Discussion by Gianluca Violante

This insightful paper by Eisfeldt, Falato and Xiaolan (EFX thereafter) introduces the concept of human capitalists, employees below the C-suite who receive a significant share of their pay as equity-based compensation. By collecting data on reserved shares across firms, this study documents the importance of this phenomenon in the corporate manufacturing sector. It then develops a theoretical equilibrium model to organize the correct income and value added accounting. Finally, it argues that acknowledging the existence human capitalists can change our view on two key macroeconomic questions: (i) the recent decline in the aggregate labor share is smaller than previously estimated; (ii) the degree of capital-skill complementarity in aggregate technology is stronger than we thought.

This is a paper of general interest because its findings are relevant for a number of diverse literatures in economics: the measurement of workers’ compensation, beyond wages; the prevalence of incentive-based pay and the design optimal labor contracts; the dynamics of the aggregate labor share; patterns of capital-labor substitution in the aggregate economy; intangible capital; and the nature of idiosyncratic labor market (or, as it is called in finance, background) risk. The paper provides new data, new facts and new insights that impact all these research areas where an accurate measurement of worker compensation, and how it relates to the marginal product of labor, is crucial.

I will organize my comments in five parts: (i) quick model recap; (ii) measurement of the skilled labor share of income; (iii) model identification; (iv) estimation of capital-skill complementarity; (v) relation to the literature on background risk.

1 Model recap

It is useful to recap the authors’ main model. In doing so I will use, at times, a slightly different notation from the authors’ one which serves better my purposes. I will focus on a version without product differentiation and monopolistic competition. Consider directly the dynamic problem of a firm. Let $k_t$, $h_t$ and $u_t$ be, respectively, the stock of physical and human capital, and the amount of unskilled labor in the firm, and let $r^k_t$, $r^h_t$, $r^u_t$ denote their rental rates, i.e. the compensation for services provided to the firm in period $t$ by each of these inputs. Let $f(k_t, h_t, u_t)$ be the firm production technology, $z_t$ be total factor productivity, and $y_t$ be firm’s output. Let $V_t$ be the total firm value, $v_t = V_t/h_t$ the firm value per unit of human capital, and $\beta$ its discount factor. The firm problem can be written as:

$$ V_t = \max_{h_t, k_t, u_t, \lambda, \theta} z_t f(k_t, h_t, u_t) - r^k_t k_t - r^h_t h_t - r^u_t u_t + \beta V_{t+1} $$

s.t.

$$ r^h_t + (1 - \lambda) v_t \geq r^h_t + \bar{v}_t $$

The first three terms in the value function determine firms profits, i.e. output net of remuneration to inputs $k_t, h_t$ and $u_t$, which are optimally chosen every period. All markets are competitive and frictionless, and thus the rental rates equal the marginal product of capital.

The remuneration of human capital services includes both monetary wage payments $w_t$ and equity-based compensation. Equity-based compensation is also needed for retention.
purposes: the firm faces the participation constraint (1) stating that the value promised by
the firm to the worker (a share $1 - \lambda$ of the total firm value) must at least equal its outside
option $\bar{v}_t$, e.g. the value of being employed at a competing firm. To retain the worker, the
firm chooses $(1 - \lambda)$ to satisfy that constraint with equality. The income from equity-based
compensation accruing to the worker in period $t$ for retention purposes is the flow value
$(1 - \lambda) \Delta v_t$.

If we let $e_t$ be the total equity-based compensation per unit of $h_t$ in period $t$, a share
$\theta e_t$ will be paid to human capitalists as compensation for their marginal product, i.e. $r^h_t = w_t + \theta e_t$. The residual share $(1 - \theta)$ is paid for retention purposes, i.e. $(1 - \theta) e_t = (1 - \lambda) \Delta v_t$.

2 Measurement of the skilled labor share of income

The total income share going to human capitalists $s^h_t$—or the skilled labor share—includes
wage payments and all equity-based compensation paid for both labor services and retention
purposes:

$$s^h_t = \frac{[w_t + \theta e_t + (1 - \lambda) \Delta v_t] h_t}{y_t} = \frac{W_t + E_t}{y_t}$$

where $W_t$ is the firm wage bill and $E_t$ is the total equity-based compensation paid to all
human capitalists in the firm. Note that, to measure the human capital share of income, $\theta$ does not matter since $(1 - \lambda) \Delta v_t = (1 - \theta) e_t$. The authors have information on the stock
of shares reserved for employee compensation for a wide cross section of firms and a long
time series of 60 years from 1960–2019. They also have information on the average vesting
period. They then measure the flow of equity based compensation in period $t$ as:

$$E_t = \# \text{ of reserved shares}_t \left\{ \frac{\text{average vesting period}}{\text{new grants}} \right\} \times \text{stock price}_t$$

This calculation, however, does not include capital gains or losses in the value of deferred
compensation due to fluctuations in stock prices. EFX are aware of this. In the Appendix,
they write: “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.” This position is shareable: the value
of stocks at the time of allocation best reflects the value of labor services and the value of
retention to the firm. At the same time, the current value reflects the realized earnings for
the worker, and cost to the firm, if the option were to be exercised. It seems therefore of
interest to ask how much their calculations would be affected by the inclusion of capital
gains.

Let $q_t$ be the number of reserved shares at $t$ and $p_t$ their price. Then $E_t = \Delta q_t p_t + q_{t-1} \Delta p_t$, where the second term captures capital gains/losses during the period. The skilled labor
share of income would then be augmented by the component

$$\text{capital gains}_t^{\text{income}} = \frac{q_{t-1} p_{t-1}}{y_t} \times \frac{\Delta p_t}{p_{t-1}}.$$
Figure 1: The evolution of the skilled labor shares computed in three ways. BEA/BLS is the naive computation without accounting for equity-based compensation. EFX is the authors’ calculation that abstracts from capital gains in the value of reserved shares. EFX + CAP GAINS includes capital gains as explained in the main text.

Assume $\frac{\Delta p_t}{p_{t-1}} = 0.05$, i.e. stock prices grow by 5% per year in real term, and abstract from short-term fluctuations. Figure 1 shows by how much the skilled labor share would change if EFX had incorporated capital gains, relative to their own calculations and to a definition of the labor share that ignores altogether the equity-based component of labor earnings, such as those of the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS). The cumulation of capital gains would have added another 2 pp to the EFX skilled labor share between 1970 and 2000 and made the gap with the BEA/BLS one even starker.

Another important question is the following: if we add income to skilled labor we must subtract it from other factors for consistency: which share would be reduced? The answer depends on accounting practices for stock-based compensation followed by firms when compiling their books. Unfortunately, over time practices have changed and even now there is no uniformly accepted rule. For example, Deloitte has a 500 page roadmap on how to properly account for share-based payment awards. They likely show up as profits in many books, but according to the current Generally Accepted Accounting Procedures (GAAP), stock-based compensation is a non-cash operating expense on the income statement. As such it could show up either in the wage bill of the firm (still, it would not be picked up by National Accounts, as explained by EFX) or in other operating costs related to investment in intangibles, e.g. R&D, marketing and advertising expenses. In the latter case, EFX provide support for the mechanism proposed by Koh et al. (2020). According to these authors, the decline in the labor share is directly linked to the rise of investment in intangibles, because on the income side of National Accounts statistical agencies attribute all the income corresponding to these intangible expenditures to capital. EFX document that part of this income is, in reality, deferred compensation to skilled labor and so, as argued by Koh et al. (2020), should be added back to the labor share.
3 Identification

The parameter $\theta$ is crucial in the analysis because it is required to compute the marginal product of skilled labor which, in turn, is needed to estimate the parameters of the production function. EFX postulate the following nested CES specification for the production function $z_t f(k_t, h_t, u_t)$:

$$y_t = z_t \left[ \alpha c \left( \alpha k_t^\rho + (1 - \alpha_k) h_t^\rho \right)^\frac{\sigma}{\sigma} + (1 - \alpha_c) u_t^\sigma \right]^{\frac{1}{\sigma}}$$

where $\rho, \sigma \in (-\infty, 1)$. Combining the optimality conditions for $k_t$ and $h_t$ in the firm problem (1) yields:

$$\frac{r^k_t}{r^h_t} = \frac{\alpha_k h_t^{\rho-1}}{(1 - \alpha_k) h_t^{\rho-1}}$$

From $r^h_t h_t = W_t + \theta E_t$, the definition of the skilled labor share in (2), and the definition of the capital share $s^k_t = r^k_t k_t / y_t$, we arrive at:

$$\log s^k_t - \log s^h_t = \log \left( \frac{\alpha_k}{1 - \alpha_k} \right) + \rho \log \left( \frac{k_t}{h_t} \right) + \log \omega^h_t (\theta)$$

where

$$\omega^h_t (\theta) = \frac{W_t + \theta E_t}{W_t + E_t}.$$

This relation shows clearly that, given data on factor shares and quantity of inputs, the estimate of $\rho$ depends on $\theta$, and vice versa. EFX approach this problem by attempting an estimation of $\rho$ through cross-industry variation and then, given $\rho$, they recover the value of $\theta$ which is consistent with the model evaluated at that estimate of $\rho$.

Using rental rates in (3) to substitute out input quantities in (4), and denoting industry with a subscript $j$ yields:

$$\log s^k_{jt} - \log s^h_{jt} = \text{constant} + \frac{\rho}{1 - \rho} \log r^h_{jt} - \frac{\rho}{1 - \rho} \log r^k_{jt} + \log \omega^h_{jt}$$

EFX make two assumptions reflected in the specification above: (A1) $r^h_{jt} = r^h_j$, i.e. the marginal product of human capital is time invariant and hence can be captured by industry effects in a panel regression; (A2) $\omega^h_{jt} = \omega^h_j$, i.e. $W_t, \theta, E_t$ are common across industries and can be captured by time effects. Thus $\rho$ is identified by exploiting variation of $r^k_{jt}$ which is directly measurable.

These two assumptions are quite strong. For example, it is quite possible that the rental rate of human capital vary over time, as aggregate supply and demand for $h_t$ change. Let’s consider what happens if this assumption is violated. The omitted variable in equation (5) is $\frac{\rho}{1 - \rho} \left( \log r^h_{jt} - \log r^h_j \right)$ which implies:

$$\frac{\hat{\rho}}{1 - \hat{\rho}} = \left( \frac{\rho}{1 - \rho} \right) \left[ 1 - \frac{\text{cov} \left( \log \left( \frac{r^h_{jt}}{r^h_j} \right), \log r^k_{jt} \right)}{\text{var} \left( \log r^k_{jt} \right)} \right].$$

If $r^k_{jt}$ and $r^h_{jt}$ comove positively over time (e.g., because of aggregate productivity shocks), then the term in the square bracket is less than one and $\hat{\rho}$ is downward biased.
It is also possible that different sectors use equity-based compensation to different degrees, for example because human capital specificity varies and, as a result, they face more or less severe retention issues. If A2 is violated, then $\omega_{jt}$ varies across industries and the omitted variable in equation (5) is $\log \omega_{jt} - \log \omega_t$ which implies:

$$\hat{\rho} - \hat{\rho} = \frac{\rho}{1 - \rho} - \frac{\text{cov} (\log (\omega_{jt}/\omega_t), \log r_{jt})}{\text{var} (\log r_{jt})}.$$

In this case signing the bias is more challenging without knowing more about cross-industry patterns in the data. If, for example, skill intensive industries (which display high $r_{jt}$ if physical and human capital are complements) face more severe retention issues (i.e., they feature low $\theta$, high $E_t$, and low $\omega_{jt}$), then $\hat{\rho}$ would be upward biased.

Thus, depending on which assumption is violated, the authors could under- or overestimate the degree of capital-skill complementarity. The good news is that the two biases, at least in my examples, push in opposite directions so hopefully they offset each other.

### 4 Capital-skill complementarity

One of the main findings of EFZ is that they find evidence of capital-skill complementarity only after adding equity-based compensation to the skilled labor share. Using the BEA/BLS definition of the labor share, they cannot reject a Cobb-Douglas specification in total capital and skilled labor. At first sight, this result seems to contradict the findings in Krusell et al. (2000), KORV thereafter, who used the “naive” definition of the labor share without accounting for equity-based compensation.

There is, however, a big difference between the authors’ analysis and KORV’s study in the definition of capital. EFX aggregate different types of capital in one capital input, whereas KORV explicitly distinguish between structures and equipment. KORV’s estimates
Table 1: GMM estimates of $\rho$ and $\sigma$ based on equation 6. Each column corresponds to a different combination of how capital is aggregated and how the skilled share is computed. Standard errors in parenthesis. The null hypothesis of the J test is that the instruments are valid.

<table>
<thead>
<tr>
<th></th>
<th>Capital aggregated</th>
<th>Equipment &amp; structures separated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Naive</td>
<td>Adjusted</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.513 (0.063)</td>
<td>0.341 (0.094)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.146 (0.070)</td>
<td>-0.467 (0.219)</td>
</tr>
<tr>
<td>p-value for J test</td>
<td>0.755</td>
<td>0.130</td>
</tr>
</tbody>
</table>

refer to complementarity between equipment and skilled labor. It is important, I’d argue, to separate these two inputs because the dynamics of their prices was vastly different over the past 60 years: equipment prices dropped dramatically, whereas the price of structures rose, relative to the price of consumption (Figure 3), a reflection of faster embodied technical change in equipment capital.

In this section, I will investigate how the KORV estimates of capital skill complementarity are modified when the skilled labor share is augmented with equity-based compensation. Recall the aggregate production function in KORV:

$$y_t = z_t k_{st}^\alpha \left[ \alpha_c (\alpha_k k_{et}^\rho + (1 - \alpha_k) h_t^\rho) \frac{\rho}{\sigma} + (1 - \alpha_c) u_t^\sigma \right]^{\frac{1 - \alpha_k}{\sigma}}$$

where $k_{st}$ is structures and $k_{et}$ is equipment. Under this technology, the expression for the skill premium is:

$$\log \left( \frac{w_{ht}}{w_{ut}} \right) = \text{constant} + \frac{\sigma - \rho}{\rho} \log \left[ \lambda \left( \frac{k_{et}}{h_t} \right)^\rho + (1 - \lambda) \right] + (1 - \sigma) \log \left( \frac{u_t}{h_t} \right). \quad (6)$$

I will use the data series in Ohanian et al. (2021) who extended the original dataset in KORV, which spanned 1963-1993, up to 2019. The dataset contains time series for wages, quality-adjusted capital equipment, structures, skilled labor and unskilled labor, relative price of equipment, and depreciation rates. I estimate various versions of equation (6) by GMM using as instruments lagged values for all the variables above (except wages).

First, like EFX, I bundle all capital together and estimate equation (6) with total capital (structures plus equipment) taking the place of $k_{et}$. The first column in Table 1 shows that I replicate their finding that using the naively computed skilled share, the data offer no support for capital-skill complementarity, i.e. the estimate for $\rho$ is slightly positive, but close to zero (the Cobb-Douglas case). As claimed by EFX, adding equity-based compensation to skilled wages (second column) restores total capital-skill complementarity, although my point estimate for $\rho$ is imprecise. If we, however, split capital between equipment and structures, even using the naive skilled share I do find evidence of equipment-skill labor complementarity. The third column of Table 1 shows that I estimate an elasticity of substitution between

1To add equity-based compensation to skilled wages in the Ohanian et al. (2021) dataset, I benchmark it to value added based on Figure 4 of the EFX paper.

2As shown in Table 1, the Sargan-Hansen J-test fails to rejects the null hypothesis that the instruments are orthogonal to the residuals.
equipment and skilled labor of 0.69 and an elasticity of substitution between the equipment-skilled labor composite and unskilled labor of 2.22. These two values are close to the original estimates in KORV, respectively 0.67 and 1.67. Finally, I augment the skilled share with equity-based compensation. I use a value of $\theta = 0.98$, the authors’ estimate. Now, the relative wages of skilled workers rise even further, but the equipment-skill ratio and the skilled-unskilled labor ratio in equation (6) are the same and thus, to account for the data, the elasticity of substitution between equipment and skilled labor must fall further to 0.589.

Overall, including equity-based pay in the compensation of skilled labor increases the estimates of capital equipment-skill complementarity, but not by much. Figure ?? plots data and model-implied skill premium under the naive and adjusted data on the skilled labor share.

5 Implications for uninsurable labor market risk

The findings by EFZ have some interesting implications for estimates of uninsurable individual earnings risk. The measurement of unpredictable fluctuations in individual earnings is a key input for a large class of incomplete market heterogeneous agent models, and an important source of welfare loss for households.

The typical empirical analysis in this literature uses datasets such as the Panel Study of Income Dynamics, Social Security Administration (SSA) records, or Internal Revenue Service tax returns that, as explained by the authors, do not properly account for equity-based compensation. One would expect this component of earnings to be more cyclical and volatile than base wages.

Differential exposure of labor earnings to the business cycle can be a channel of amplification or dampening of macroeconomic shocks in HANK models: the stronger the cross-
sectional correlation between marginal propensity to consume and the change in household income induced by the macro shock, the more this shock gets amplified. Figure 4, reproduced from Guvenen et al. (2017), shows the elasticity of individual labor income to aggregate labor income across the distribution. The elasticity is U-shaped. In particular, this elasticity is very high at the top. I conjecture that adding equity-based compensation would mostly affect the top decile of this plot, and would make it even more sensitive to aggregate income fluctuations.

Turning to idiosyncratic volatility, a recent paper by Braxton et al. (2021), documents that the volatility of the persistent component of earnings shocks is higher, and it has increased more since 1990, for skilled workers than for unskilled workers. The inclusion of equity-based compensation would strengthen both conclusions because this component is more volatile than base wages and because it has become a larger share of total labor income for skilled labor over time.
References


