is from 1960 to 2005.

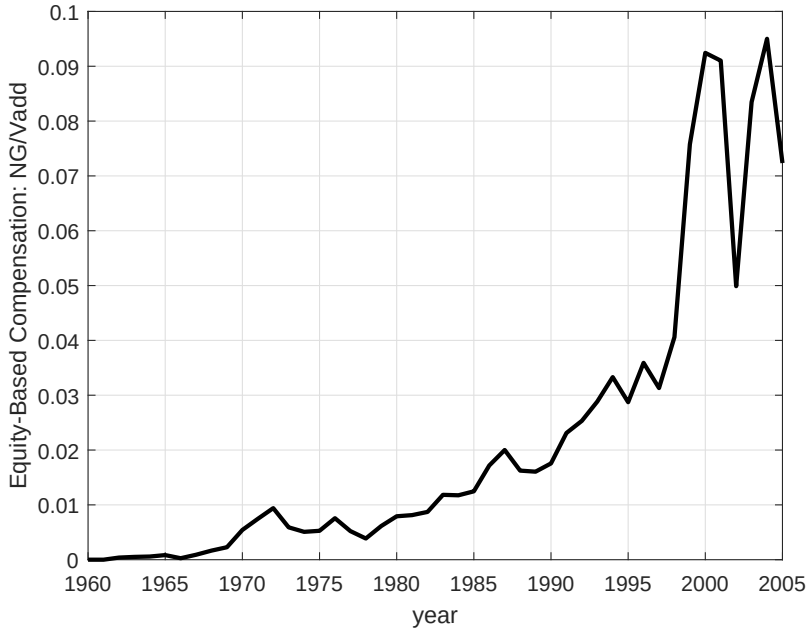

Figure 2: Ownership Share: Employee-Owned Fraction of Public Firms

The plot reports the time series of the ownership share: the ratio of the value of reserved shares for employee equity-based compensation to stock market capitalization. Data source: Compustat Fundamental Annual (1960–1996) and RiskMetrics (IRRC) (1996–2005). The sample period is from 1960 to 2005.

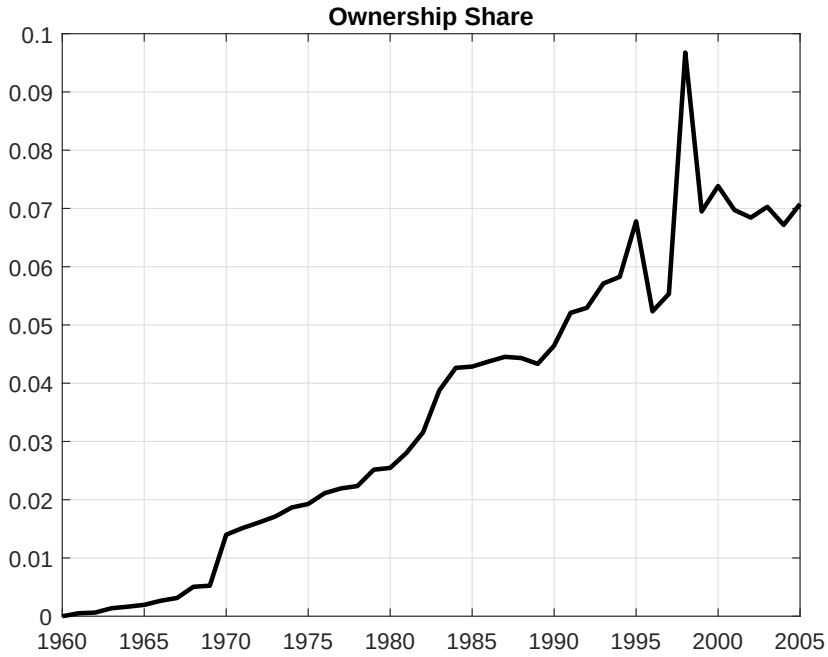

Figure 3: Human Capital Share of Income: Reserved Share Measure

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

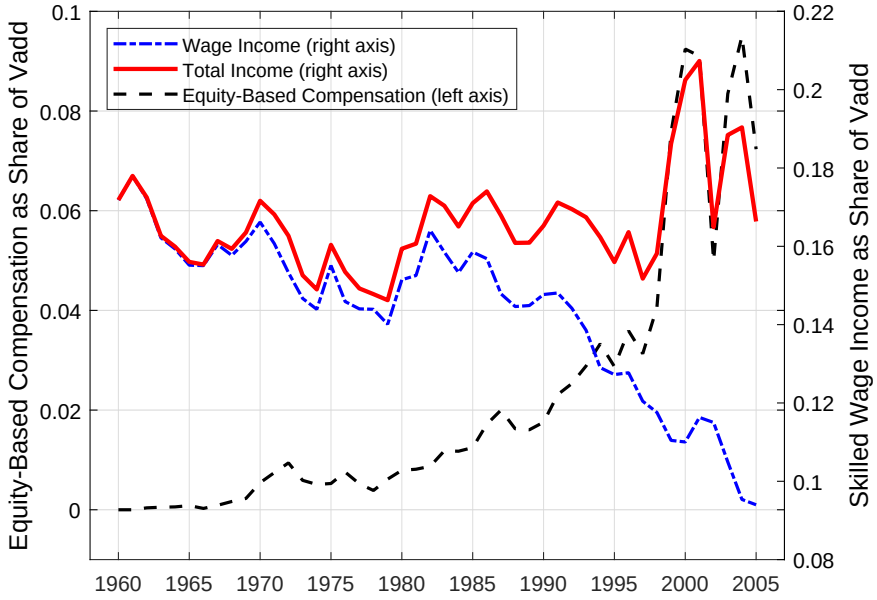

Figure 4: Measures of Equity-Based Compensation as a Fraction of Value Added

The plot reports the time series of our three grant-based measures and one expense-based measure of the aggregate equity-based ratio of compensation to value added. In the top left panel, the solid blue line NG/Vadd reports the annual flow of equity-based compensation using NG = RS/5, where 5 is the weighted average granting period. The the dotted red line NG(Actual GP) is the aggregate value of reserved shares divided by the actual average remaining life of RS on the balance sheets in the IRRC sample. In the top right panel, the dashed pink line BS/Vadd is the aggregate Black–Scholes value of newly granted stock options relative to value added constructed using the IRRC sample from 1996–2005. The solid blue line is NG=RS/5. In the bottom left panel, the annual flow is calculated as the raw change in RS= $RS_{t+1} - RS_t$ relative to value added. In the bottom right panel, the annual flow of equity-based compensation is the expense-based measure $0.3SG\&A$. Data source: Compustat Fundamental Annual (1960–1996), RiskMetrics (IRRC) (1996–2005), and NBER-CES Manufacturing Industry Database (1960–2005). The sample period is from 1960 to 2005.

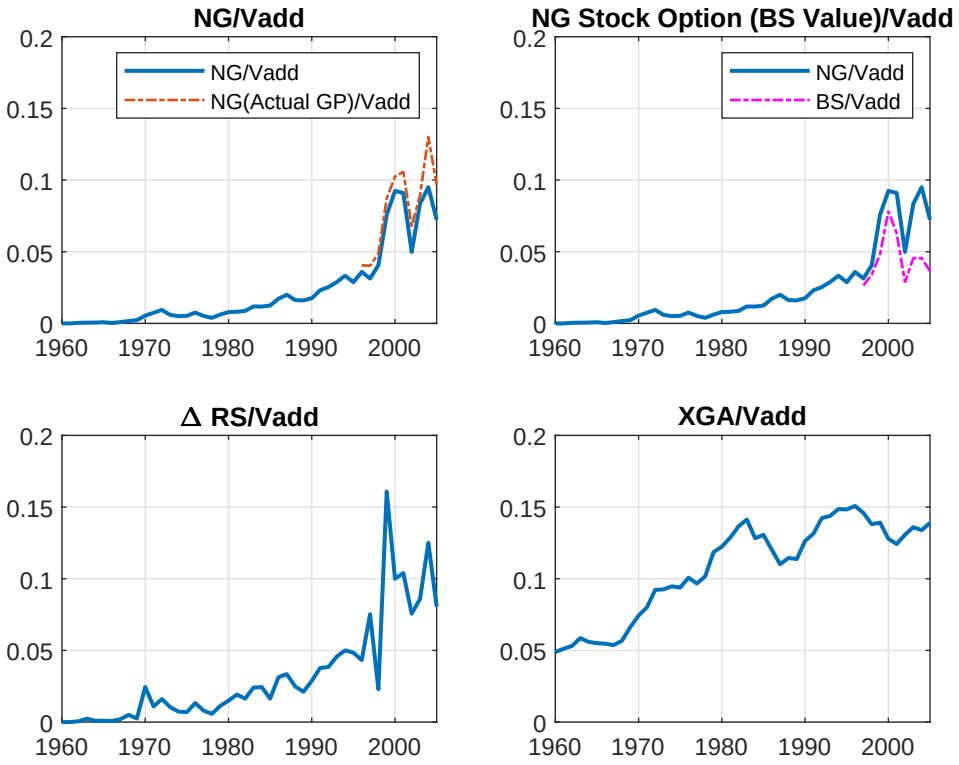

Figure 5: Factor Shares of Income and Investment Goods Prices

Total labor share is labor income divided by value added. We present both of the grant-based and the expense-based measures of human capital share of income. The grant-based total human capitalists' income share is the sum of the wage income share and the equity-based income share. The expense-based measure is the flow income share of human capitalists, defined as 30%S&GA by value added. Physical capitalists' income share is physical capital investment divided by value added. Profit share is operating profits (OIBDP) divided by value added. The aggregate investment goods price is the employment weighted average of industry-level investment goods prices. Data source: Compustat Fundamental Annual (1960–1996), RiskMetrics (IRRC) (1996–2005), and NBER-CES Manufacturing Industry Database (1960–2005). The sample period is from 1960 to 2005.

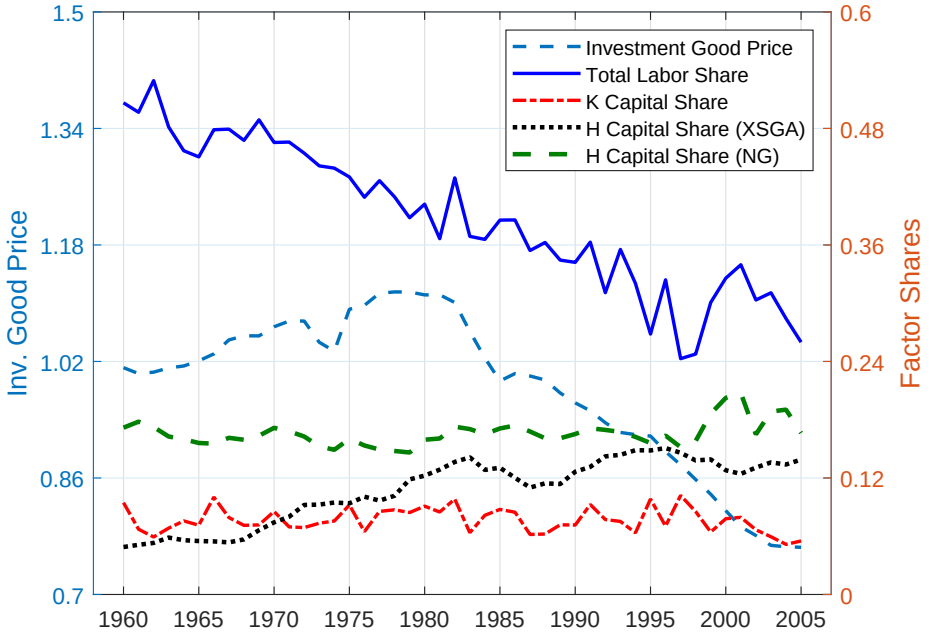

Figure 6: Aggregate Labor Share

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

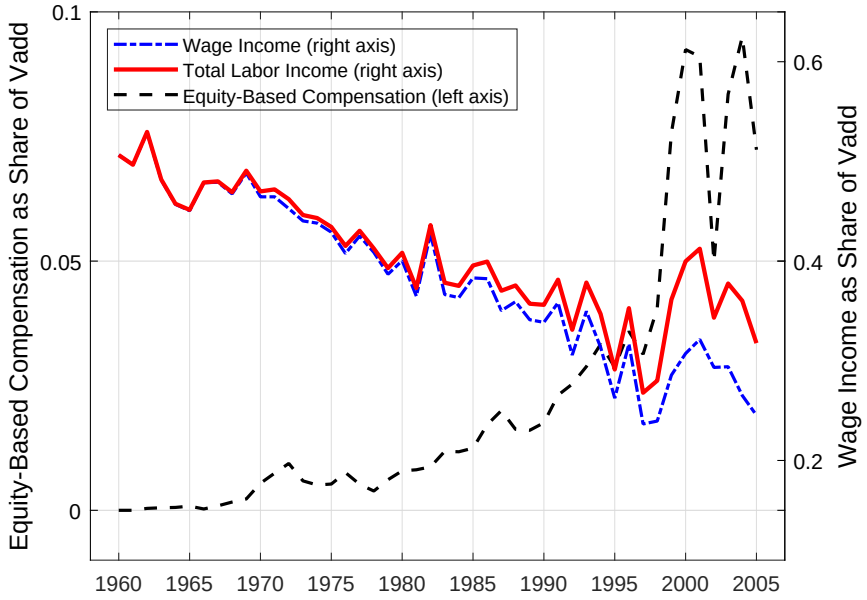

Figure 7: Elasticities of Substitution and Equity-Based Compensation

This figure shows estimates of parameters that govern the elasticity of substitution between physical and human capital ρ and the elasticity of substitution between capital and labor, σ, when allowing for different values of θ. In the top panel, the solid black line is the estimated ρ, where we apply a 2-year moving average to the target moment in the data. In the bottom panel, the solid black line is the estimated σ, where we apply a 2-year moving average to the target moment in the data. Data source: Compustat Fundamental Annual, RiskMetrics (IRRC), and NBER-CES Manufacturing Industry Database. The sample period is from 1980 to 2005.