Corporate Tax Cuts and the Decline of the Labor Share

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Abstract

We document a strong empirical connection between corporate taxation and the labor's share of income in the manufacturing sector across OECD countries. The estimates indicate that the decline in corporate taxes is, on average, associated with 40% of the observed decline in labor's share. We then present a model of industry dynamics where firms differ in their capital intensity as well as their productivity. A drop in the corporate tax rate reduces the labor share by shifting the distribution of production towards capital intensive firms. Industry concentration rises as a result, and firm entry falls, consistent with the US experience documented in Kehrig and Vincent (2017) and Autor et al. (2017). Calibration of the model to the US economy indicates that corporate tax cuts explain at least a third of the decline in labor's share in the US manufacturing industry.

Keywords: Labor Share, Corporate Taxation, Industry Dynamics, Industry Concentration

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1 Introduction

The recent literature has presented compelling evidence that labor's share of income has been declining across the world, with the most striking falls observed in industries that have traditionally been more capital intensive, such as manufacturing (see, for instance, Elsby et al. (2013), or Karabarbounis and Neiman (2013)).

In this paper, we show that the observed patterns in labor share coincide with a global downward trend in corporate tax rates. There is a strong correlation between the changes in the labor share and the corporate tax rates among OECD countries. Countries that reduced their corporate tax rates by more have also experienced a steeper decline in labor's share of income, especially in manufacturing where a 10 percentage point decline in the corporate tax rate is associated with a 2.2 percentage point drop in labor share.

Motivated by these results, we develop a general equilibrium model of industry dynamics to study the impact of declining corporate tax rates in US since the 1960s on labor's share of income in the US. The model features firms that differ in their capital intensity as well as their productivity. The equilibrium industry labor share is determined by the distribution of capital intensities among firms as well as their share of output in the industry, which in turn depends on the relative costs of capital and labor. With varying intensities, firms also differ in their elasticity of demand for capital. In this setting, a reduction in the corporate tax rate lowers the cost of capital, and disproportionately benefits the capital intensive firms. This leads to a concentration of output among capital intensive firms, resulting in a lower aggregate labor share. In equilibrium, a lower tax rate also raises industry output and puts an upward pressure on the real wage. Higher labor costs lead to a reduction in output, in particular for labor intensive firms. With endogenous exit, highly labor intensive firms are driven out of the industry, further amplifying the decline in the labor share. The average value of incumbent firms may increase or decrease depending on the gains from lower taxes relative to higher labor costs, and, therefore, the effect of reductions in tax rates on the overall entry rate remains ambiguous. In our quantitative exercise, however, we find that the decrease in corporate taxation entails a lower entry rate. This is due to the fact that after a tax cut the largest increases in firm value occur for the most capital intensive firms. At the same time, the firm distribution shifts towards capital intensive firms. Taken together, a smaller fraction of incumbent firms exits the industry.

Next, we provide quantitative predictions for the part of the decline in labor's share of income that can be attributed to the fall in the corporate tax rates. To that end, we calibrate the model to replicate the distribution of labor shares and valued added in US manufacturing in 1967, and simulate economies with lower tax rates. The results suggest that the observed decline in the effective marginal corporate tax rate has led to a roughly 7 percentage point drop in aggregate

labor share, or roughly 35% of the total decline in manufacturing.[1]

Our paper contributes to a budding literature on the causes of the decline in the labor share. Other reasons recently proposed in the literature include declining prices of capital equipment (Karabarbounis and Neiman, 2013), globalization and import competition Elsby et al. (2013) and declining market power (Autor et al., 2017), or as well as capital biased technical change (Alvarez-Cuadrado et al., 2018). Autor et al. (2017) and Autor et al. (2017) show that a large part of the decline took place within narrowly defined industries, through a reallocation of market size from labor intensive firms to capital intensive firms. They also document that within firm labor shares have remained relatively stable. Our model is consistent with these facts. While firms have constant-labor-share production functions, the industry level labor share depends on the distribution of value added among firms. Therefore, the industry level "macro" elasticity of substitution between capital and labor is higher than the firm-level elasticity.[2]

2 Empirical

In this section we empirically investigate the link between corporate taxation and the labor share. The first analysis is at the country level and covers the 1981 to 2006 period for a set of OECD countries. Data on labor share comes from the KLEMS database. Statistics on the corporate tax rates are taken from the OECD.[3] Globally, the aggregate labor share has fallen by 7.5 percentage points (pp) from 63.6% to 56.1% between 1981 and 2006. The decline is more pronounced in the manufacturing sector (10.3pp) relative to services (4.6pp). These patterns are shared by most countries. Of the 21 countries in our sample, 17 of them experienced a decline in their labor share, with some countries experiencing a decline of over 20pp.

During the same period, there have been significant cuts in corporate taxation. For the countries we observe throughout the sample period, the decline in the corporate tax rate has been 17pp on average. There is also a substantial variation in how much the corporate tax rate declined. The largest cuts are observed in Sweden and Ireland with a decline of over 30pp, and the smallest cuts are seen in Finland, Germany and Spain with under 5pp. For all countries, the average decline has been -0.70pp per year.

At a cross-sectional level, there is a strong correlation between the corporate tax rate and labor's share of income. Figure 1 shows a scatter plot of the two variables in 2007 for manufacturing and

[1]The figures mentioned here are obtained from a version of the model with exogenous entry and exit as the calibration of the model with endogenous entry/exit is not yet finalized.

[2]In related work, Oberfield and Raval (2014) finds that the aggregate elasticity of substitution is higher than micro-elasticity of substitution at the plant-level.

[3]We use statutory tax rates in our analysis. Our benchmark regressions below assume that the relative changes in the statutory tax rates are representative of the relative changes in the effective tax rates across countries.

Figure 1: Corporate Tax Rate and Labor Share in the Manufacturing Sector



Note.– Data shows the statutory corporate tax rate and the labor's share of income in 2007. Source: OECD and KLEMS.

services. The correlation coefficient is 0.58 for manufacturing and 0.36 for services. The fact that the correlation is higher for manufacturing is not surprising. Since labor costs are deducted from the corporate tax base, the tax burden essentially falls on capital. As a result, capital intensive sectors are more sensitive to the differences in the corporate tax rate.

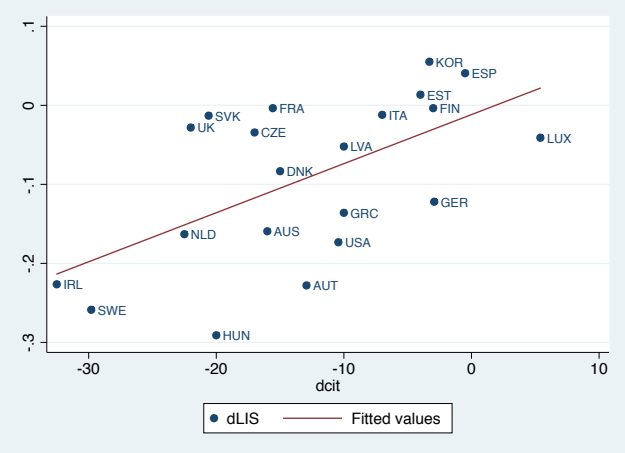
In Figure 2, we plot the changes in the labor share against the changes in the corporate tax rate by country. In the manufacturing sector, a stark positive correlation of 0.56 is seen between the two variables. Countries that implemented larger cuts in corporate tax rates experienced a faster fall in labor's share of income. The positive correlation between the tax rates and the labor share observed at the cross-sectional level does not, however, seem to translate to changes over time in the service sector.

To test the impact of corporate taxes on labor share more formally, we regress the the labor share on the corporate tax rate, controlling for fixed country and year effects. The results for manufacturing, services and aggregate labor shares are reported in Table 1. In manufacturing, the coefficient on the corporate tax rate is 0.37 with a standard error of 0.10, which implies a p-value of less than 1%. The labor share in services does not seem to respond to the tax rates in any significant way. These results confirm the visual inspection of Figure 2. On the aggregate, the result suggest that a 10pp drop in the corporate tax rate is associated with 1.7pp drop in a country's labor share.[4]

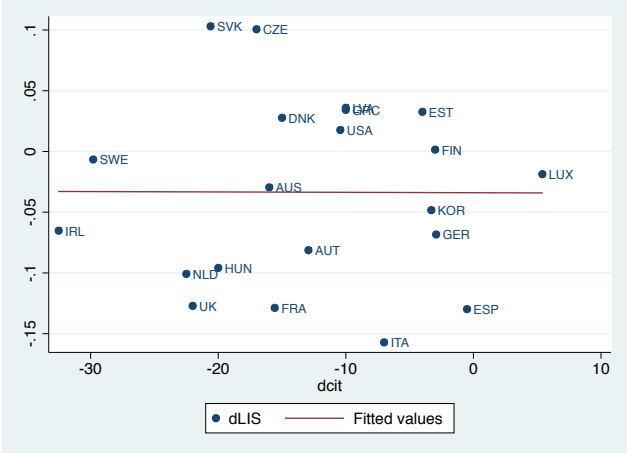
[4]In Table 1, we use a levels specification. An alternative would be to estimate a difference specification. To check the sensitivity of the results to specification, we regressed the 10-year changes in the labor share on the 10-year changes in the corporate tax rate. The coefficients are similar with 0.31 (0.11) for manufacturing, .08 (.05) for service and 0.16 (0.05) for the aggregate economy.

Figure 2: Trends in Corporate Tax Rate and Labor Share: 1981 - 2007

(a) Manufacturing



(b) Services



Note.– Data shows the changes in statutory corporate tax rate and the labor's share of income between 1981 and 2007. Source: OECD and KLEMS.

Table 1: Corporate Taxation and the Labor Share

	(1) Manufacturing	(2) Services	(3) Aggregate	(4) Manufacturing	(5) Services	(6) Aggregate
corporate tax rate	0.37^{**}	0.06	0.16^{**}	0.22^{**}	0.15^{*}	0.17^{**}
	(0.10)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
country trends	no	no	no	yes	yes	yes
N	528	528	528	528	528	528

* $p < 0.05$, ** $p < 0.01$

Note.– Data comes from KLEMS database and OECD 1981 to 2007. Dependent variable is labor's share of income. All specifications control for fixed year and country effects. Standard errors are clustered at the country level.

One concern with the results may be the presence of other factors that lead to a decline in the labor share, and that maybe correlated with changes in the corporate tax rate during the sample period. To address this concern to some extent Columns 4-6 in Table 1 include country-specific trends in the labor share for each sector. The coefficient of the corporate tax rate is therefore identified by the accelerations and decelerations in the pace of the decline of the labor share. For the manufacturing sample, the coefficient on the corporate tax rate is somewhat smaller at 0.22, but still statistically significant with a p-value of less than 1%. For services, allowing for country-specific trends reveals the impact of tax cuts to be significant at 5% with a coefficient of 0.15. The opposing changes in the sectoral coefficients leaves the coefficient for the aggregate economies unchanged at 0.17.

Given the observed declines in the tax rates, the coefficients obtained in Columns 4 and 5 of Table 1 imply that, on average, the corporate tax cuts are associated with approximately a 4.0pp drop in the manufacturing labor share and about 2.7pp drop in the service sector throughout the sample period. On the aggregate, corporate tax cuts are responsible for about 40 percent of the total observed decline in the labor share.

Our take away from the cross-country analysis is that there is a strong empirical link between corporate tax rates and labor's share of income in the manufacturing sector. A somewhat weaker relation, both in a statistical and in a quantitative way is observed in the service sector. Next, we turn to the US.

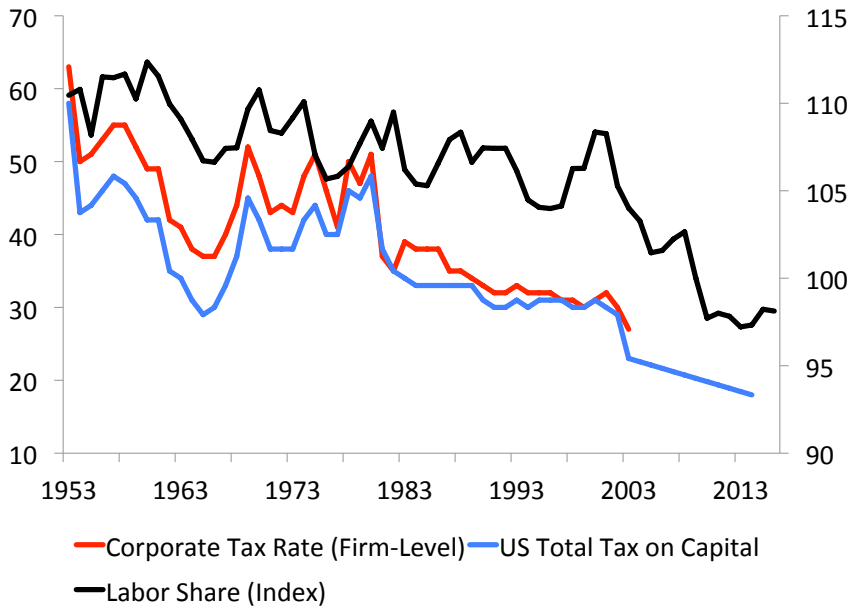
2.1 Labor Share in the US

The global trends in the labor share and corporate taxation are also mirrored in the US. Figure 3 shows the BLS labor share index for the aggregate economy along with the effective marginal tax rates (MTR) on corporations and on total capital reported by Gravelle (2004).[5] The labor share falls by 13.5% between 1953 and 2014. A similar fall is observed in the effective marginal corporate tax rate from over 50% in the 1950s to 27% in 2003. Including non-corporate entities, the effective MTR on capital falls from 58% in 1953 to 23% in 2003, the last year reported by Gravelle (2004). The Congressional Budget Office reports an effective MTR on capital of 18% for the US in 2014. This suggests that the decline in corporate taxation continued through the 2000s, when the labor share decline was steepest.

The trends in the two series hint at a positive association between capital taxes and the labor share. A more formal estimation of the impact of corporate taxes on labor share within a country is not straightforward, since the statutory tax codes are typically universal, calling for uniform taxation of all sectors and firms. We take a more structural approach. We first develop a model

[5]The total effective marginal tax rate on capital includes taxes on corporations, non-corporate entities as well as housing. See Gravelle (2004) for details.

Figure 3: Capital Taxation and Labor's Share of Income in US



Notes.– Figure shows the evolution the labor share and effective tax rates on capital in US. Labor share index is obtained from BLS. The effective capital tax rates are reported in percentages, and come from Gravelle (2004) for the years between 1953 and 2003. The US total tax rate on capital reflects a linear projection between 2003 and 2014 using the effective tax rate computed by CBS for 2014.

that captures the salient features of the US manufacturing industry in the 1960s, and then simulate counterfactual economies with lower corporate tax rates to gauge the impact of corporate taxes on the labor share

3 Model

The model we employ is a version of an industrial equilibrium model in the spirit of Hopenhayn (1992) and Hopenhayn and Rogerson (1993), modified to include heterogeneity in labor intensity.

Time is discrete and the horizon is infinite. The economy consists of a measure of heterogeneous firms, a representative household, and a government.[6] At time t, a positive mass of price-taking firms produces a homogenous output good with capital and labor. Firms differ in their productivity, ε, and their capital intensity, α. At time t a firm i with capital share α_i has the production function $q_{it} = \varepsilon_{it}({k_{it}}^{\alpha_i} {n_{it}}^{\beta_i})$. The production function displays diminishing returns to scale: $\alpha_i + \beta_i = \gamma < 1 \quad \forall i$ and the intensity of capital is time-invariant.

The time-varying productivity parameter ε_{it} is idiosyncratic to a firm, and follows the stochastic process described below:

$$\log \varepsilon_t = \rho \varepsilon_{t-1} + \sigma_\varepsilon \eta_t,$$

where $\eta_t \sim N(0,1)$ for all $t \geq 0$. Let $H(\varepsilon_{t+1}|\varepsilon_t)$ denote the conditional distribution of a firm's productivity. This process is assumed to be independent of a firm's capital share. ~~or.~~

Firms accumulate capital, hire labor services on the spot market at the wage rate w, and discount future profits with $\rho \in (0,1)$. Capital depreciates at rate $\delta \in (0,1)$. Operating firms incur an operational cost of $c_f > 0$ units of labor each period.

A linear corporate income tax τ is imposed on positive net firm income. The proceeds from taxation are redistributed to the representative household in a lump-sum fashion, ensuring a balanced budget at all times.

Each period firms may cease production and exit the industry. If they do so, they cannot reenter the market at a later period. They liquidate the remaining available resources and distribute them to its shareholders.

Every period there is a large mass of potential entrants, of whom a constant mass $M > 0$ enters the industry. Upon entry, firms draw an initial productivity level ε_0 from the density $H(\varepsilon)$ and a time-invariant value of α from the density $G(\alpha)$.[7] After entry, the evolution of firm productivity is

[6] Throughout the description of the model, we use the term 'firm' to describe a single unit. The data we use to calibrate the model is collected at the 'establishment' level. The two terms will be used interchangeably throughout the text.

[7] We assume that new entrants are drawing from the time-invariant distributions of productivity and the capital

governed by the conditional density $H(\varepsilon_{t+1}|\varepsilon_t)$, while α remains fixed. All entrants pay an entry cost $c_e \geq 0$ denoted in labor units. The decision to enter therefore trades off the entry cost wc_e with the expected value of an incumbent firm given the distributions $H(\varepsilon)$ and $G(\alpha)$.

The representative household supplies labor to the production sector in return for wage income, collects dividends from operational firms and the tax rebate, and consumes the output.

3.1 Incumbent Firm's Problem

An incumbent firm's state vector consists of its capital share α, the amount of available resources after production m, as well as the the level of future productivity ε. The timing of events is as follows: A firm observes the idiosyncratic productivity level ε for the next period before making an investment decision. Given m and ε the firm decides whether to exit the industry or continue operating. If the firm continues, it makes a capital investment for the next period. Labor is chosen statically, given k and ε. The value of a firm with capital-share α, available resources m, and future productivity ε is given by

$$V(m, \varepsilon, \alpha) = \max \left\{ V_x(m), V_c(m, \varepsilon, \alpha) \right\}, \tag{1}$$

with the value of exiting given by

$$V_x(m) = m, \tag{2}$$

and the value of continuing given by

$$V_c(m, \varepsilon, \alpha) = m + \max_{k,n} \left\{ -pk + \rho \mathbb{E}_{\varepsilon'|\varepsilon} V(m', \varepsilon', \alpha) \right\}. \tag{3}$$

The law of motion for the evolution of the available resources is given by

$$m' = \pi_b(m, \varepsilon, \alpha) - \tau \cdot \max \left\{ 0, \pi_b(m, \varepsilon, \alpha) \right\} + pk \tag{4}$$

where $\pi_b(m, \varepsilon, \alpha)$ denotes profits net of depreciation costs, i.e. the tax base, and is given by

$$\pi_b(m, \varepsilon, \alpha) = p\varepsilon k^{\alpha} n^{\beta} - wn - wc_f - p\delta k \tag{5}$$

Several features of this program merit discussion. The value function $V_x(m)$ in (2) says that if the firm decides to exit it pays out any available resources m to its shareholders. The value function $V_c(m, \varepsilon, \alpha)$ in (3) says that conditional on staying the firm chooses k and n to maximize the expected future value of the firm minus the cost of investment. The future value of the firm

share, $H(\varepsilon)$ and $G(\alpha)$.

depends on resources after production m', and on the expected value of ε'. Given $V_c(m, \varepsilon, \alpha)$ and $V_x(m)$, the firm decides whether to continue operating or to exit, represented by (1). Note that because m enters both the value of continuing and exiting it does not play a role in the exit decision of a firm.

Because of the presence of fixed costs of production, the exit behavior of a firm with a given level of α will be characterized by a cutoff value of productivity $\hat{\varepsilon}(\alpha)$. If the state variable ε, representing next period's productivity, is below the threshold described by $\hat{\varepsilon}(\alpha)$, the firm of type α will exit due to non-negative persistence in ε over time. The threshold is implicitly defined as the productivity level that equates the values of continuing and exiting. The policy function for exit will be denoted as $x(\varepsilon, \alpha)$.

$$\hat{\varepsilon}(\alpha) \ : \ V_c(m, \hat{\varepsilon}, \alpha) = V_x(m) \tag{6}$$

Equation (4) defines available resources in the next period. Profits net of depreciation, $\pi_b(m, \varepsilon, \alpha)$ constitute the tax base and are defined in (5). They are given by revenue minus wage costs and the labor-denominated fixed cost of operation. In line with the tax code in the U.S. and other developed countries, capital depreciation costs are also factored into the firm's tax base. The corporate tax τ applies to positive profits made by the firm. If profits are non-positive, a tax rate of zero is applied. This is captured by the $\max$ operator in (4).

3.2 Potential Entrant's Problem

Each period, there is a large mass of ex-ante identical potential entrants. A potential entrant starts operating if the value of entry exceeds the entry cost. The value function of a potential entrant is given by

$$V^e = \int \int V(0, \varepsilon, \alpha) dH(\varepsilon) dG(\alpha) - wc_e. \tag{7}$$

The entry cost is parameterized by a fixed cost c_e, denominated in labor units. This can be interpreted as a cost of setting up shop, finding a customer target group, etc.. Once the entry cost has been paid, the firm's permanent value of α and the initial productivity draw ε_0 are revealed. The new firm can then choose a level of investment for the first period of operation. The first term on the right-hand side of (7) represents the expected value of an incumbent firm of type i with $m = 0$ and an initial productivity level ε_0 minus the entry costs. This implies that the free-entry condition is given by

$$wc_e = \int \int V(0, \varepsilon, \alpha) dH(\varepsilon) dG(\alpha). \tag{8}$$

At any equilibrium with positive entry, equation (8) holds. A rise in the average value of an

incumbent firm attracts more entrants, and the equilibrium price level p falls to ensure that value of entry equals the cost of entry.

3.3 Distribution of Firms

We denote the distribution of incumbent firms defined over the space of capital share types, available resources, and productivity as $\mathbf{\Gamma}$. To describe the evolution of $\mathbf{\Gamma}$ over time due to entry, exit and productivity shocks, define $\mathcal{B}(\mathcal{M})$ for all Borel sets $\mathcal{M} \subset \mathcal{R}$ as follows:

$$\mathcal{B}(\mathcal{M}) = \{m : m'(m, \varepsilon, \alpha) \in \mathcal{M} \quad \text{for any } (\varepsilon, \alpha) \in (\mathcal{E} \times \mathcal{A})\}$$

Similarly, for sets $\mathcal{M} \times \mathcal{E} \times \mathcal{A} \subset \mathcal{R} \times \mathcal{R}_+ \times [0, 1]$, the measure of entrants is given by:

$$\mu(\mathcal{M}, \mathcal{E}, \mathcal{A}) = M \int_{\mathcal{A}} \int_{\mathcal{E}} dH(\varepsilon) dG(\alpha) \text{ and } m_0 \in \mathcal{M}, \text{ and } 0 \text{ otherwise.}$$

Given these definitions, the evolution of the distribution of firms is described as follows.

$$\mathbf{\Gamma}'(\mathcal{M}, \mathcal{E}, \mathcal{A}) = \int_{\mathcal{A}} \int_{\mathcal{E}} \int_{B(\mathcal{M})} (1 - x(\varepsilon, \alpha))\, d\mathbf{\Gamma}(m, \varepsilon, \alpha) dH(\varepsilon'|\varepsilon) dG(\alpha) + \mu(\mathcal{M}, \mathcal{E}, \mathcal{A})$$

3.4 Households

There is a representative household that derives utility from consumption and disutility from labor. The income of the representative household consists of earnings, dividends and transfers from the government. They choose the supply of labor hours to maximize their utility:

$$\max_{c,n} \frac{c^{1-\sigma}}{1-\sigma} - \theta \frac{n^{1+\phi}}{1+\phi} \qquad s.t.\ c = wn + d + T$$

Since investment decision is handled by firms, the household's problem is static.

3.5 Competitive Equilibrium

A stationary recursive competitive equilibrium consists of value functions $V(m, \varepsilon, \alpha)$, $V_c(m, \varepsilon, \alpha)$ and $V_x(m)$, policy functions $k(m, \varepsilon, \alpha)$, $n(m, \varepsilon, \alpha)$, $m'(m, \varepsilon, \alpha)$, and $x(\varepsilon, \alpha)$, a price p, labor supply $L^s(w)$, a measure of incumbent firms $\mathbf{\Gamma}$ and a measure of entrants μ such that:

1. $V(m, \varepsilon, \alpha)$, $V_c(m, \varepsilon, \alpha)$, $V_x(m)$, $k(m, \varepsilon, \alpha)$, $n(m, \varepsilon, \alpha)$, $m'(m, \varepsilon, \alpha)$ and $x(\varepsilon, \alpha)$ solve the incumbent firm's problem.

2. The free entry condition (8) is satisfied

3. The labor market clears at w:

$$\int \left[n(m,\varepsilon,\alpha) + c_f\right] d\mathbf{\Gamma} + Mc_e = L^s(w)$$

4. The financial market clears at:

$$d = \int \left[\pi_b(m,\varepsilon,\alpha) - \tau \cdot \max\{0, \pi_b(m,\varepsilon,\alpha)\} + m - (1 - x(m,\varepsilon,\alpha)) \cdot k(m,\varepsilon,\alpha)\right] d\mathbf{\Gamma}$$

5. Government budget is balanced:

$$T = \tau \int \max\{0, \pi_b(m,\varepsilon,\alpha)\} d\mathbf{\Gamma}$$

6. The distribution of incumbent firms is stationary: $\mathbf{\Gamma}' = \mathbf{\Gamma}$.

The fourth condition above defines the total amount of dividends paid to the representative household. Dividends are given by profits net of taxes plus available resources minus new capital investments in case that the firm is not exiting for all firms.

We assume that the government's budget balances each period. This implies that the total amount of tax revenue which is reimbursed to the representative household in a lump-sum manner is given by the total amount of taxes raised from all firms.

3.6 Characterization of Equilibrium

We now characterize the equilibrium of the model. To keep the main workings of the model transparent we begin with the special case of $c_f = 0$, i.e. without fixed costs of operation. This ensures that firm income net of depreciation is always non-negative, and avoids kinks in factor demand functions caused by loss provisions that otherwise complicate the notation without adding much to the intuition of the model. This special case furthermore implies that there will be no endogenous exit. We return to the full model described in Section 3 further below.

From (3) the first order conditions for labor and capital demand of a continuing firm are:

$$\rho \mathbb{E}_{\varepsilon'|\varepsilon}\left[V_{m'} \frac{\partial m}{\partial n}\right] = 0 \tag{9}$$

$$-p + \beta \mathbb{E}_{\varepsilon'|\varepsilon}\left[V_{m'} \frac{\partial m}{\partial k}\right] = 0 \tag{10}$$

Noting $V_{m'} = 1$, and substituting the relevant partial derivatives and re-arranging gives the following optimality conditions for capital and labor:

$$\bar{w} \equiv \frac{w}{p} = \beta \varepsilon k^{\alpha} n^{\beta-1} \tag{11}$$

$$r_{\tau} \equiv \frac{1-\rho}{\rho \cdot (1-\tau)} + \delta = \alpha \varepsilon k^{\alpha-1} n^{\beta} \tag{12}$$

These equations reflect the factor demands by each firm, where r_{τ} denotes the gross user cost of capital as a function of the discount rate, the corporate tax rate and the depreciation rate. Solving the system above, the policy functions for labor and capital can be written as

$$n(m, \varepsilon, \alpha) = \left[\frac{\beta^{1-\alpha}\alpha^{\alpha}}{\bar{w}^{1-\alpha} r_{\tau}^{\alpha}}\right]^{\frac{1}{1-\gamma}} \varepsilon^{\frac{1}{1-\gamma}} \tag{13}$$

$$k(m, \varepsilon, \alpha) = \left[\frac{\beta^{\beta}\alpha^{1-\beta}}{\bar{w}^{\beta} r_{\tau}^{1-\beta}}\right]^{\frac{1}{1-\gamma}} \varepsilon^{\frac{1}{1-\gamma}} \tag{14}$$

Combining these functions, a firm's production is given by

$$q(m, \varepsilon, \alpha) = \varepsilon^{\frac{1}{1-\gamma}} \left(\frac{\alpha}{r_{\tau}}\right)^{\frac{\alpha}{1-\gamma}} \left(\frac{\beta}{\bar{w}}\right)^{\frac{\beta}{1-\gamma}}. \tag{15}$$

A firm's taxable income is given by (5) evaluated at the optimal policy functions:

$$\Pi_b(m, \varepsilon, \alpha) = \varepsilon^{\frac{1}{1-\gamma}} p^{\frac{1-\alpha}{1-\gamma}} \cdot \left[\left(\frac{\alpha}{r_{\tau}}\right)^{\alpha} \left(\frac{\beta}{w}\right)^{\beta}\right]^{\frac{1}{1-\gamma}} \left(1 - \beta - \delta\frac{\alpha}{r_{\tau}}\right) \tag{16}$$

A couple of remarks are in order. First, note that the cost elasticities of output depend on the labor share parameter. The distribution of output across firms therefore depends on the relative costs of capital and labor. Capital intensive firms (higher α) are relatively more sensitive to changes in the cost of capital, and less sensitive to changes in the cost of labor. Consequently, a decrease in the corporate tax rate τ, by lowering the cost of capital, leads to a ceteris paribus stronger increase in output in more capital intensive firms. Second, the price level, p, enters equations (13) - (15) only through the real wage rate, which affects the relative factor costs differently for firms with different capital intensities. Third, taxable income is monotonically increasing in the capital share parameter α since it includes payments to capital (net of depreciation costs) in addition to economic profits. As a result, capital intensive firms typically have a higher value to shareholders.

Note that in (15) and (16) taxes τ enter through r_τ.[8] After-tax profits are then simply given by

$$\Pi_a(m, \varepsilon, \alpha) = (1 - \tau) \cdot \Pi_b(m, \varepsilon, \alpha). \tag{17}$$

The value of the firm becomes

$$V(m, \varepsilon, \alpha) = \Pi_a(m, \varepsilon, \alpha) + \rho \mathbb{E}_{\varepsilon'|\varepsilon} V(m', \varepsilon', \alpha). \tag{18}$$

Here the max operator from (1) has disappeared because with $c_f = 0$ there is no endogenous exit. The free-entry condition is given by (8). Labor market clearing requires that total labor demand equal supply. Labor demand is composed of productive labor as well as the entry costs, which are denominated in labor units. The scalar M denotes the mass of entrants.

$$M \mu w c_e + M \int n(m, \varepsilon, \alpha) d\tilde{G} = N^s \tag{19}$$

The equations above are sufficient the convey the main mechanism of the decline in the labor share in the model. A drop in the corporate tax rate lowers the cost of capital, and fosters additional output, especially by capital intensive firms. This is accompanied by a higher demand for labor and capital among these firms. The increase in the demand for labor raises the equilibrium real wage. Since labor intensive firms are more sensitive to changes in the real wage rate, they shrink further, resulting in the concentration of the industry among capital intensive firms.

3.7 Endogenous Exit and Operational Losses

Endogenous exit requires that the fixed cost of production be positive, $c_f > 0$. In addition, this generates a discontinuity in the factor demand functions. On the margin, small investments do not generate large enough sales to compensate fixed costs, resulting in net losses. Since profits are taxed at rate τ, the marginal cost of investment makes a jump when investment is large enough to generate profits. Effectively, first few dollars of investment is tax-free for each firm.

In Appendix A we characterize the equilibrium for the more general case of $c_f > 0$. The quantitative results presented in the next section are for the case of exogenous exit.

Next, we calibrate our model to the US economy.

4 Quantitative Results

Our objective is to use the model in order to assess the ability of the decrease in the corporate tax rate τ over the last 50 years to explain the decline in the aggregate labor share. We therefore

[8] In (16) we re-wrote output in terms of the nominal wage w instead of the real wage $\bar{w}$.

calibrate the model to match salient features of the 1967 US manufacturing sector.

For this section we assume an exogenous labor supply by households, which we normalize to one.

4.1 Results with Exogenous Exit

We start by calibrating the model to an economy with an exogenous entry and exit. We choose an exit rate of 10%.[9] The fixed cost of operation c_f is set to zero for this exercise.

4.2 Calibration

A model period corresponds to one year. The discount rate ρ is set to 0.96. The depreciation rate is set to 0.10. The extent of decreasing returns to scale at the firm-level is set to 0.85 (Restuccia and Rogerson (2008)). The wage is the numéraire. We set the corporate tax rate to $\tau = 52\%$ as in Gravelle (2004). In the experiment which we carry out below, we reduce τ to 18%, which is the estimate of the marginal effective tax rate on capital for 2014 provided by the CBO. These parameter choices are summarized in Table 2.

Parameter	Value	Interpretation	Reason
δ	0.1	Depreciation Rate	—
γ	0.85	Returns to Scale	—
ρ	0.96	Discount Factor	Annual $r \approx 4\%$
w	1	Wage	Numéraire
τ	0.52	Corporate Income Tax	Value from 1969

Table 2: Non-Calibrated Parameters

The remaining parameters are calibrated indirectly using a simulated method of moments (SMM) procedure. This is summarized in Table 3. We estimate five parameters using five target moments. The first three parameters to be estimated govern the idiosyncratic productivity process ε. We use the average firm size (in employees), as well as two employment concentration measures from the 1967 Census of Manufacturing as targets. These are the fraction of employment in the bottom 65% of firms and the fraction of employment in the largest 4.25% of firms. We choose those numbers because the 1967 Census of Manufacturing reports concentration measures

[9]There exists by now a well-documented decline in the rate of establishment entry and exit over time, which this version of the model with exogenous entry and exit will not be able to generate. The exogenous exit rate we choose comes from the U.S. Census' BDS manufacturing data between 1977 and 1979.

for various size-class bins.[10]

In order to calibrate the distribution of labor shares across firms in 1967 we use information from the 1970 Statistical Abstract of the United States, the 1967 Census of Manufacturing as well as the evidence presented in Kehrig and Vincent (2017). The authors document the amount of concentration in the labor share and total value added across establishments with different labor shares, which we use as a calibration target.[11] More specifically, we assume that labor shares β follow a symmetric triangular distribution across firms. This distribution is characterized by two parameters, an upper and a lower bound. Since β cannot exceed γ, this parameter determines the upper bound. The lower bound $\underline{x}$ will be determined by targeting the aggregate labor share in 1967, which was equal to 55.6%. Finally, we find the entry cost c_e that generates the same ratio of the median labor share weighted by value-added to the unweighted median labor share as reported by Kehrig and Vincent (2017).[12] This value was equal to 0.886 in 1967, implying only a modest amount of concentration of total value added in establishments that have below-median labor shares. The entry cost c_e implies a price p from (8).

Unlike the standard industry dynamics model with common labor shares, the price now interacts in a non-linear fashion with firms' heterogeneous levels of α. To see this, consider a different way of combining pre-tax income in (16):

$$\Pi_b(m,\varepsilon,\alpha) = \varepsilon^{\frac{1}{1-\gamma}} p \left[\left(\frac{\alpha}{r_\tau} \right)^{\alpha} \left(\frac{\beta}{w/p} \right)^{\beta} \right]^{\frac{1}{1-\gamma}} (1 - \beta - \frac{\alpha\delta}{r_\tau}) \tag{20}$$

It is clear that the price p determines the real wage w/p and therefore the relative prices of capital and labor. A higher price p (i.e. a lower real wage w/p) disproportionately benefits firms with a high labor share β and shifts the median value added weighted labor share upwards. Because the unweighted median labor share is determined through the lower bound $\underline{x}$, the effect of c_e on the price identifies the targeted moment.[13]

[10]The precise information coming from the 1970 Statistical Abstract of the United States is that 60.05% of total manufacturing employment in 1967 was located in establishments with 250 or more employees. These establishments account for 4.25% of all firms. Similarly, the smallest establishments (<20 employees) made up 65% of establishments but only represented 5.6% of employment.

[11]In the model, output corresponds to value added.

[12]The median labor share denotes an unweighted median across establishments. The median value added weighted labor share says that 50% of all value added is produced by establishments with a labor share lower than or equal to this value.

[13]This non-linearity is the reason why the entry cost c_e cannot be normalized in our setup as in Restuccia and Rogerson (2008)

Parameter	Value	Targets from 1967	Data	Model
ρ_ε	0.745	Employment in smallest 65% of establishments	0.056	0.056
σ_ε	0.195	Employment in largest 4.25% of establishments	0.601	0.600
μ_ε	0.569	Average Firm Size	60.50	60.50
$\underline{x}$	0.301	Aggregate labor share	0.556	0.556
c_e	14.50	VA-weighted p50(LS)/median(LS)	0.886	0.905

Table 3: Simulated Method of Moments

4.3 Quantitative Results

Figure **??** shows the distribution of labor shares and value added in our model and in the 1967 Census of Manufacturing as presented in Kehrig and Vincent (2017).[14]

Our model matches two important features of the data. First, the distribution of labor shares does not show any significant signs of skewness towards either high- or low-labor share firms. Secondly, the distribution of value added is slightly skewed towards firms with low labor shares. The extent of this skewness is captured by the ratio of the median value-added weighted labor share and the median labor share discussed above. As shown in Figure 4, the extent of this skewness is slightly exaggerated in our model.

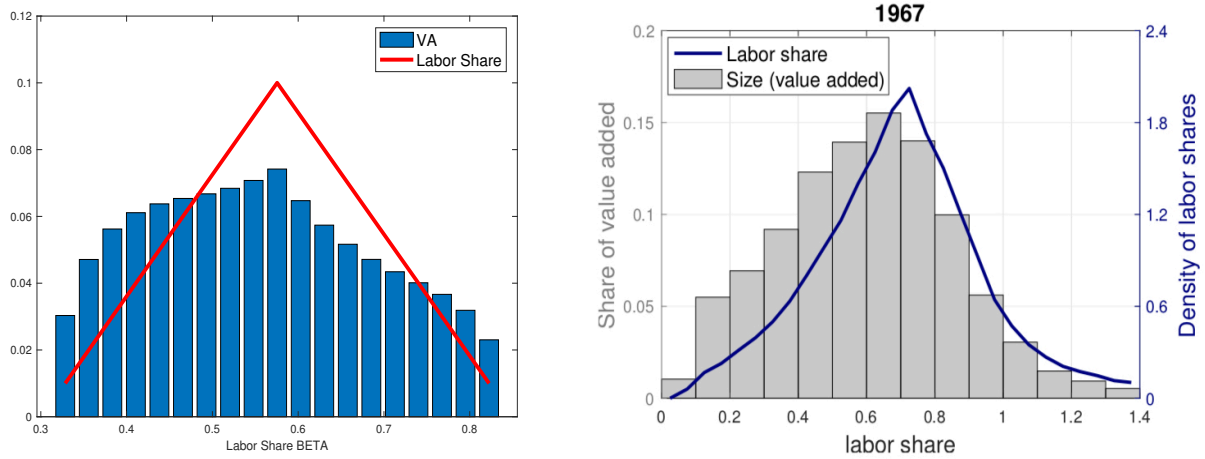


Figure 4: The joint distribution of labor shares and value added. On the left are results from our model. The figure on the right is taken from Kehrig and Vincent (2017).

[14]Note that the scales of both the x-axes and the y-axes are different in the two figures.

4.4 Policy Experiment

We now consider a fall in the corporate tax rate τ from 52% to the 18% rate observed in 2014. A decrease in τ will decrease the cost of capital. However, this will disproportionately benefit firms with a high capital share because these firms are more intensely using the factor whose relative cost is declining. We thus expect a shift of production to more capital-intensive firms, implying a drop in the labor share and an increase of concentration. This is precisely what we find. Our results are summarized in Table 4.

Moment	Benchmark	Post tax reform
Aggregate labor share	0.556	0.485
Price Level p	0.872	0.643
Aggregate Real Output Q^*	1.665	2.173
Employment in smallest 65% of establishments	0.056	0.049
Employment in largest 4.25% of establishments	0.600	0.625
VA-weighted p50(LS)/median(LS)	0.905	0.666

Table 4: Policy Experiment: A drop in Corporate Taxes

The first row reports our key finding. **The effect on the aggregate labor share is a decline from 55.6% to 48.5%**, i.e. a decline of over seven percentage points. This is more than a third of the total decline of the manufacturing labor share between 1967 and the late 2000's.

The total decline in the labor share can be decomposed into two parts: a direct, partial equilibrium effect, and an indirect, general equilibrium effect. The first effect comes from the decrease in the corporate tax rate, which lowers the cost of capital. Recall that this cost is given by $r_\tau \equiv \frac{1-\rho}{\rho\cdot(1-\tau)} + \delta$. This implies that for firms with positive profits (which is all firms in the model with exogenous exit and $c_f = 0$) the cost r_τ declines as a result of the decrease in τ. Ceteris paribus, this increases the demand for capital and labor in all firms. However, because of the heterogeneity in firms' capital shares, firms that employ more capital benefit more from the decrease in the cost of the factor of production they are using more intensively. As the more capital-intensive firms' output (value added) grows in relation to the less capital-intensive firms, the aggregate labor share falls.

The second effect concerns the adjustment of the equilibrium price level p following the tax cut. For a given price level, a decrease in the corporate tax rate raises aggregate output supply. Consequently, the price level falls to clear the goods market. Another way of interpreting the fall in p is through the free-entry condition (8). A lower cost of capital increases the average value of an incumbent firm. For the free-entry condition to hold, it must be that the price falls. A consequence of the fall in p is an increase in the real wage w/p. Ceteris paribus, this decreases the labor

Effect	Effect on Labor Share
Drop in r_τ	-4.06pp
Drop in p	-3.42pp

Table 5: Decomposing the Decline in the Labor Share due to a fall in τ

demand of all firms. However, the increase in the cost of labor disproportionately affects the most labor-intensive firms, causing these firms to shrink, both in terms of value added and employment. Similar to the drop in r_τ, the drop in p acts to shift production away from labor-intensive firms and therefore exerts negative pressure on the aggregate labor share.

Table 4 shows the results from two counterfactual experiments to gauge the magnitudes of these two effects. In the first row, we report the labor share in a simulated economy, where the price level is held fixed as the corporate tax declines. The effect of the tax decrease is now solely transmitted through a lower r_τ. The effect on the aggregate labor share is a decline of 4.06 percentage points. In the second row, we maintain a fixed corporate tax rate, but reduce the price level to its post-reform equilibrium level. The effect on the aggregate labor share is a decline of 3.42 percentage points.

Aggregate output increases by 30.5% as a result of the decrease in taxes. This effect is due to the reallocation of production towards firms with lower labor shares.

This reallocation also leads to an increase in industry concentration. The fraction of employment concentrated in the smallest 65% of firms falls from 5.6% to 4.9%. At the same time, the largest 4.25% firms now employ 62.5% of total employment (compared to 60% prior to the change). The value added weighted median labor share falls to 38.31% (from 52.04% before the tax decrease).[15]

Figure 5 illustrates the changes in the joint distribution of labor shares and value added. On the left, we show the distribution coming from our model after the reduction in the corporate tax rate. On the right, we have added the corresponding figure that shows data for the year 2007, the most recent data in Kehrig and Vincent (2017).

5 Conclusion

[15]Note that with exogenous entry and exit the median unweighted labor share stays constant. This implies the change reported in the sixth row of Table 4. Kehrig and Vincent (2017) report a decline in the value-added weighted median labor share from 62% in 1967 to 32% in 2007. Our results in Table 4 indicate that 48.9% of this increase in the concentration of output in firms with low labor shares can be explained by decreases in corporate taxes.

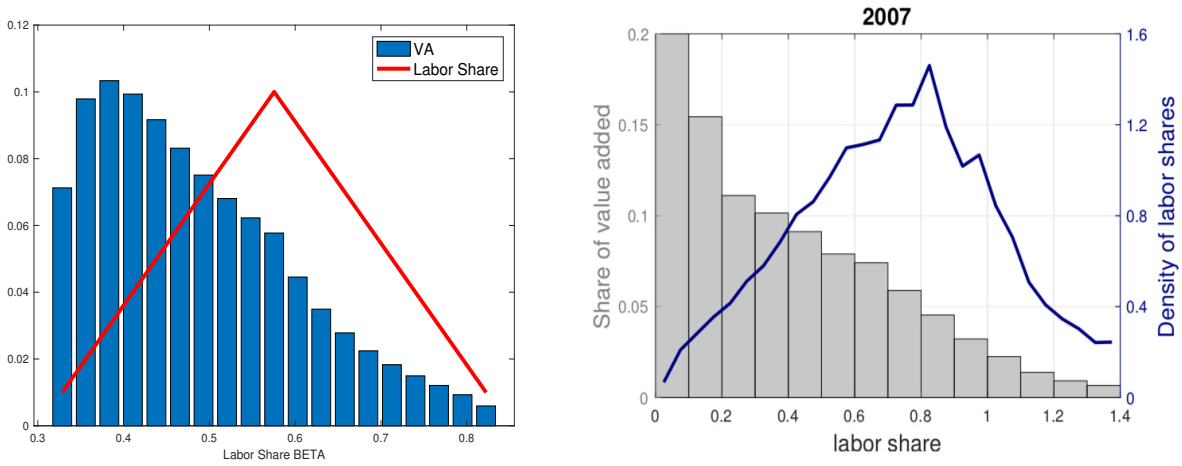


Figure 5: The joint distribution of labor shares and value added. On the left are results from our model. The figure on the right is taken from Kehrig and Vincent (2017).

A Characterization of Equilibrium when $c_f > 0$

With positive fixed costs of operation the equilibrium is characterized by the following equations. While the first-order condition with respect to labor remains unchanged, we now add an indicator function to the first-order condition for capital.

$$r_\tau \equiv \frac{1-\rho}{\rho \cdot (1-\tau \cdot \mathbb{1}^\tau)} + \delta = \alpha \varepsilon k^{\alpha-1} n^\beta \tag{21}$$

The indicator function $\mathbb{1}^\tau$ is equal to one if the firm is subject to corporate income tax and zero otherwise. This indicator depends on the firm's productivity level, as well as the chosen values of k and n.

The expression for pre-tax income is the same as in (16) but now includes the fixed cost of operation. In addition, we are making the dependence on τ explicit by adding the superscript.

$$\Pi_b^\tau(m, \varepsilon, \alpha) = \varepsilon^{\frac{1}{1-\gamma}} p^{\frac{1-\alpha}{1-\gamma}} \cdot \left[\left(\frac{\alpha}{r_\tau} \right)^\alpha \left(\frac{\beta}{w} \right)^\beta \right]^{\frac{1}{1-\gamma}} \left(1 - \beta - \delta \frac{\alpha}{r_\tau} \right) - w c_f \tag{22}$$

Similarly to the type-dependent exit threshold in productivity, $\hat{\varepsilon}(\alpha)$, derived above, there now exists another productivity cutoff, which determines whether a firm pays corporate income tax. This threshold will be denoted as $\tilde{\varepsilon}(\alpha)$. In particular, let $\tilde{\varepsilon}(\alpha)$ denote the level of productivity such that pre-tax income is zero. Solving for the tax-threshold $\tilde{\varepsilon}(\alpha)$ gives

$$\tilde{\varepsilon}(\alpha) = \left(\frac{w c_f}{\Delta(m, \varepsilon, \alpha, 0)} \right)^{1-\gamma} \frac{1}{p^{1-\alpha}}, \tag{23}$$

where we have defined production minus wage and depreciation costs as a function of taxes as

$$\Delta(m, \varepsilon; \alpha, \tau) = \left[\left(\frac{\alpha}{r_\tau} \right)^\alpha \left(\frac{\beta}{w} \right)^\beta \right]^{\frac{1}{1-\gamma}} \left(1 - \beta - \delta \frac{\alpha}{r_\tau} \right). \tag{24}$$

Note that $\Pi_b^0(m, \tilde{\varepsilon}(\alpha), \alpha)$, i.e. pre-tax income evaluated at $\tau = 0$, is different from $\Pi_b^\tau(m, \tilde{\varepsilon}(\alpha), \alpha)$, i.e. pre-tax income evaluated at any $\tau > 0$. This is because, from the marginal investor's perspective the investment in capital is not taxed until is large enough to generate profits. This was not reflected in (16) which had assumed that every unit of investment was subject to the same costs r_τ. This leads us to the following generalized expression for pre-tax income.

$$\Pi_b^*(m,\varepsilon,\alpha) = \Pi_b^0(m,\varepsilon,\alpha)\mathbb{1}_{\varepsilon<\tilde{\varepsilon}(\alpha)} + \mathbb{1}_{\varepsilon\geq\tilde{\varepsilon}(\alpha)}\left[\Pi_b^\tau(m,\varepsilon,\alpha) + \Pi_b^0(m,\tilde{\varepsilon}(\alpha),\alpha) - \Pi_b^\tau(m,\tilde{\varepsilon}(\alpha),\alpha)\right] \tag{25}$$

Up until the point where ε is large enough to be paying taxes, the tax rate $\tau = 0$ is used, implying that the indicator $\mathbb{1}^\tau$ used in (21) is equal to zero. Once productivity has reached the critical level $\tilde{\varepsilon}(\alpha)$ the indicator becomes one, as the firm starts paying taxes, while the last two terms in (25) correct for a level shift. All of the remaining policy functions have to be corrected in an identical fashion.

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