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Intermediate Input Prices and the Labor Share

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ABSTRACT

We argue that the relative price of materials is an important determinant of the labor share of income. When materials and primary inputs are complements and the profit share is positive, a higher price of materials lowers the labor share and raises the profit share of value added, without requiring markups or returns to scale to change. We show that materials-price fluctuations align with U.S. labor-share trends, provide causal evidence on this mechanism across industries and commuting zones, and quantify its importance in a dynamic quantitative model. Finally, we use our mechanism to rationalize differential labor-share trends across countries.

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1 Introduction

The labor share of income in the United States has experienced significant changes in the past several decades. Despite extensive research on the topic, the literature has struggled to explain some important patterns in the dynamics of the labor share. In particular, it is unclear why the labor share declined so sharply in the 2000s, why it stabilized in the following decade, and why the decline was absent from many service sectors. To shed light on these patterns, we propose a new mechanism that explains medium-term fluctuations in the labor share, focusing on the price of materials in the economy. Our study is motivated by a strong negative correlation between the price of materials and the labor share in the data. Figure 1 presents this relationship at the aggregate level for the United States in the past 50 years, plotting the labor share alongside the relative prices of both unprocessed and processed intermediate goods. We argue that fluctuations in the price of materials can help to reconcile differences across sectors and countries, and introduce a "long-cycle" component in the labor share's dynamics, bridging the large literature that documents a long-term decline with the few papers that suggest a cyclical behavior.[1]

We start by theoretically exploring under what conditions the price of materials affects the labor share. Since the labor share is defined out of value added, which excludes payments for intermediates, this relationship is not obvious. We show that when the profit share of revenues is positive and materials are complementary to primary inputs, an increase in the relative price of materials raises their share in production costs, leading to a higher profit share in value added and a decline in the shares of both labor and capital. A positive profit share of revenues can arise from markups or non-constant returns to scale. Importantly, the effect does not rely on rising markups or changes in returns to scale, and is consistent with recent research documenting a fall in the capital share parallel to the labor share.[2]

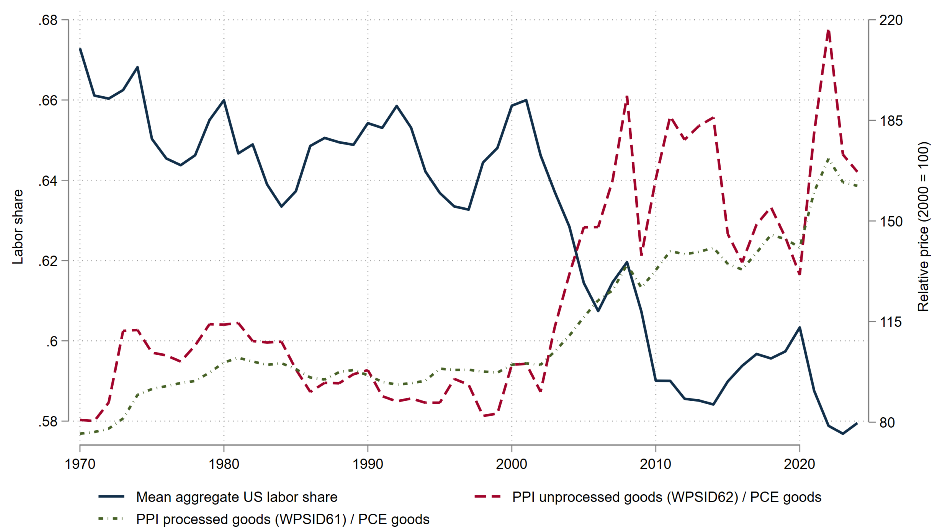
We derive a closed-form expression for the elasticity of the labor share to the price of materials in a setting with constant elasticity of substitution between materials and primary inputs and a constant profit share of revenues, and then generalize it to settings with a general production function, variable profit shares (e.g. due to variable

[1]See Koh, Santaeulàlia-Llopis, and Zheng (2020) and Barro (2021) for this claim.

[2]See Barkai (2020).

markups), and fixed costs. We also show that this partial-equilibrium mechanism carries over to multiple general equilibrium environments – a roundabout production economy, a two-sector economy, and a small open economy – in all of which higher materials prices lower the labor share when the profit share is positive ex-ante and materials are sufficiently complementary to primary inputs.

Figure 1: Trends in the Aggregate Labor Share and Relative Price of Materials



Note: The solid line shows the mean of four measures for the U.S. aggregate labor share – see Section 3 for more details. The dashed line is the ratio of the PPI for unprocessed goods for intermediate demand (FRED series WPSID62) to the PCE index for goods. The dot-dashed line is the ratio of the PPI for processed goods for intermediate demand (FRED series WPSID61) to the PCE index for goods. Both relative price series are normalized to 100 in 2000.

We investigate the above mechanism using multiple sources of variation. We first demonstrate that materials-intensive U.S. sectors experienced both larger increases in material input prices and sharper declines in their labor share during the 2000s. We then focus on U.S. manufacturing – where the decline was particularly pronounced – and show that the ratio of labor compensation to materials expenditure fell in lockstep with rising materials prices, providing direct evidence of our proposed mechanism. To obtain exogenous variation, we construct a shift-share instrument based on industry exposure to globally traded commodities, using input-output tables to map commodity prices into industry-level shocks. Across narrowly defined manufacturing industries and commuting zones, we find a robust negative relationship between materials prices and the labor share. We provide a structural interpretation of these estimates through the lens of our theory, linking them to the degree of complementarity between materials and primary inputs and to profit rates. In a back-of-the-envelope calculation, we assess that changes in materials prices can account for around a third of the changes in the labor share in recent decades.

As a further validation, we exploit the 1970s oil shock as a second natural experiment, using industry-level energy intensity as an instrument, and obtain comparable results. Although energy prices spiked during the 1970s, the increase in the relative price of the overall materials bundle was much smaller than in the 2000s (as can be seen in Figure 1), consistent with the more moderate decline in the labor share over that period; we discuss this in detail in Section 3.8. Finally, we also develop an alternative instrument based on natural disaster shocks in major commodity-exporting countries, which provides a fundamentally different source of exogenous variation and also yields similar estimates.

As a complementary exercise to assess the aggregate relevance of our mechanism, we develop a dynamic model with capital accumulation for U.S. manufacturing. We invert the model period-by-period to recover time-varying fundamentals – including markups, capital intensity, and productivity terms – from observed data on factor shares, investment, capital, and output. Counterfactual experiments that hold materials prices constant at their baseline level while allowing all other fundamentals to follow their observed paths indicate that rising materials prices account for 25–33% of the decline in the manufacturing labor share over the 2000s. Importantly, this approach allows us to isolate the role of materials prices from competing narratives such as rising markups or automation, addressing the concern raised by Grossman and Oberfield (2022) that many proposed explanations for changes in the labor share are not mutually exclusive.

While the price of commodities has nominally increased across the globe since the 2000s, countries have experienced different trends in their labor share. We develop a simple multi-country trade model with a global commodity market in which countries experience different changes in their *relative* price of materials despite a common nominal price, leading to heterogeneous effects on the labor share. We verify these predictions using data from the EU-KLEMS dataset: the U.S. and Japan experienced both a large increase in the relative price of materials and a larger decline in their manufacturing labor share, while Europe saw a relatively stable labor share alongside a close-to-constant relative price of materials. Extending our analysis to a cross-country panel, we again find a negative relationship between the relative price of materials and the labor share.

Related Literature. Our main contribution is to the recent literature studying changes in the U.S. labor share. One strand of this literature has focused on neoclassical explanations, suggesting that the share of capital in value added has risen. Examples include Elsby, Hobijn, and Şahin (2013), Karabarbounis and Neiman (2014), Acemoglu and Restrepo (2018), Grossman, Helpman, Oberfield, and Sampson (2021), and Hubmer (2023). Relatedly, Oberfield and Raval (2021) study labor-share movements through changes in the wage-rental ratio and a residual "bias of technical change" component.[3] Our mechanism is most closely related to the one in Karabarbounis and Neiman (2014) and Hubmer (2023), in which a change in the relative price of inputs alters their mix in total costs. However, we do not require the capital share to rise. Moreover, the mechanism in these papers relies on the elasticity of substitution between capital and labor being greater than one – a contested finding in this literature.[4] By contrast, the theoretical restrictions that are required for our mechanism to take place (complementarities between materials and primary inputs and positive profit shares) are consistent with available studies in this literature (e.g. Atalay 2017, Boehm, Flaaen, and Pandalai-Nayar 2019, Oberfield and Raval 2021, and Peter and Ruane 2025).

A second group of explanations suggests that broad technological changes have led to an increase in the share of income from rents, either through rising price-cost markups or labor market power. Examples include Barkai (2020), De Loecker, Eeckhout, and Unger (2020), Gouin-Bonenfant (2022), Aghion, Bergeaud, Boppart, Klenow, and Li (2023), and Autor, Dorn, Katz, Patterson, and Van Reenen (2020). We relate to this literature by suggesting a mechanism that leads to a higher share of profits in value added, without requiring a rise in firms' markups or markdowns.[5] A

[3]Specifically, Oberfield and Raval (2021) decompose labor share movements into a component driven by the wage-rental ratio and a residual "bias of technical change" component. In our framework, with a positive profit share, changes in materials prices are an additional source of labor-share variation even when the wage-rental ratio is unchanged and there is no factor-biased technical change.

[4]See Glover and Short (2020) and Oberfield and Raval (2021) for evidence that capital and labor are complements.

[5]Some studies, including Autor et al. (2020) and Kehrig and Vincent (2021), have emphasized the importance of within-industry firm heterogeneity, showing that the downward trend is much less pronounced for the median firm. While we focus on industry or regional outcomes, our theory predicts heterogeneous responses amplified by the

related explanation, proposed by Philippon (2019) and Gutiérrez and Piton (2020), emphasizes changes in the U.S. institutional environment; as discussed in Section 5, our mechanism offers an alternative account of cross-country heterogeneity that does not rely on institutional changes.

Most of the above studies take the stance that there has been a long-term decline in the U.S. labor share. Some papers, notably Atkeson (2020), Koh et al. (2020), and Barro (2021), claim that this long-run trend is no longer clear after correctly accounting for intellectual property and intangible capital in the national accounts. Our paper is consistent with these corrected series, which still exhibit significant medium-term fluctuations (e.g. the 2000s drop and subsequent rebound) that our mechanism can explain.

Finally, we also relate to the literature on aggregate elasticities of substitution across inputs in production, and in particular papers that consider the degree of substitution between materials and primary inputs. While this is not the focus of our study, we get results that align with Atalay (2017), Baqaee and Farhi (2019), Boehm et al. (2019), Oberfield and Raval (2021), Peter and Ruane (2025), and Hassler, Krusell, and Olovsson (2021), that suggest strong complementarities between materials and primary inputs in the manufacturing sector. In this context, we utilize booms in global commodity prices as our main source of identification, and complement it with the 1970s oil shock and with natural disaster shocks in major commodity-exporting countries as alternative sources of exogenous variation.

Throughout the paper, we use the term "materials" to refer broadly to intermediate goods – both processed and unprocessed – and include energy goods in this definition. We refer to unprocessed goods or raw materials as a subcategory that drives much of the variation in the prices of the overall materials bundle, and rely on such variation as a source of identification, particularly when analyzing the global commodity boom in the 2000s. We mostly abstract from sourced services, although a similar mechanism can operate through this margin.[6]

The rest of the paper is organized as follows. Section 2 investigates theoretically the link between materials prices and the labor share. Section 3 describes the identi-

profit share, with ex-ante low labor share firms experiencing greater declines. Empirically, our results are virtually unchanged when controlling for industry concentration dynamics.

[6]Sourced services are often thought of as being gross substitutes for in-house production. In this case, a decline in the relative cost of outsourcing can lead to a decline in the labor share through a similar mechanism.

fication strategy, the data, and the empirical results of our study of the relationship between the labor share and the price of materials across U.S. sectors, industries, and local labor markets. In Section 4 we develop a dynamic quantitative model with capital accumulation and use it to quantify the importance of our mechanism for the decline of the manufacturing labor share. Section 5 investigates our mechanism in a cross-country setting, both theoretically and empirically. Section 6 concludes.

2 Theoretical Framework

In this section, we provide theoretical conditions for a negative relationship between the price of materials and the labor share. We consider firms that produce using three factors: labor l, capital k, and materials m. Throughout, we denote the labor share out of value added by λ and the share of factor i in variable costs by θ_i.

2.1 Environment

Technology. A firm produces gross output y using capital k, labor l, and materials m according to

$$y \leq \Big(F\big(A_K k,\ A_L l,\ Bm\big)\Big)^{\zeta}, \tag{1}$$

where F is a constant-returns-to-scale production function; $\zeta \in (0,1]$ governs returns to scale in measured variable inputs; and (A_K, A_L, B) are factor-augmenting technology shifters.[7]

Cost minimization. The firm takes input prices (w, r, p_m) and technology as given, and chooses (k, l, m) to minimize variable costs conditional on producing y:

$$C(w, r, p_m; y) \equiv \min_{k,l,m} \Big\{ rk + wl + p_m m :\ y \leq \big(F(A_K k, A_L l, Bm)\big)^{\zeta} \Big\}. \tag{2}$$

Since F is CRS, the cost shares $\theta_l \equiv wl/C$, $\theta_k \equiv rk/C$, and $\theta_m \equiv p_m m/C$ depend on factor prices and technology shifters only through the ratios w/A_L, r/A_K, and p_m/B.

Revenue, profits, and the profit share. Let $R \equiv py$ denote revenue and define profits (or factorless income) as $\Pi \equiv R - C$. We summarize the gap between revenue and variable cost with the *profit share of revenues*, $\pi \equiv \Pi/R = (R - C)/R$.

[7] As emphasized by Diamond, McFadden, and Rodriguez (1978), factor-augmenting technical change creates an identification challenge, since factor-specific productivity shifts can be observationally similar to movements along an isoquant. This issue is relevant for our empirical strategy, and we return to it in Section 2.6 and Appendix A.1.

We remain agnostic about the source of $\pi > 0$ throughout most of the analysis, but lay out two microfoundations below.

Value added and the labor share. Let $M \equiv p_m m$ denote total expenditure on materials and $Y \equiv R - M = py - p_m m$ denote value added. Using $C = (1-\pi)R$ and $M = \theta_m C$, we can write $Y = \left(\frac{1}{1-\pi} - \theta_m\right) C$. The value-added labor share is

$$\lambda \equiv \frac{wl}{Y} = \frac{\theta_l C}{\left(\frac{1}{1-\pi} - \theta_m\right) C} = \frac{(1-\pi)\,\theta_l}{1-(1-\pi)\,\theta_m}. \tag{3}$$

2.2 Baseline result with CES production function

We now specialize the production function to a constant elasticity of substitution (CES) structure between materials and a primary-input composite:

$$F\big(A_K k,\, A_L l,\, Bm\big) = \Big(G(A_K k,\, A_L l)^{\frac{\sigma-1}{\sigma}} + (Bm)^{\frac{\sigma-1}{\sigma}}\Big)^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

where σ is the elasticity of substitution between materials and primary inputs and $G(A_K k, A_L l)$ is a flexible bundle that combines effective capital and labor under constant returns to scale.[8]

Totally differentiating (3) and incorporating the firm's optimal choice of inputs under the CES structure, we obtain the following result:

Proposition 1. *Under the CES production function in* (4) *and a constant profit share* π*, the elasticity of the labor share to the price of materials is given by*

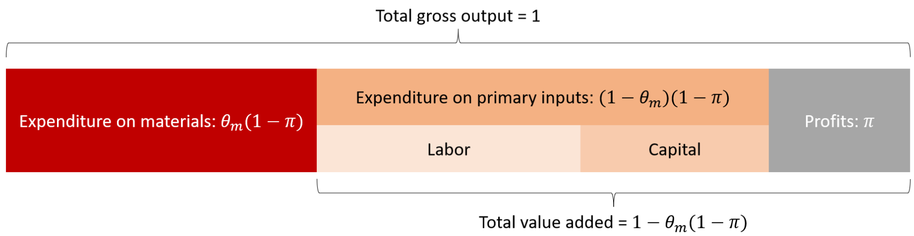
$$\frac{d\log\lambda}{d\log p_m} = -\,(1-\sigma)\,\frac{\pi}{1-\pi}\frac{M}{Y}, \tag{5}$$

where σ *is the elasticity of substitution between materials and primary inputs;* π *is the profit share in gross revenue;* $M \equiv p_m m$ *is total expenditure on materials; and* $Y \equiv py - p_m m$ *is total value added.*

Proof. See Appendix A.1. □

[8] A well-known result in growth theory is that balanced growth – i.e., a path along which factor shares are constant – requires the growing component of technology to be purely labor-augmenting whenever G is not Cobb–Douglas (see, e.g., Uzawa, 1961; Acemoglu, 2003). This is nested in our specification: balanced growth corresponds to the case in which A_K is constant and A_L grows over time, with B potentially growing as well.

Figure 2: Distribution of Output and Value Added



According to Proposition 1, an increase in the price of materials, holding other input prices and technology constant, leads to a lower labor share if two conditions hold: (i) materials and primary inputs are complements ($\sigma < 1$),[9] and (ii) the profit share is positive ($\pi > 0$). In addition, the transmission of higher material prices to the labor share is stronger under a higher ex-ante profit share and higher materials intensity M/Y. These features align with the concentration of the labor share's decline in materials-intensive sectors such as manufacturing. They also align with the key role of low labor share firms in this trend, which in our framework are firms with higher ex-ante profit shares, as documented in Kehrig and Vincent (2021).

Intuition. To provide further intuition, consider how total revenues are distributed between profits, expenditure on materials, and expenditure on primary inputs, as illustrated in Figure 2. First, note that the profit share in total revenues, π, is independent of how variable costs are allocated between materials and primary inputs: it is determined by the gap between revenue and total cost, which depends on the curvature of demand and/or the degree of returns to scale, not on the composition of variable costs. Second, note that the share of primary inputs in total revenues is $(1-\theta_m)(1-\pi)$, which declines when the cost share of materials θ_m increases. Combining these two observations, an increase in the price of materials p_m, in the presence of complementarities, shifts revenue away from primary inputs and toward materials, while leaving the profit share in revenue unchanged. This raises the profit share of value added. Importantly, the absolute level of profits can still decline, as long as expenditure on primary inputs declines by even more.

An extreme version of this mechanism arises as $\theta_m \to 1$. In that limit, nearly all

[9] By "complements" we mean gross complementarity: when $\sigma < 1$, an increase in the relative price of one input raises the expenditure share of that input, corresponding to an elasticity of substitution below the Cobb–Douglas benchmark.

variable costs are absorbed by materials, value added becomes small relative to gross output, and the labor share of value added approaches zero. One can thus think of a world with high material prices, or more generally a high materials share, as one in which a larger share of total income is associated with the intermediary role of firms, leaving less for primary factors.

2.3 Microfoundations for the profit wedge

Proposition 1 requires a positive profit share $\pi > 0$ but is agnostic about its source.[10] We briefly discuss two standard ways from which a positive π can arise.

Assume that the production function features constant returns to scale ($\zeta = 1$) and the firm charges a price-cost markup $\mu > 1$ (e.g. under monopolistic competition). Since revenues exceed costs by a factor of μ, we have $R = \mu C$ and the profit share is $\pi = 1 - 1/\mu$. Suppose instead that the technology has decreasing returns ($\zeta < 1$) and markets are competitive. Total factor payments equal only a fraction ζ of revenue, so $C = \zeta R$ and $\pi = 1 - \zeta$. This case does not require imperfect competition, and decreasing returns alone generate a positive profit share. More generally, with both decreasing returns and a markup, $\pi = 1 - \zeta/\mu$.

A positive wedge between price and average variable cost alone is not sufficient for $\pi > 0$, however, if the firm must also cover fixed costs. Suppose total cost is $C + F_C$, where C is variable cost and F_C is a fixed labor cost. Net economic profit is $\Pi = R - C - F_C$, and letting $\omega \equiv F_C/C$, the net profit share is $\pi = 1 - (1 + \omega)/\mu$. Positive economic profits therefore require $\mu > 1 + \omega$.[11]

2.4 Generalizations

We now explore generalizations of the elasticity of the labor share to the price of materials derived in Proposition 1.

General production function. First, consider a general production function $F(k, l, m)$ rather than the CES production function in (4).[12] The elasticity of the

[10] If a fraction of gross profits is redistributed to workers (e.g. through profit-sharing or stock-based compensation), π should be interpreted as the profit share net of this redistribution. Formally, if workers receive a share ϕ_l of profits, Proposition 1 holds with $\pi/(1-\pi) = (\mu - 1)(1 - \phi_l/\lambda)$, where λ is the measured labor share inclusive of profit-sharing income.

[11] A positive markup over variable cost can therefore coexist with zero economic profits when fixed costs drive a wedge between marginal and average cost (Rotemberg and Woodford, 1995).

[12] We assume that F is continuous, monotone, quasi-concave, and twice differentiable.

labor share to the price of materials is

$$\frac{d\log\lambda}{d\log p_m} = -\left(1-\left(\frac{\theta_l}{\theta_l+\theta_k}\sigma_{lm}+\frac{\theta_k}{\theta_l+\theta_k}\sigma_{km}\right)\right)\frac{\pi}{1-\pi}\frac{M}{Y}+\frac{\theta_k}{\theta_l+\theta_k}\left(\sigma_{lm}-\sigma_{km}\right),$$

where σ_{im} is the *Morishima* elasticity of substitution between factor i and materials.[13] This expression has two differences relative to our benchmark CES case. First, since materials are no longer separable from labor and capital, σ is replaced with a cost-weighted average of the Morishima elasticities. Second, a higher price of materials can now also lower the labor share by shifting expenditure from labor to capital, if $\sigma_{lm} < \sigma_{km}$. Empirically, we find little evidence of this additional term, as we do not find an effect of the price of materials on capital-labor ratios, nor do our estimates change when we control for them. Therefore, in most of the paper, we focus on the case that $\sigma_{lm} = \sigma_{km}$, in which the effect operates only through a higher profit share of value added and does not shift expenditure from labor to capital.

Variable profit share. Second, suppose the firm faces a general demand function $D(p)$ with non-constant elasticity $\epsilon \equiv -\frac{d\log D(p)}{d\log p}$ and super-elasticity $\xi \equiv \frac{d\log\epsilon}{d\log p}$. The markup $\mu = \epsilon/(\epsilon-1)$ and profit share now vary with the output price, and the expression in Proposition 1 becomes

$$\frac{d\log\lambda}{d\log p_m} = \left(-(1-\sigma)\frac{\pi}{1-\pi}+\xi\frac{\mu}{\epsilon-1+\xi}\right)\frac{M}{Y}.$$

When $\xi = 0$, this collapses to Proposition 1. For standard demand systems satisfying Marshall's second law ($\xi > 0$), a higher materials price lowers the markup, partially offsetting the baseline effect.

Fixed costs. Third, consider a firm with variable costs C and a fixed cost F_C paid in labor. Let $\omega \equiv F_C/C$ denote the ratio of fixed to variable costs. Suppose further that the firm faces isoelastic demand with elasticity ϵ, so that $\mu = \epsilon/(\epsilon-1)$ is constant. Using $\pi = 1-(1+\omega)/\mu$, the elasticity becomes

$$\frac{d\log\lambda}{d\log p_m} = \left[-(1-\sigma)\frac{\pi}{1-\pi}+\omega\left(\frac{(\epsilon-\sigma)(\mu-\theta_m)}{\theta_l+\omega}-\frac{1-\sigma}{1-\pi}\right)\right]\frac{M}{Y}.$$

[13] The Morishima elasticity of substitution of input i for input j is $\sigma_{ij} \equiv \frac{\partial\log(x_i/x_j)}{\partial\log w_j}\big|_{y,\,w_{-j}}$, where $x_i(w,y)$ and $x_j(w,y)$ are cost-minimizing (Hicksian) input demands to produce output y at input prices w, holding all other input prices constant.

The first term is the baseline channel from Proposition 1 (which this expression nests when $\omega = 0$); the second captures changes in the ratio of variable to fixed labor costs. Even when $\pi = 0$ and the baseline channel vanishes, this fixed-cost channel remains. Its sign is in general ambiguous: it amplifies the baseline effect when ϵ is low, and dampens it only when ϵ is sufficiently larger than σ to offset the negative term $-(1-\sigma)/(1-\pi)$. In particular, at $\epsilon = \sigma$ the fixed-cost channel is strictly negative.

2.5 General equilibrium

The analysis so far is partial equilibrium, taking input prices as given. To show that the mechanism extends to general equilibrium, we consider three stylized settings – a roundabout production economy, a two-sector vertical economy, and a small open economy – in which different shocks raise the price of materials but the aggregate labor share falls through the same logic. For simplicity, we abstract from capital and set $G(k, l) = l$. In all three settings, firms have a positive profit share $\pi > 0$.

A roundabout production economy. Consider an economy in which firms source units of the final good as materials, combining them with labor L. A sourcing friction means that only a fraction $1/\kappa$ of sourced goods can be used in production. Normalizing the wage to one, the relative price of materials is

$$p_m = \frac{B}{A_L}\left(\left(\frac{(1-\pi)B}{\kappa}\right)^{1-\sigma} - 1\right)^{-\frac{1}{1-\sigma}},$$

which is increasing in κ/B when $\sigma < 1$. The labor share is

$$\lambda = \frac{1}{1 + \frac{\pi/(1-\pi)}{1-\left(\frac{\kappa}{(1-\pi)B}\right)^{1-\sigma}}}.$$

An increase in the sourcing friction κ relative to B thus leads to a lower labor share if $\sigma < 1$ and $\pi > 0$.

A two-sector economy. Consider an economy with an extractive sector endowed with raw materials $\bar{m}$ and a manufacturing sector that combines them with labor L

to produce the final good. Normalizing the wage to one, the price of materials is

$$p_m = \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{-\frac{1}{\sigma}},$$

which is decreasing in the relative endowment $\bar{m}/L$. The manufacturing labor share is $\lambda^{manuf} = \left(1 + \frac{\pi}{1-\pi}\left(1 + \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{\frac{\sigma-1}{\sigma}}\right)\right)^{-1}$, which is increasing in $\bar{m}/L$ when $\sigma < 1$ and $\pi > 0$. The aggregate labor share, incorporating extractive-sector rents $p_m\bar{m}$, is

$$\lambda = \frac{1-\pi}{1 + \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{\frac{\sigma-1}{\sigma}}}.$$

An exogenous decline in $\bar{m}/L$ raises p_m and lowers both labor shares when $\sigma < 1$. Notably, the manufacturing profit share π need not be positive here, since rents to the endowment of materials generate a positive aggregate profit share even when $\pi = 0$.

A small open economy. Finally, consider a small open economy that sources materials at a given world price p_m and sells output at a given price p. The materials cost share is $\theta_m = \left(\frac{p_m}{B(1-\pi)p}\right)^{1-\sigma}$, which is increasing in $p_m/(Bp)$ when $\sigma < 1$. The labor share is

$$\lambda = \frac{(1-\pi)(1-\theta_m)}{1-(1-\pi)\theta_m},$$

so that a higher p_m leads to a lower labor share when $\sigma < 1$ and $\pi > 0$.

These examples confirm that the conditions of Proposition 1 – complementarities in production and a positive profit share – are sufficient for the mechanism to operate in general equilibrium, regardless of the nature of sourced materials or the underlying shock.

2.6 Total differential of the labor share

We conclude this section by deriving the full total differential of the labor share, to motivate our empirical strategy and to highlight the other forces – beyond materials prices – that must be accounted for in estimation. Under the production function in (4), the total differential can be written as[14]

$$d\log\lambda = -\frac{\pi}{1-\pi}(1-\sigma)\frac{M}{Y}\Big(d\log p_m - d\log B - d\log c_G(w/A_L,\, r/A_K)\Big) \\ +\; d\log\alpha(w/A_L,\, r/A_K) \;-\; \frac{R}{Y}\, d\log\left(\frac{1}{1-\pi}\right), \qquad (6)$$

where B is materials-augmenting productivity; $c_G(w/A_L,\, r/A_K)$ is the unit cost of the primary-input bundle; and $\alpha(w/A_L,\, r/A_K) = wl/(wl{+}rk)$ is labor's cost share within primary inputs. Note that under our assumption of separability between materials and the primary-input bundle G, both c_G and α are independent of p_m and B. In Section 3, we provide evidence supporting this assumption: non-separability would generate an effect of p_m on capital-labor ratios, which we do not find in the data. The first term captures our mechanism: when the price of materials rises relative to materials-augmenting productivity and the unit cost of primary inputs, the labor share falls, with the effect scaled by the profit share and materials intensity. The second term captures reallocation between labor and capital within the primary-input bundle, driven by changes in relative primary-input prices or factor-biased technical change. The third term captures changes in the profit share of sales – which we take as exogenous – whether due to markups, returns to scale, or other sources of rents. We take equation (6) to the data in the next section and discuss how to estimate the effect of p_m on λ while holding constant the remaining terms.

3 Empirical evidence

3.1 Aggregate and sectoral evidence

We begin our empirical analysis with an exploration of aggregate trends in the U.S. labor share and the relative price of raw materials. We take as our baseline aggregate labor share a simple average of four popular series used in the literature.[15]

[14] See Appendix A.1, equation (A.14), for the derivation. For brevity, we present the total differential under separability; Appendix A.1 derives the full total differential under a general (non-separable) production function (equation (A.10)), which nests (6) as a special case. In both cases, the forces that shift the labor share beyond materials prices are factor-biased technical change, changes in other input prices, and changes in the profit share of sales.

[15] We take an average of the following measures: (1) The main specification suggested in Gomme and Rupert (2004); (2) The labor share in U.S. non-financial corporations, constructed based on NIPA data; (3) The series computed by Fernald (2014); (4) The definition of the Bureau for Labor Statistics (BLS) for non-farm business-sector labor share, constructed from NIPA data.

We compare the labor share to the relative prices of both unprocessed and processed intermediate goods, constructed as the ratios of the Bureau of Labor Statistics (henceforth BLS) Producer Price Indexes (PPI) for unprocessed and processed goods for intermediate demand to the Bureau of Economic Analysis (BEA) Personal Consumption Expenditures (PCE) index for goods.[16] Figure 1 shows these measures in the past fifty years. All series demonstrate relative stability during the 1980s and the 1990s. In the 2000s, the relative price of materials increased significantly, coinciding with a sharp drop in the labor share.[17] Interestingly, despite the large increase in energy prices during the 1970s, the increase in the real price of the overall materials bundle was small by comparison, in line with the moderate decline in the labor share over this period. We discuss this period in greater detail in Section 3.8.

We now turn to explore trends at the sector level. To this end, we utilize the BEA's Integrated Industry-Level Production Account (KLEMS), which provides estimates of output and input prices and quantities for 63 industries.[18] First, we divide all industries into two groups based on their ratio of materials and energy expenditure to value added in 1997, such that each group represents half of total value added in the economy. Panel (a) in Figure 3 shows a Törnqvist chain-type price index of materials and energy for each group. While both groups experienced similar changes in the price of material inputs over the 1990s, the materials-intensive group has seen a significantly greater increase over the 2000s, reflecting greater exposure to upstream materials and commodities. Accordingly, Panel (b) shows that the materials-intensive sectors have seen a greater decline in the labor share over the 2000s. The gap between both groups suggests that changes in material prices could account for roughly 30–40% of the decline in labor share over these years, a similar magnitude to our more systematic analysis below.

[16] We focus on these PPI series because of their long time coverage. We present them separately rather than as a single aggregate because the BLS does not publish the expenditure weights needed to construct a combined index. In our disaggregated analysis in Section 3.3, we use industry-specific materials price indexes that capture the full bundle of intermediates for each industry.

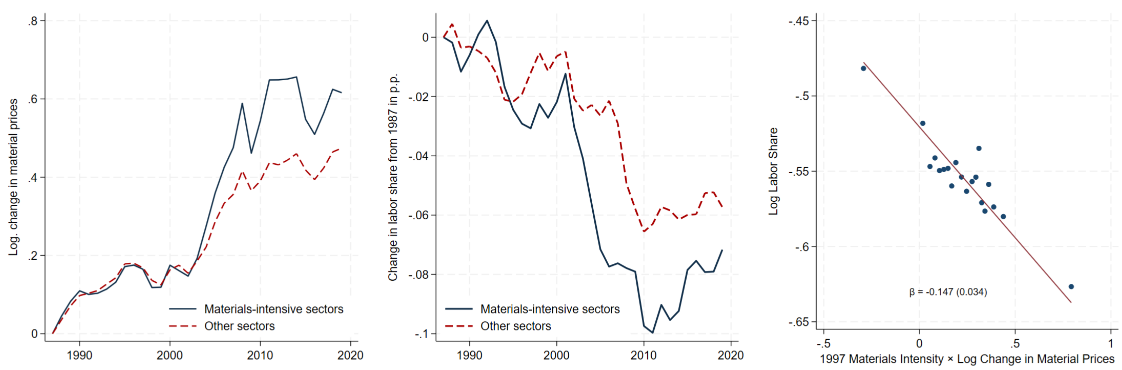
[17] Deflating the nominal price of unprocessed goods by the PCE for goods reflects the need to hold constant the prices of other inputs in production, as suggested by our theory. The PCE represents the final price of goods as reported by producers and retailers in the U.S. One concern is that it captures changes in markups in addition to changes in costs. To the extent that markups have indeed increased over time as suggested by De Loecker et al. (2020), the actual unit cost is higher in earlier years and lower in later years. In this case, the rise in the relative price of unprocessed goods should be even larger during the 2000s and even more moderate during the 1970s.

[18] We use a previous vintage of the BEA-BLS KLEMS data that covers 1987–2021. Following an update to the GDP-by-Industry accounts in September 2023, the current vintage available on the BEA website begins only in 1997. We exclude government, agriculture, and utilities sectors, leaving 58 industries in our sample.

Panel (c) in Figure 3 shows a binscatter plot of the log labor share against exposure to the rise in material input prices, given by the product of ex-ante materials intensity (expenditure on materials and energy over value-added) and the log-change in the sectoral materials price index (reflecting the object $\frac{M}{Y} \times d \log p_m$ in the notation of Proposition 1). The materials price index is a Törnqvist chain-type aggregate of materials and energy prices at the industry level. We control for sector and time fixed effects, and for the log price index of sectoral value-added, to account for changes in other factor prices. Sectors with high exposure to rising materials prices have seen the greatest decline in labor share.[19]

Figure 3: Labor Shares and Material Price Shocks Across U.S. Sectors

(a) Sectoral material prices **(b)** Sectoral labor shares **(c)** Sectoral exposure



Note: Panel (a) shows the change in a Törnqvist chain-type price index of materials and energy across two groups of U.S. industries split by their 1997 ratio of materials and energy expenditure to value added, with each group representing half of total value added. The materials-intensive group includes sectors in manufacturing, mining, construction, most of the transportation sector and some services sectors such as dining places. The other group includes most services and trade sectors. Panel (b) shows the change in the aggregate labor share since 1987 for both groups. Panel (c) shows a binscatter plot of the log labor share against a measure of exposure to the rise in material input prices (initial materials-to-value-added ratio in 1997 × log-change in the sector material price index) across 58 BEA-KLEMS industries, controlling for sector and time fixed effects and for the log price index of sector value added.

3.2 Evidence from the U.S. Manufacturing Sector

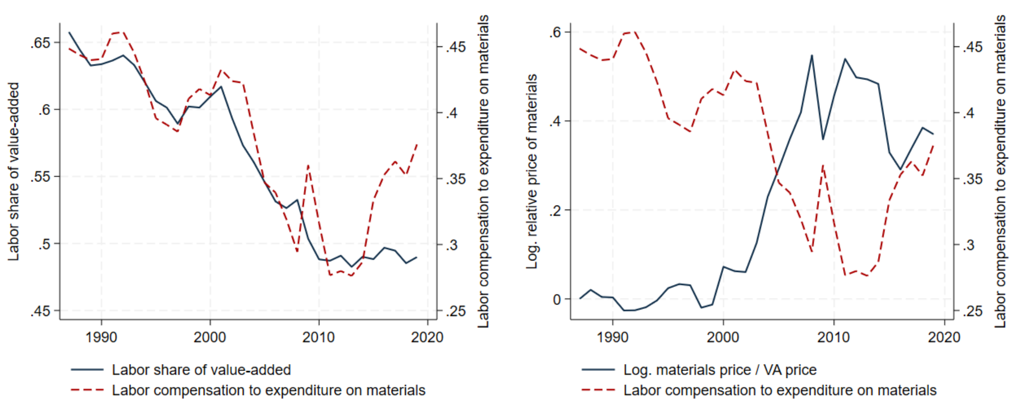
We now delve further into the U.S. manufacturing sector, a key driver of the aggregate changes in the labor share, where the decline in the labor share during the 2000s was especially pronounced. Before proceeding to our cross-sectional analysis, we first provide evidence for our mechanism for the manufacturing sector as a whole.

[19] This negative relationship is robust to investigating separately goods-producing and services-producing sectors, and to different weighting schemes.

First, we show that in line with our mechanism, the increase in the relative price of materials has resulted in a *reallocation of costs* between materials and primary inputs. Since the non-labor part of value-added includes both capital costs and profits, we focus on reallocation between materials and labor. Panel (a) in Figure 4 shows the ratio of labor compensation to expenditure on materials in the U.S. manufacturing sector over time, as well as the manufacturing labor share. A clear pattern of cost reallocation from labor to materials emerges, with a particularly sharp decline over the 2000s. Panel (b) plots the same series against the relative price of materials inputs. In line with our suggested mechanism, the reallocation between labor and materials aligns well in magnitude and timing with the rising price of materials. Alternative explanations that operate through higher markups cannot explain this reallocation since, other things equal, a higher markup keeps the distribution of costs between inputs unchanged.[20,21]

Figure 4: Cost reallocation from labor to materials

(a) Cost-reallocation from labor to materials **(b)** Cost-reallocation and relative material prices



Note: Panel (a) shows the ratio of labor compensation to expenditure on materials in the U.S. manufacturing sector over time (dashed red line) and the manufacturing labor share of value-added (solid line) from the BEA-KLEMS data. Panel (b) shows the same cost ratio against the log relative price of materials (materials price divided by value-added price), aggregated across manufacturing subsectors using Törnqvist weights.

[20] Rising markups over time actually make our mechanism more plausible. The reason is that under cost minimization, the share of materials in *costs* must equal a product of their share in *sales* and the price-cost markup. Since the share of materials in sales did not experience a decline, rising markups must lead to the conclusion that the cost share of materials has risen, leading to a lower labor share in the presence of markups. Therefore, any explanation that relies on rising markups must also imply an independent effect on the labor share through our suggested mechanism.

[21] Explanations that emphasize a higher capital share, such as capital deepening as described by Karabarbounis and Neiman (2014), could potentially generate this trend under specific assumptions about the substitution patterns between different inputs. However, the correlation with the relative price of materials – and its timing, which coincides with the global commodity boom – suggests a significant role for our proposed mechanism.

We now turn to explore our mechanism across narrowly defined manufacturing industries, and later across U.S. local labor markets. Motivated by the total differential in equation (6), we seek to isolate the materials price channel from the other forces that shape the labor share. We estimate the following regression specification:

$$\log \lambda_{jt} = \beta \times \frac{M_{j,0}}{VA_{j,0}} \times \log p_{m,jt} + X_{jt}\gamma + \delta_j + \delta_t + \varepsilon_{jt} \tag{7}$$

where j denotes an industry, t denotes time, λ_{jt} is the industry-level labor share, and $\frac{M_{j,0}}{VA_{j,0}} \times \log p_{m,jt}$ is our regressor of interest – the interaction between the price of materials for industry j in period t and its ex-ante materials intensity.[22]

As discussed in Section 2.6, other forces besides materials prices can shift the labor share, including changes in effective primary-input prices and factor-augmenting technical change, which operate through the unit cost of primary inputs $c_G(w/A_L, r/A_K)$ and labor's cost share within primary inputs $\alpha(w/A_L, r/A_K)$, as well as materials-augmenting technical change B and changes in the profit share of sales. Industry and year fixed effects absorb time-invariant industry heterogeneity and aggregate shocks, while our controls for wages and investment prices, and in some specifications for the capital-labor ratio and the production-worker share, proxy for observable movements in input prices, the capital-labor mix, and workforce composition. The remaining industry-time variation in these channels enters the error term ε_{jt}, together with measurement error in industry-specific price indices. Under classical assumptions, measurement error attenuates OLS toward zero, whereas the sign of omitted-variable bias from the other residual components is ambiguous in general.

For identification, we develop an instrumental variable strategy that exploits variation in the prices of globally traded primary commodities, which is plausible insofar as narrowly defined U.S. manufacturing industries are price takers in these markets. The identifying assumption is that, conditional on controls and fixed effects, the global commodity-price movements entering our instrument are orthogonal to residual industry-level shocks to labor-, capital-, and materials-augmenting productivity and

[22]Equation (7) is the empirical counterpart of the separable case behind Proposition 1, in which materials-price changes affect the labor share through the materials cost share but do not induce within-primary reallocation between labor and capital. The more general expression in Section 2.4 allows for non-separability ($\sigma_{lm} \neq \sigma_{km}$), which motivates the augmented regression in Appendix Table C.4. We focus on the separable specification because we find little evidence for non-separability: materials prices do not affect $\log(K/L)$ in Table C.3, controlling for $\log(K/L)$ does not change our estimates (Table 1, Column 7), and in Appendix Table C.4 the coefficient on the interaction remains stable when we include $\log p_{m,jt}$ separately.

to residual changes in the profit share. We accommodate remaining concerns through a range of extensions, including flexible subsector×time fixed effects and industry-specific trends, which absorb industry- or sector-level slow-moving confounders, as well as controls for import penetration and industry concentration, which capture trade and market-structure forces that could affect the profit share.

3.3 Data Sources

We rely on three main data sources; additional details and a summary of data sources across all empirical exercises are provided in Appendix B (Table B.1). Our primary source for industry-level outcomes is the NBER-CES Manufacturing Industry Database (Becker, Gray, and Marvakov, 2021), which provides a yearly panel of value added, payroll, materials cost, and price indices for all 361 six-digit NAICS U.S. manufacturing industries. We construct the labor share as the ratio of payroll to value added.[23]

For commodity prices, we follow Fally and Sayre (2022) in defining a list of commodities that correspond to a significant share of total global commodity trade, and obtain Trade Unit Values for 1991–2016 from UN-COMTRADE.[24] We use the 1997 BEA Input-Output table to construct measures of industry-level exposure to commodity prices.[25] In most of the analysis, we focus on the years 1991–2016, in which all of the required data is available. In robustness specifications, we additionally control for import penetration (constructed from Peter Schott's trade data and the Census Bureau) and industry concentration (from the U.S. Economic Census).

3.4 Cross-Sectional Evidence

Before turning to causal estimation, we document the cross-industry relationship between exposure to materials prices and industry outcomes. Figure 5 presents this relationship for two outcomes: the log labor share (left) and the log ratio of materials expenditure to the industry wage bill (right). Panel A shows simple long-difference scatter plots for the period 2000–2010, during which the commodity boom was con-

[23] The payroll variable captures a narrow definition of labor compensation, and the materials variable excludes some forms of intermediates, implying that the level of the labor share is too low relative to the national accounts. Despite this limitation, the data remain useful for comparing trends across industries. See Appendix B for details.

[24] See `https://are.berkeley.edu/~fally/Data/commodity_names.xlsx` for the commodity list.

[25] We choose this version because it is the first detailed NAICS-based table available and predates the 2000s commodity boom.

centrated. Each point is an industry, and the x-axis measures the product of materials intensity and the log change in the materials price index over the decade. Panel B shows the analogous relationship in the full panel (1991–2016), using binscatter plots that partial out industry and year fixed effects, weighted by value added. In both panels, industries with greater exposure to rising materials prices experienced a larger decline in the labor share and a larger increase in the materials-to-labor expenditure ratio, consistent with the predictions of Proposition 1. In Appendix C.2, we complement this evidence with a non-parametric event-study analysis that confirms these patterns using only cross-industry heterogeneity in ex-ante commodity intensity, without relying on price variation.

3.5 Constructing Commodity Intensity and Price Shocks

We construct a shift-share instrument for industry-level materials prices using predetermined input-output linkages and global commodity prices (see Appendix B for the full construction). Since we lack expenditure data at the specific commodity level, we proxy the expenditure share of industry j on commodity k using the input-output tables, assigning equal weights to different commodities produced by the same industry. Let $M_{jk,1997}$ be the expenditure of industry j on commodity k; $M_{j,1997}$ be j's total expenditure on intermediates; and $W_{j,1997}$ be j's total labor compensation. The expenditure share of industry j on commodity k is

$$\omega_{jk,1997} \equiv \frac{M_{jk,1997}}{M_{j,1997} + W_{j,1997}}. \tag{8}$$

Industry j's commodity intensity is its total expenditure on commodities as a share of total costs:

$$\theta_{j1997}^{comm} \equiv \sum_k \omega_{jk,1997}. \tag{9}$$

This variable captures ex-ante exposure to commodity prices but does not utilize realized price changes. Our shift-share instrument combines these weights with realized commodity prices:

$$\log p_{jt}^{comm} \equiv \sum_k \omega_{jk,1997} \log \left(price_{k,t}\right). \tag{10}$$

Figure 5: The Relationship Between Material Prices and Industry Outcomes

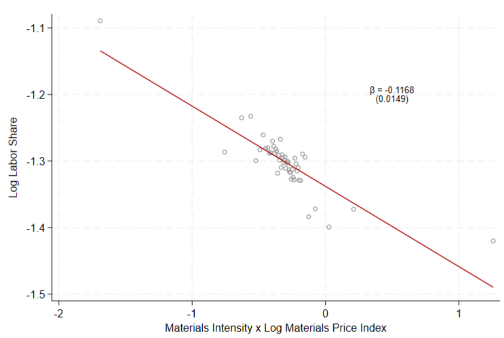
Panel A: Long-Difference Scatter (2000–2010)

(a) Labor Share

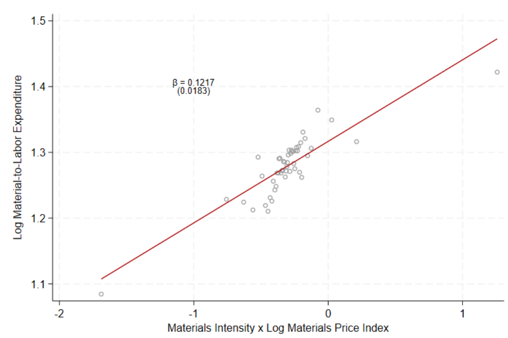
(b) Material-to-Labor Expenditure Ratio

Panel B: Panel Binscatter (1991–2016)

(c) Labor Share



(d) Material-to-Labor Expenditure Ratio



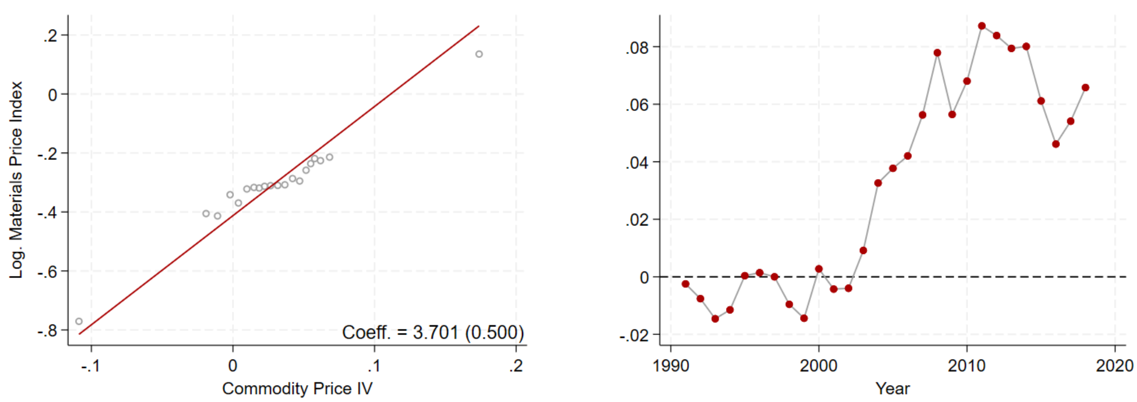
Note: The top panel shows scatter plots of long-difference (2000–2010) industry outcomes against the product of materials intensity in 2000 and the change in the log price index of materials over the decade. Each circle is an industry, and the line is a value-added-weighted linear fit. The bottom panel shows binscatter plots of industry outcomes against the product of materials intensity in 1990 and the log price index of materials in the full panel (1991–2016), after residualizing industry and year fixed effects. Each circle represents the mean of a quantile bin, where observations are weighted by value added in 1990. The line is a linear fit. Reported coefficients and standard errors (in parentheses) are from value-added-weighted regressions; standard errors in the bottom panel are clustered by industry.

This measure leverages both the heterogeneous changes in commodity prices and the differential baseline exposure of each manufacturing industry. We use $\log p_{jt}^{comm}$ as an instrument for the interaction between the industry-level materials price index and its ex-ante materials intensity. Figure 6b shows that the average commodity price shock tracks the aggregate dynamics in Figure 1, and Figure 6a confirms a strong positive correlation between the instrument and the NBER-CES materials price index at the industry level.[26]

Figure 6: Commodity Cost Shock Measure

(a) Commodity and Materials Prices

(b) Average Commodity Price Shock



Note: Panel (a) is a binned scatter plot of the treatment variable (materials intensity × log materials price index) between 1991–2016 against our shift-share instrumental variable, after controlling for industry and year fixed effects and weighting by value added in 1990. Panel (b) shows our commodity cost shock measure (Equation 10) over time, averaged across industries weighted by value added in 1990.

The rationale for our instrument is rooted in the main narrative for the 2000s commodities boom: rising demand from emerging economies, and in particular China, is widely viewed as the leading cause of the price increase.[27] This raises the potential concern that the commodity price shock might be correlated with other implications of China's growth, such as import competition or rising demand in product markets. Therefore, we control for these alternative trade exposure measures in X_{jt}. In line with past literature, we find no evidence for a relationship between these demand-side exposure measures and the labor share, and essentially no correlation between them

[26] Appendix B provides additional information, including the commodities with the largest price increases (Table C.1) and the most affected industries (Table C.2).

[27] Carter, Rausser, and Smith (2011), Baumeister and Kilian (2016), Stuermer (2018), Jacks and Stuermer (2020).

and our instrument.[28]

3.6 The Effect of Material Prices on the Labor Share

We now turn to estimate the causal effect by relying on differential variation in material prices induced by changes in prices of specific commodities. To this end, we instrument the industry-level price index of materials with the measure defined in Equation 10, and estimate the regression specification in Equation 7. In all specifications, we cluster standard errors at the industry level.

Table 1 presents results for regressing the yearly log labor share for each industry on the log of materials prices multiplied by materials intensity using the identification strategy and the specification detailed in the previous subsections. Columns (1) and (2) present unweighted OLS results for regressions that include only our regressor of interest, and that control for other input prices (average wages and the price of investment goods), respectively. Columns (3) and (4) present unweighted 2SLS results for the same specifications. The coefficient on the log price of materials is negative and significant both statistically and economically in the four cases, and including controls for the prices of the other inputs does not change the estimate. In line with our earlier discussion, the OLS result is closer to 0, hinting towards an attenuation bias due to mismeasurements in the price index of materials. Columns (5) to (8) provide robustness checks, weighting by industry value added in 1990 and adding additional controls for the capital-labor ratio, the share of production workers, and changes in import penetration. Nevertheless, the coefficient remains stable at around -0.18 to -0.19 across weighted specifications. This estimate implies that a 1% increase in the price of materials, all else equal, reduces the manufacturing labor share by about 0.23% for an industry with the average baseline materials intensity (≈ 1.2). Column (9) further accommodates concerns about industry-specific factor-biased technical change or other slow-moving confounders by adding industry-specific linear time trends. While the coefficient remains negative and statistically significant, it is attenuated relative to the other columns. This is expected: industry trends absorb some of the low-frequency variation in relative materials prices across sectors that is central to identification, increasing the noise-to-signal ratio. It is therefore not

[28] In a regression of our instrument on import penetration from China, export exposure to China, and the full set of controls, neither is statistically significant (p-values of approximately 0.4 and 0.8, respectively). See also Autor et al. (2020).

Table 1: The Effect of Material Prices on the Labor Share

	Industry Log Labor Share								
	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS	(8) 2SLS	(9) 2SLS
Materials Intensity × Log. Materials Price	-0.132***	-0.135***	-0.222***	-0.232***	-0.178***	-0.192***	-0.192***	-0.190***	-0.120***
	(0.0212)	(0.0219)	(0.0423)	(0.0464)	(0.0246)	(0.0317)	(0.0280)	(0.0275)	(0.0231)
Log. Average Wage		-0.0335		-0.0138		0.0611	0.0234	0.0291	0.00749
		(0.0742)		(0.0754)		(0.149)	(0.145)	(0.136)	(0.112)
Log. Investment Price		0.0421		0.232		0.322*	0.495**	0.546**	0.480
		(0.115)		(0.148)		(0.188)	(0.194)	(0.221)	(0.462)
Production Workers Share							-0.635**	-0.644**	-0.481
							(0.259)	(0.269)	(0.303)
Log. Capital-Labor Ratio							0.0767*	0.0599	-0.0150
							(0.0413)	(0.0400)	(0.0429)
Import Penetration								0.0225	-0.0218
								(0.0502)	(0.0471)
Import Penetration - China								0.171	0.405*
								(0.134)	(0.246)
First-stage F-stat (KP-Wald)			41.82	37.78	54.69	39.26	36.49	35.89	12.82
N	9386	9386	9386	9386	9386	9386	9386	9386	9386
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Industry-Specific Trends	No	No	No	No	No	No	No	No	Yes

Note: This table reports results from the regression of industry-level log labor shares on the log of the price index of materials multiplied by the materials intensity in 1990. Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset for the period between 1991 and 2016. All specifications control for industry and year fixed effects. Column (1) and (2) report OLS results. Columns (3) to (9) instrument the log. of the materials price index with the instrumental variable detailed in Expression 10. Columns (5) to (9) are weighted by the value added of the industry in year 1990. Column (7) adds a control for the log of the capital-labor ratio and the share of production workers in the industry, and Column (8) adds import penetration - from China and overall. Column (9) further adds industry-specific linear time trends. Standard errors clustered at the industry-level are in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

clear whether the benchmark estimate should be Column (8) or Column (9); in the quantitative exercise below, we report counterfactuals using both.

3.7 Evidence from local labor markets

As an additional source of variation, we repeat our analysis for U.S. local labor markets. We construct a panel of 525 commuting zones over 2001–2016 using county-level data from the BEA Regional Economic Accounts and the BLS Quarterly Census of Employment and Wages (see Appendix B for details). Regional materials price indices and the commodity shock instrument are constructed by weighting industry-level measures according to their ex-ante share in the regional economy.

Table 2 replicates the cross-industry analysis for this sample of local labor markets. All specifications control for factor prices (regional wages and the price of investment goods) as well as commuting-zone and year fixed effects. Columns (4) and (5) add controls for log total regional employment, the manufacturing share in regional value added, and import penetration. Column (6) further adds commuting-zone-specific linear time trends, paralleling Column (9) in Table 1. The estimated coefficient is around -0.17 across all specifications, closely matching the industry-level estimates in Table 1. This consistency across different units of observation – industries and local labor markets – suggests that local general equilibrium forces do not substantially offset the partial equilibrium mechanism.

Table 2: The Effect of Material Prices – Variation from Local Labor Markets

	Log Labor Share					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.149**	-0.177***	-0.169***	-0.166***	-0.170***	-0.216***
	(0.0697)	(0.0423)	(0.0472)	(0.0466)	(0.0460)	(0.0614)
First-stage F-stat (KP-Wald)		34.66	43.12	43.39	44.38	196.2
N	8400	8400	8400	8400	8400	8400
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes	Yes
Controls for regional employment and manuf. share	No	No	No	Yes	Yes	Yes
Controls for import penetration	No	No	No	No	Yes	Yes
Region and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes	Yes
CZ-Specific Trends	No	No	No	No	No	Yes

Note: This table reports results from the regression of the log manufacturing labor share at the commuting-zone level on the interaction of regional materials intensity and the log materials price index in that commuting-zone. Observations correspond to commuting-zone-year pairs for a balanced panel of 525 commuting zones between 2001 and 2016. All specifications control for the log of the average wage and the log of the price of investment, as well as commuting zone and year-fixed effects. Column 1 reports OLS results. Columns 2 to 6 instrument the log. of the materials price index with the instrumental variable detailed in the text. Columns 3 to 6 are weighted by total manufacturing GDP in the commuting zone in 2001. Column 4 adds controls for the log of regional employment and for the share of manufacturing in regional GDP, and Column 5 adds import penetration - from China and overall. Column 6 further adds commuting-zone-specific linear time trends. Standard errors clustered at the commuting-zone level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

3.8 The 1970s Oil Shocks

We now exploit a different source of exogenous variation: the 1970s oil shocks. The 1973 OAPEC embargo and subsequent disruptions resulted in a threefold increase in the real price of oil. We instrument the industry-level materials price index with the interaction of the log oil price (common across industries) and an industry-specific measure of energy intensity – the ratio of energy expenditure to total output in 1972, a year before the embargo:[29]

$$\log p^e_{jt} \equiv s_{ej,1972} \log \text{Oil Price}_t, \tag{11}$$

where $s_{ej,1972}$ is the revenue share of expenditure on energy.

Table 3 presents 2SLS results for 1970–1980. The estimated effect is negative and statistically significant, with confidence intervals that overlap with the baseline estimates in Table 1 despite the different identification strategy and historical period. Columns (5) and (6) replace year fixed effects with year×3-digit NAICS subsector fixed effects, exploiting only within-subsector variation, and find similar or stronger results.[30]

Despite the large oil price increase, the aggregate manufacturing labor share remained relatively stable in the 1970s. Through the lens of our mechanism, this is expected: energy goods account for only about 5% of total materials expenditure in manufacturing, and the 1970s boom was partly offset by rapid increases in other factor prices during that period's inflationary environment. While there was sufficient cross-industry variation to identify our mechanism, the overall increase in the relative price of the materials bundle was modest relative to the 2000s (as can also be seen in Figure 1), limiting the aggregate implications for the labor share.

3.9 Natural Disasters as an Alternative Source of Variation

As a further robustness exercise, we develop an alternative instrument that exploits supply disruptions caused by natural disasters in countries that are major exporters of specific commodities. For each HS4 product, we identify countries that account for a large share of global exports, and construct a dummy variable that is activated when such a country experiences a major natural disaster (as recorded in EM-DAT, the International Disaster Database). We then aggregate these product-level disaster shocks to the industry level using input-output linkages, analogously to our baseline instrument. The resulting instrument is relevant – first-stage F-statistics range from 21.5 to 32.5 – and the 2SLS estimates are consistent with our baseline

[29] Oil prices are taken from https://www.worldbank.org/en/research/commodity-markets. Energy intensity is constructed using the NBER-CES Dataset.

[30] We do not replicate Column (8) in Table 1 in the 1970s due to the lack of trade data. For the baseline exercise, we control for subsector-specific trends in the robustness Section 3.11.

Table 3: The Effect of Material Prices on the Labor Share – 1970s Oil Shock

	Industry Log Labor Share					
	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Materials Intensity × Log. Materials Price	-0.0384**	-0.219***	-0.167***	-0.166***	-0.233***	-0.230***
	(0.0183)	(0.0739)	(0.0551)	(0.0545)	(0.0784)	(0.0770)
First-stage F-stat (KP-Wald)		5.299	2.185	2.297	7.075	7.937
N	3971	3971	3971	3971	3971	3971
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	No	Yes	No	Yes
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year ×Sector FE	No	No	No	No	Yes	Yes
Weighted	No	No	Yes	Yes	Yes	Yes

Note: This table reports results from the regression of industry-level labor shares on the log. of the price index of materials multiplied by the materials intensity, the log. of the average wage and the log. of the price of investment goods. Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset for the period between 1970 and 1980. Specifications in columns (1) to (4) control for industry and year fixed effects. Specifications in columns (5) and (6) control for industry fixed effects and the interaction of year and 3-digit NAICS sub-sectors fixed effects. Column (1) reports OLS results and Columns (2) to (6) instrument the log. of the materials price index with the instrumental variable detailed in Expression 11. Columns (3) to (6) are weighted by the value added in 1972. Columns (4) and (6) add a control for the log. of the capital-labor ratio and the share of production workers in the industry. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

results, with a point estimate of -0.183 (s.e. $= 0.086$) in the preferred specification compared to -0.190 (s.e. $= 0.028$) in Table 1. The full construction and results are presented in Online Appendix D.

3.10 Structural Interpretation and Aggregate Quantification

We now relate the estimates in Table 1 to the structural parameters from Section 2 and evaluate the aggregate importance of our mechanism. From Proposition 1, β depends on the elasticity of substitution between materials and primary inputs, σ, and the profit share π:

$$\beta \equiv \frac{d\log\lambda}{\frac{M}{Y}d\log p_m} = -\frac{\pi}{1-\pi}\left(1-\sigma\right). \tag{12}$$

This interpretation relies on the separability of materials from the capital-labor bundle in the production function (4), under which materials prices do not shift the capital-labor mix.[31] Since $\sigma < 1$ implies $\beta < 0$, the negative estimates in Table 1 are consistent with complementarities between materials and primary inputs. In Fig-

[31] As discussed above, we find strong support for this assumption: materials prices have no effect on capital-labor ratios (Table C.3), and controlling for capital-labor ratios does not change our estimates (Table 1, Column 7).

ure 7a, we plot the implied relationship between σ and π using the estimates for β in Columns (8) and (9) of Table 1. Each estimate defines a locus of (σ, π) combinations consistent with the estimated elasticity. To further discipline this relationship, we use two additional implications of the mechanism: the elasticity of $\log(M/Y)$ and the elasticity of $\log(Y/R)$, both with respect to the price of materials.[32] Estimated with and without industry-specific trends, these moments yield four point estimates in Figure 7a. Across them, the implied elasticity of substitution is below one, ranging from about 0.04 to 0.33, while the implied profit share ranges from about 0.12 to 0.21. For comparison, the point estimate for σ in Peter and Ruane (2025) is around 0.3, whereas it is close to 0 in Boehm et al. (2019) and below 0.2 in Atalay (2017).

We next quantify the aggregate importance of our mechanism for the manufacturing labor share. We construct a counterfactual path that shuts down the materials price channel: $\Delta \log \lambda_t^{CF} = \Delta \log \lambda_t + |\hat{\beta}| \times (M/Y)_{t-1} \times \Delta \log \tilde{p}_{m,t}$, where $\Delta \log \tilde{p}_{m,t}$ is the change in the deflated relative price of materials. We implement this exercise using BEA-KLEMS data for the manufacturing sector, which provides comprehensive measures of compensation and value added consistent with the U.S. national accounts. The aggregate materials price index is constructed by Törnqvist chaining across materials and energy within each subsector, and then aggregating across subsectors using expenditure-share-weighted Törnqvist weights. To isolate relative price movements from general inflation, we regress the sector-level log materials price on the log value-added price deflator with sector and year fixed effects, weighting by base-year value added; the year fixed effects capture $\Delta \log \tilde{p}_{m,t}$.

As discussed above, it is not clear whether the preferred estimate is Column (8) or Column (9) of Table 1, since industry trends absorb some of the identifying variation along with potential confounders. We therefore report counterfactuals using both. Figure 7b plots the results. The counterfactual and actual labor shares are closely aligned before the 2000s, but diverge markedly during the commodities boom. To quantify this, we compute a cumulative contribution measure that captures how much of the labor share's total movement from its initial value is eliminated in the counterfactual.[33] Using the estimate from Column (8), the cumulative decline in the labor

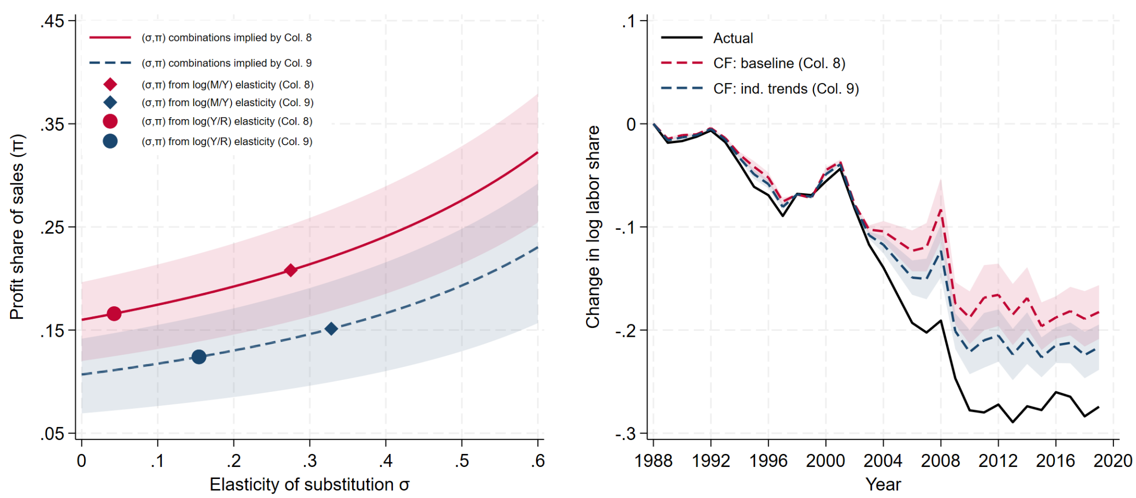
[32] Appendix Table C.5 reports the corresponding estimates.

[33] Specifically, we compute $1 - \sum_t |\lambda_t^{CF} - \lambda_0| / \sum_t |\lambda_t - \lambda_0|$, where λ_0 is the labor share in the first year and the sums run over all years. This measure aggregates deviations across the entire path rather than benchmarking to a single endpoint.

share would have been approximately 32% smaller; using Column (9), approximately 20% smaller. The two specifications bracket a range in which the decline would have been 20–32% smaller absent the rise in the relative price of materials.

Figure 7: Structural Interpretation and Counterfactual Labor Share

(a) Implied relationship between σ and π **(b)** Counterfactual labor share



Note: In Panel (a), the solid cranberry line plots the combinations of σ and π implied by the estimate $\hat{\beta} = -0.190$ from Column (8) of Table 1, and the dashed navy line plots the combinations implied by $\hat{\beta} = -0.120$ from Column (9), which includes industry-specific trends. Diamonds denote the (σ, π) pairs obtained by combining the labor-share estimate with the auxiliary elasticity of $\log(M/Y)$ with respect to the price of materials, and circles denote the corresponding pairs obtained using the auxiliary elasticity of $\log(Y/R)$. In each case, cranberry corresponds to the baseline specification and navy to the industry-trends specification. In Panel (b) we plot the actual change in the log manufacturing labor share relative to 1988 (solid black line) and counterfactual labor shares that shut down our mechanism, using data on U.S. manufacturing from BEA-KLEMS. The cranberry dashed line uses the baseline estimate (Col. 8) and the navy dashed line uses the industry-trends estimate (Col. 9), with corresponding 95% CIs.

3.11 Extensions and Robustness Checks

We now turn to a series of robustness checks and extensions of our results. For brevity, we provide only the main highlights and refer readers to our Online Appendix for additional details.

Other Industry Outcomes. We test auxiliary predictions of the theory by examining the effect of materials prices on other industry outcomes (Table C.3). In line with our mechanism, higher materials prices increase the ratio of materials expenditure to value added, and increase expenditure on materials relative to both labor costs and capital expenditure. Moreover, the increase relative to labor and capital exceeds the increase relative to value added, consistent with the prediction that the profit share of value added rises (Section 2.2, Figure 2). We find no effect of materials prices on capital-labor ratios, supporting the separability assumption embedded in Equation (4).

Augmented Specification. To further test separability, we augment the baseline regression with a separate $\log p_{m,jt}$ term. Under the more general expression in Section 2.4, such a term captures the direct effect of materials prices on the labor share when $\sigma_{lm} \neq \sigma_{km}$; under separability, materials prices should enter only through the interaction with baseline materials intensity (Appendix Table C.4). In the data, the interaction coefficient remains stable, while the coefficient on $\log p_{m,jt}$ is noisy and only marginally significant in some specifications, consistent with separability.

Sectoral Trends. We restrict the source of variation to differential exposure within NAICS 3-digit subsectors by adding year×3-digit subsector fixed effects (Table C.6). This alleviates concerns that the instrument is correlated with sectoral factor-augmenting shocks. The results remain statistically significant and quantitatively similar.

Heterogeneous Effects. We allow for heterogeneous effects across NAICS 3-digit subsectors by interacting our baseline treatment with subsector indicators (Figure C.4). The negative effect of rising materials prices on the labor share is prevalent across most manufacturing subsectors.

BEA Data and Sourced Services. We replicate our baseline results using more aggregate BEA-KLEMS data for 19 manufacturing subsectors, which provides superior measures of total compensation and includes sourced services (Table C.7). The results remain very similar, and controlling for the share and price of outsourced services does not weaken the effect – if anything, it becomes quantitatively stronger.

Accounting for Input-Output Linkages. We augment our instrument to capture both direct and indirect effects of commodity prices through input-output linkages, constructing the shares ω_{jk} from the Leontief Inverse matrix (Table C.8). The results are very similar.

Utilizing Only Variation in Prices. Following Borusyak, Hull, and Jaravel (2022), we isolate variation from price shifts by dividing the instrument by the total commodity cost share from Equation 9 (Table C.9). The estimate remains negative and quantitatively similar, though as expected, more noisy.

Industry Concentration. A prominent explanation for the decline of the labor share is rising industry concentration (Autor et al., 2020). We add two concentration measures – the log HHI for the top 50 firms and the sales share of the top 4 firms (Table C.10). While a negative relationship between concentration and the labor share emerges, the effect of materials prices remains virtually unchanged. Moreover, the implied contribution of changes in concentration to the decline of the manufacturing labor share is smaller than that of materials prices, largely because concentration changed little in the average manufacturing industry over this period. A related finding in this literature is that the labor share did not decline for the median manufacturing establishment (Kehrig and Vincent, 2021). This pattern is consistent with our mechanism: an ex-ante positive profit share is required for materials prices to affect the labor share (Proposition 1), so the effect should be concentrated at establishments with ex-ante low labor shares.

Energy vs. Non-energy Commodities. We decompose the shift-share instrument into its energy and non-energy components and estimate separately with each (Table C.11). Energy commodities yield a very strong first stage and point estimates similar to the baseline. Non-energy commodities yield weaker first stages but, if anything, more negative point estimates.

4 A Dynamic Model with Capital Accumulation

We now turn to quantify the importance of our mechanism in a structural model of the U.S. manufacturing sector that incorporates investment and capital dynamics. This quantification complements our reduced-form analysis in Section 3.10, and offers three key advantages relative to it. First, it explicitly matches the path of investment and the capital stock, so alternative explanations based on capital deepening are brought directly into the analysis. Second, by jointly matching factor payments, investment, capital accumulation, and output, it also reproduces the observed path of free cash flow, which helps discipline the path of the profit rate of sales (whether interpreted as markups or returns to scale). Third, it allows us to generate counterfactual predictions for additional key moments of interest beyond the labor share, such as the investment rate and the free cash flow rate of value added. We implement our approach for the aggregate manufacturing sector in the main text, and for individual manufacturing subsectors in Appendix E.8.

4.1 Setup

Firms. We consider a sector populated by a unit measure of identical monopolistically competitive firms. Each firm takes as given the sequence of input prices $\{w_t, p_{m,t}, p_{i,t}\}_{t=0}^{\infty}$ (wages, materials prices, and investment goods prices, respectively), the sequence of sectoral expenditure $\{E_t\}_{t=0}^{\infty}$, and the path of exogenous time-varying fundamentals $\{\chi_t, A_t, B_t, \alpha_t, \mu_t\}_{t=0}^{\infty}$, detailed below.

Production Technology. Firms produce output q_t using a nested CES production function F that combines a capital-labor bundle with materials:

$$q_t = F(k_t, l_t, m_t) = \left[\left(A_t l_t^{\alpha_t} k_t^{1-\alpha_t} \right)^{\frac{\sigma-1}{\sigma}} + \left(B_t m_t \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{13}$$

where l_t is labor, k_t is capital, m_t is materials, A_t is primary factor-augmenting productivity, B_t is materials-augmenting productivity, α_t is the labor share within the capital-labor bundle, and σ is the elasticity of substitution between the capital-labor bundle and materials.

Capital Accumulation. Capital evolves according to:

$$k_{t+1} = \chi_t i_t^{\gamma} k_t^{1-\gamma} + (1-\delta) k_t, \tag{14}$$

where i_t is investment, χ_t is investment efficiency, $\gamma \in (0, 1]$ governs adjustment frictions, and δ is the depreciation rate. The case of $\gamma = 1$ corresponds to the standard benchmark of no adjustment costs, and $\gamma = 0.5$ corresponds to the case of quadratic adjustment costs.

Demand. Firms operate under monopolistic competition with a CES demand aggregator. Letting E_t denote aggregate sectoral expenditure, P_t the sectoral price index, and $\eta_t > 1$ the time-varying elasticity of substitution across varieties, the firm's revenues are $R_t = E_t^{1/\eta_t} P_t^{(\eta_t-1)/\eta_t} q_t^{(\eta_t-1)/\eta_t}$, which equals E_t in symmetric equilibrium with a unit mass of identical firms. The associated gross markup is $\mu_t \equiv \eta_t/(\eta_t - 1)$. We treat the markup as a time-varying fundamental, although equivalently it can be viewed as a time-varying demand elasticity or time-varying return to scale. In all of these cases, it captures an exogenous time-varying wedge between firms' output price and their average unit cost.

Firm's Problem. The firm maximizes the present discounted value of profits:

$$\max_{\{l_t,m_t,i_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left\{ E_t^{\frac{1}{\eta_t}} P_t^{\frac{\eta_t-1}{\eta_t}} q_t^{\frac{\eta_t-1}{\eta_t}} - p_{m,t}m_t - w_t l_t - p_{i,t} i_t \right\}$$

$$\begin{aligned} \text{subject to:} \quad & q_t = F(k_t, l_t, m_t), \\ & k_{t+1} = \chi_t i_t^{\gamma} k_t^{1-\gamma} + (1-\delta)k_t, \\ & k_0 \text{ given.} \end{aligned} \tag{15}$$

4.2 Firm solutions

Define the output elasticities of materials and labor as:

$$\theta_{m,t} \equiv \frac{(B_t m_t)^{\frac{\sigma-1}{\sigma}}}{\left(A_t l_t^{\alpha_t} k_t^{1-\alpha_t}\right)^{\frac{\sigma-1}{\sigma}} + (B_t m_t)^{\frac{\sigma-1}{\sigma}}}, \quad \theta_{l,t} \equiv \frac{\alpha_t \left(A_t l_t^{\alpha_t} k_t^{1-\alpha_t}\right)^{\frac{\sigma-1}{\sigma}}}{\left(A_t l_t^{\alpha_t} k_t^{1-\alpha_t}\right)^{\frac{\sigma-1}{\sigma}} + (B_t m_t)^{\frac{\sigma-1}{\sigma}}}. \tag{16}$$

The output elasticities satisfy $\theta_{l,t} = \alpha_t(1-\theta_{m,t})$ and the capital output elasticity is $\theta_{k,t} = (1-\alpha_t)(1-\theta_{m,t})$, so that $\theta_{m,t} + \theta_{l,t} + \theta_{k,t} = 1$.

The static first-order conditions for labor and materials imply:

$$\frac{w_t l_t}{E_t} = \frac{\theta_{l,t}}{\mu_t}, \quad \frac{p_{m,t} m_t}{E_t} = \frac{\theta_{m,t}}{\mu_t}. \tag{17}$$

Factor payments as a share of revenues equal the corresponding output elasticity divided by the markup.

The dynamic first-order condition for investment yields:

$$s_{i,t} = \beta \dot{E}_{t+1} \left(\frac{\dot{k}_{t+1} - (1-\delta)}{\dot{k}_{t+1}} \right) \left\{ \gamma \frac{1 - \theta_{m,t+1} - \theta_{l,t+1}}{\mu_{t+1}} + s_{i,t+1} \left(\frac{1-\delta}{\dot{k}_{t+2} - (1-\delta)} + (1-\gamma) \right) \right\}, \tag{18}$$

where $s_{i,t} \equiv p_{i,t} i_t / E_t$ is the investment share of revenues, $\dot{E}_{t+1} \equiv E_{t+1}/E_t$ is the gross growth rate of expenditure, and $\dot{k}_{t+1} \equiv k_{t+1}/k_t$ is the gross growth rate of capital.

The labor share of value added is:

$$\lambda_t = \frac{s_{l,t}}{1 - s_{m,t}} = \frac{\theta_{l,t}/\mu_t}{1 - \theta_{m,t}/\mu_t} = \frac{\alpha_t(1 - \theta_{m,t})}{\mu_t - \theta_{m,t}}, \tag{19}$$

where $s_{l,t} = w_t l_t / E_t$ and $s_{m,t} = p_{m,t} m_t / E_t$ are the labor and materials shares of revenues. The labor share depends on the endogenous materials output elasticity $\theta_{m,t}$, as well as the exogenous labor share parameter α_t in the capital-labor bundle, and the exogenous markup μ_t.[34]

4.3 Mapping the Model to the Data

Data. We use annual data on U.S. manufacturing from 1998 to 2019 from the BEA industry accounts (see Appendix E for details). We apply an HP filter with a small smoothing parameter of 5 to all variables, which smooths out sharp year-to-year fluctuations while preserving the multi-year trends that are the focus of our analysis.

Model Inversion. We invert the model along a transition path to recover time-varying fundamentals from observed data.[35] We assume that total sectoral expenditure E_t and input prices (w_t, $p_{m,t}$, $p_{i,t}$) are taken as exogenously given. We then solve for the five time-varying structural residuals $\{\mu_t, \alpha_t, A_t, B_t, \chi_t\}$ by matching five endogenous moments in each period of the data: (i) the labor share of revenues ($s_{l,t}$), (ii) the materials share of revenues ($s_{m,t}$), (iii) the investment share of revenues ($s_{i,t}$), (iv) the capital stock (k_t), and (v) output (q_t). Other relevant moments, including the labor share of value added, the ratio of value added to gross output, the ratio of free cash flow to value added, and the investment-to-capital and capital-to-value-added ratios, are then implied by simple accounting manipulations of the five matched moments above.

[34] Equation (19) implies that, once μ_t and α_t are recovered, any counterfactual path for the materials output elasticity $\theta^{cf}_{m,t}$ maps mechanically into a counterfactual labor share,

$$\lambda^{cf}_t = \frac{\alpha_t(1 - \theta^{cf}_{m,t})}{\mu_t - \theta^{cf}_{m,t}}.$$

Thus, for counterfactuals stated directly in terms of $\theta_{m,t}$, only limited structure is needed. The fuller dynamic model is required to derive how counterfactual paths for prices and fundamentals map into $\theta_{m,t}$, investment, capital accumulation, and the other moments we study.

[35] We allow the model to be along a transition path across all periods of the data, but assume that after the last period of the data, there are no further expected changes in fundamentals, and that the model converges to the steady state implied by these fundamentals.

A useful way to think about the inversion is in three steps. First, the static first-order conditions map the observed labor and materials shares into the corresponding output elasticities relative to the markup. Second, the investment Euler equation recovers the capital output elasticity relative to the markup, $\theta_{k,t}/\mu_t$, from observed investment shares, capital growth, and expenditure growth. Third, once that component is known, the remaining portion of revenue net of labor and materials is attributed, through the model, to pure profits, which pins down the markup residual. Given the markup, the labor-share relationship recovers α_t, the capital accumulation equation recovers χ_t, the ratio of factor demands recovers the relative materials-productivity term B_t/A_t, and the production function pins down A_t to match output. Appendix E provides the full derivations and numerical details. We summarize these recovery steps in turn below.

Recovering $\theta_{k,t}/\mu_t$. The ratio of the capital output elasticity to the markup, $\theta_{k,t}/\mu_t$, is recovered directly from the investment Euler equation (18), using observed investment shares, capital growth rates, and expenditure growth.

Recovering markups. Given $\theta_{k,t}/\mu_t$, the gross markup follows from the first-order conditions (17) and the identity $\theta_{l,t} + \theta_{m,t} + \theta_{k,t} = 1$:

$$\mu_t = \frac{1}{\theta_{k,t}/\mu_t + s_{l,t} + s_{m,t}}. \tag{20}$$

Equivalently, revenue net of labor and materials is split between capital's marginal contribution to revenue, $\theta_{k,t}/\mu_t$, and a profit share of revenues, $1 - 1/\mu_t$. Since the investment Euler equation recovers the former, equation (20) recovers the latter residually through the lens of the model.

Recovering α_t. The labor share within the capital-labor bundle is recovered from

$$\alpha_t = \frac{\lambda_t \mu_t (1 - s_{m,t})}{1 - s_{m,t}\mu_t}, \tag{21}$$

which follows from combining (19) with $\theta_{l,t} = \alpha_t(1 - \theta_{m,t})$.

Recovering productivity parameters. The ratio of factor demands recovers the relative materials-productivity term B_t/A_t, while primary factor-augmenting productivity A_t is pinned down to match observed output. Together these imply the path of B_t. Investment efficiency χ_t is recovered from the capital accumulation equation.

Further details are provided in Appendix E.

Calibration. We calibrate the discount factor to yield an annual interest rate of 3%. The depreciation rate is set to align with the average for the manufacturing sector as reported by BEA data (approximately 11% per year). The adjustment cost parameter is set to 0.75, positioned between the extremes of no adjustment costs and quadratic adjustment costs, which is consistent with the range of values found in the empirical literature.

For the elasticity of substitution between the capital-labor bundle and materials, we set $\sigma = 0.20$, equal to the mean of the four point estimates for (σ, π) identified in Figure 7a. This value is consistent with the existing literature on the elasticity of substitution between primary inputs and materials (see, e.g., Boehm et al. (2019); Atalay (2017); Peter and Ruane (2025)).

Inversion results. We first present some key features that arise from our model inversion, before moving on to counterfactual analyses. Additional outcomes from the inversion are provided in Appendix E. We start with the gross markups implied by our inversion, which can be seen in Panel (a) of Figure 8. The markup increases gradually over the sample period, consistent with the evidence on rising market power documented in the literature. That said, the gross markup that we recover is quite low in both level and trend, ranging between around 1.06 in 1998 and 1.12 in 2019. The increase in the markup suggests that through the lens of the model, the empirical path of free cash flows in U.S. manufacturing cannot be solely explained by investment patterns, and a structural residual to capture rising profit rates is needed.

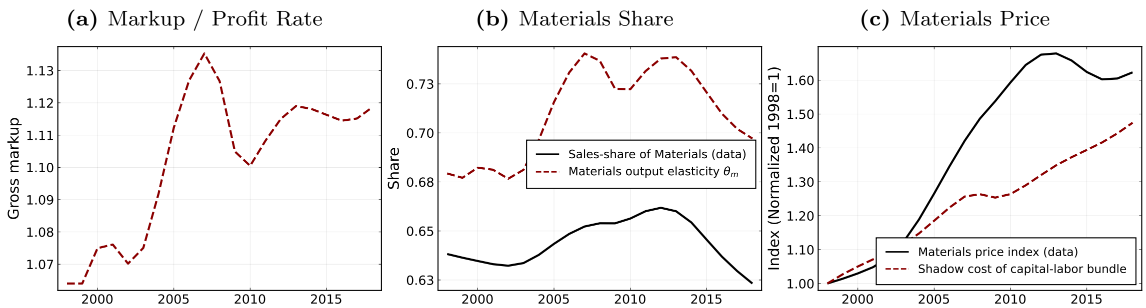
A second key outcome from the inversion is the output elasticity of materials, which can be seen in Panel (b) of Figure 8. The sales share of materials in the data increased in the early 2000s and then decreased in the 2010s. The recovered output elasticity of materials broadly follows this pattern, although given the recovered increase in markups, it remains persistently higher than at the beginning of the sample period.

Finally, Panel (c) shows the materials price index alongside the unit cost of the capital-labor bundle $\tilde{c}_G$.[36] In line with the empirical evidence, the inversion implies a large increase in the price of materials relative to the cost of other inputs of produc-

[36] $\tilde{c}_{G,t}$ is the unit cost of the unaugmented capital-labor bundle, recovered from the ratio of the first-order conditions for materials and the capital-labor composite, as detailed in Appendix E.

tion.

Figure 8: Model Inversion Results



Note: This figure shows results from the model inversion in Section 4.3. Panel (a) shows the recovered gross markup μ_t. Panel (b) shows the materials share of revenues in the data (solid black) and the recovered materials output elasticity $\theta_{m,t}$ (dashed red). Panel (c) shows the materials price index from the data (solid black) and the recovered unit cost of the unaugmented capital-labor bundle $\tilde{c}_{G,t}$ (dashed red), both normalized to 1 in 1998. Data are from the BEA industry accounts for U.S. manufacturing, 1998–2019, HP-filtered with smoothing parameter 5.

4.4 Counterfactual Analysis

Counterfactual Experiments. We conduct two counterfactual experiments to quantify the role of materials prices in shaping the dynamics of the labor share.

Counterfactual 1: Constant materials prices. We hold the materials price $p_{m,t}$ constant at its 1998 level while allowing all other fundamentals and prices to follow their historical paths, including the time-varying residuals α_t and μ_t. This experiment implies a counterfactual decline in the price of materials relative to the cost of labor and capital. Note that at least in the case of labor, for which the cost is measured well, this is a plausible scenario: historically, aside from short periods of booming materials prices, wages have increased at a faster rate than the price of materials.[37]

Counterfactual 2: Constant relative effective materials prices. We hold constant the effective relative price of materials, by adjusting the materials price in accordance with changes in the unit cost of the capital-labor bundle $\tilde{c}_G$, and by adjusting the materials-augmenting productivity B_t in accordance with changes in the primary factor-augmenting productivity A_t. This is a more restrictive counterfactual that holds constant all the exogenous factors that might change the output elasticity of

[37] This suggests that a constant materials-biased technical change is a desirable feature in the balanced growth path of an economy that features our production technology.

materials, although note that it can still change due to endogenous capital accumulation.

Counterfactual Results. Figure 9 presents results from the counterfactual experiments. Each panel shows an outcome of interest in the baseline equilibrium (solid black), which also equals the smoothed outcome in the data, and in the two counterfactual scenarios (dashed red for constant materials prices and dotted blue for constant effective materials prices).

Panel (a) shows our main outcome of interest, the labor share of value added. Holding materials prices constant and allowing everything else to change yields a smaller decline in the labor share than in the baseline. The difference picks up over the 2000s, during the period of the large increase in materials prices, with some gap remaining also at the end of the sample period. To quantify the contribution of materials prices to the changes in the labor share, we compute the cumulative change in the labor share in the counterfactual relative to the baseline:

$$\text{Contribution} = 1 - \frac{\sum_t |\lambda_t^{CF} - \lambda_0|}{\sum_t |\lambda_t^{Baseline} - \lambda_0|}, \tag{22}$$

where λ_0 denotes the labor share at the beginning of the sample (1998). This measure captures how much of the labor share's total cumulative movement from its initial value is eliminated when materials prices are held constant. Using this measure, we assess that the decline of the labor share would have been on average 25%–33% smaller if materials prices had been constant, depending on the counterfactual scenario – relatively similar to our reduced-form quantification in Section 3.

Notably, this counterfactual still allows for other key explanations for the decline in the labor share to operate, through changes in the markup residual (μ_t) and through changes in the capital intensity residual (α_t). In particular, our analysis suggests a non-trivial role for the increase in the markup residual. The model also allows us to decompose value added into labor, capital, and profit shares, since the inversion recovers μ_t. The capital share of value added, defined as the marginal revenue product of capital relative to value added, declines in the baseline but would have been higher absent materials price increases – mirroring the labor share results, with the difference absorbed by the profit share (see Appendix E.7, Figure E.2).

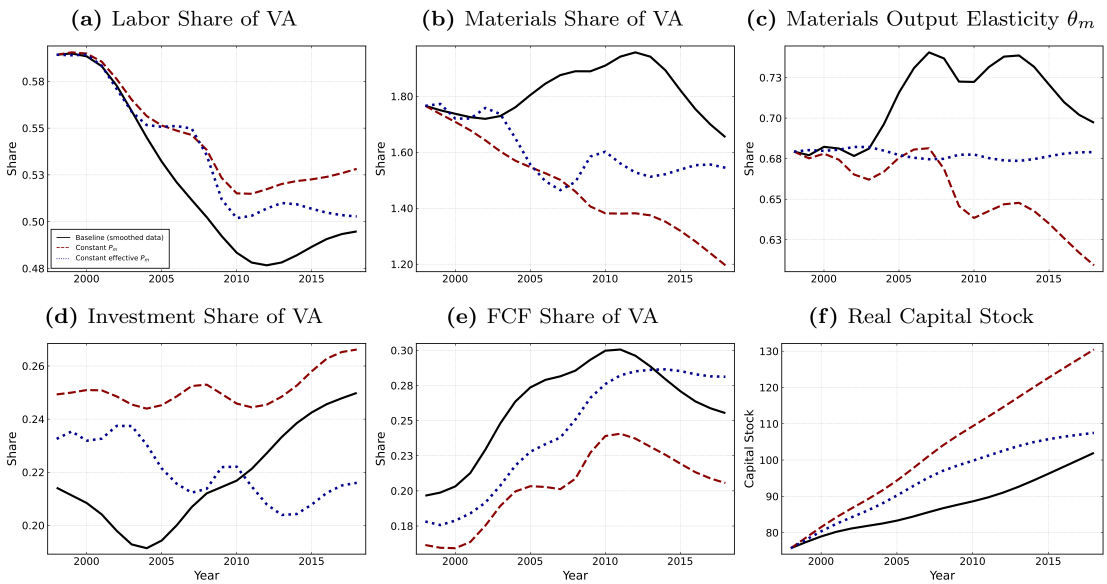
Panels (b)–(f) turn to additional outcomes: the materials-to-value-added ratio, the materials output elasticity, the investment-to-value-added ratio, the free-cash-flow-to-value-added ratio, and the real capital stock. Panels (b) and (c) show that both the materials-to-value-added ratio and the materials output elasticity are lower in the counterfactual scenarios than in the baseline, as the rise in materials prices is shut down. Indeed, absent the observed increase in materials prices, both objects would have trended downward over the sample period, reflecting both the lower relative cost of materials and, in part, the effect of rising markups.

The investment-to-value-added ratio is higher in the counterfactual scenarios, as a lower cost of materials raises the return to investment. Note that this measure jumps on impact relative to the baseline equilibrium, since investment is forward-looking. Accordingly, free cash flow ratios would have been lower in most years, because firms would have spent more on investment. This is distinct from the model's profit share: free cash flow combines capital's marginal contribution to revenue and pure profits and then subtracts current investment expenditure. Thus, while residual markups are still required to explain the rise in free cash flows through the lens of the model, free cash flow ratios would have been lower absent the rise in materials prices. Finally, since higher materials prices dampen firms' investment, the counterfactual scenarios imply a larger capital stock.[38] Similar to markups, the rise in materials prices over this time period acted as a dampening force on investment and capital accumulation, countering a push toward more investment from declining investment prices and from changes in the technological residuals.

Another insight from this analysis highlights the interplay between capital accumulation and our core mechanism. When there are complementarities in production, a higher capital stock – holding everything else constant – increases the materials output elasticity, which in turn lowers the labor share. Thus, while higher materials prices directly contribute to a lower labor share via a higher materials output elasticity, they also generate an offsetting effect: by dampening capital accumulation, they indirectly push the labor share upward.

[38]This follows from the investment Euler equation together with the envelope condition. The shadow value of capital satisfies $\partial V_t/\partial k_t = \partial R_t/\partial k_t + \beta(\partial V_{t+1}/\partial k_{t+1})(\partial k_{t+1}/\partial k_t)$, where $\partial R_t/\partial k_t = (\theta_{k,t}/\mu_t)(E_t/k_t)$ is the marginal revenue product of capital. With complementarity between materials and the capital-labor bundle, a higher materials price raises $\theta_{m,t}$ and lowers $\theta_{k,t} = (1-\alpha_t)(1-\theta_{m,t})$, thereby reducing the shadow value of capital and weakening the incentive to invest.

Figure 9: Counterfactual Sectoral Outcomes in the Quantitative Model



Note: This figure shows results from the counterfactual experiments in Section 4.4. Each panel compares the baseline equilibrium (solid black) with two counterfactual scenarios: constant materials prices $p_{m,t}$ (dashed red) and constant effective materials prices (dotted blue). Counterfactual 1 holds $p_{m,t}$ constant at its 1998 level. Counterfactual 2 holds the ratio $p_{m,t}/\tilde{c}_{G,t}$ constant at its 1998 level and keeps the ratio B_t/A_t constant at its 1998 level (see text for details).

5 Cross-Country Investigation

We now investigate the relationship between materials prices and the labor share in a multi-country setting. This serves two purposes: reconciling differences in the behavior of the labor share across countries, and providing an additional test of our mechanism using cross-country variation in relative materials prices.[39]

5.1 Multi-Country Model

We now present a simple multi-country trade model with a global market for commodities, featuring our mechanism. Detailed derivations can be found in Appendix A.3.

Setting. Consider a world with $N + 1$ countries. N countries are industrial, producing output with endowments of labor and capital and with imported raw ma-

[39] While Karabarbounis and Neiman (2014) and Autor and Salomons (2018) document a decline in the aggregate labor share for a large set of countries, Cette, Koehl, and Philippon (2020) and Gutiérrez and Piton (2020) argue that the existence of a common trend outside the U.S. is less clear after corrections for self-employment and residential housing.

terials, and trading final goods. The remaining country, indexed by 0, is endowed with the global stock of raw materials and exports them to the rest of the world, lacking industrial capabilities. Each country is endowed with an exogenous measure of F_i identical firms that engage in monopolistic competition.

Preferences. The preferences of the representative consumer in country n are given by a CES utility function across all available varieties:

$$U_n \equiv \left[\sum_{i=1}^{N} F_i C_{ni}{}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{23}$$

where C_{ni} is the amount that country n consumes of the good produced by each firm in country i, and η is the elasticity of substitution across varieties.

Production. Each industrial country is endowed with L_n units of labor and K_n units of capital. Firms engage in monopolistic competition, charging a markup $\mu \equiv \eta/(\eta-1)$ over marginal cost. The production function takes our baseline nested-CES form:

$$y_i = \left(\left(A_i l_i^{\alpha} k_i^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} + (B_i m_i)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{24}$$

where A_i and B_i are country-specific primary-augmenting and materials-augmenting productivity, respectively; k_i, l_i and m_i are the amounts of capital, labor and materials employed by each firm in country i; and α is the labor elasticity within the primary input bundle. We allow for trade costs that take the standard iceberg form, in which τ_{ni} units of output are required to ship a single unit of output from country i to country n. We assume that the global supply of materials is perfectly inelastic at $\bar{m}$; that the market for materials is perfectly competitive; and that there are no trade frictions in shipping materials.

Equilibrium in the materials market. Let p_m denote the global price of materials. Defining $\tilde{c}_{G,i} \equiv \frac{1}{A_i \alpha}\left(\frac{L_i}{K_i}\right)^{1-\alpha}$, so that $\tilde{c}_{G,i} w_i$ is the unit cost of the primary-input bundle in country i, the market clearing condition for materials can be written as

$$\bar{m} = \frac{1}{\alpha} \sum_i B_i^{\sigma-1} \tilde{c}_{G,i}^{\sigma-1} L_i \left(\frac{w_i}{p_m}\right)^{\sigma}. \tag{25}$$

The labor share. The labor share of income in country i can be expressed as

$$\lambda_i = \alpha \frac{\left(\tilde{c}_{G,i}\, w_i\right)^{1-\sigma}}{\frac{\eta}{\eta-1}\left(\tilde{c}_{G,i}\, w_i\right)^{1-\sigma} + \frac{1}{\eta-1}\left(\frac{p_m}{B_i}\right)^{1-\sigma}}. \tag{26}$$

Note that when markups are eliminated ($\eta \to \infty$), λ_i becomes the "neoclassical" labor share α, and when the elasticity of substitution σ equals 1, λ_i becomes independent of the price of materials. Otherwise, it depends on the ratio of material prices to the cost of other inputs. Alternatively, the labor share can be expressed in terms of the domestic output price p_i:

$$\lambda_i = \alpha \frac{\eta - 1}{\eta + \left[\left(\frac{\eta}{\eta-1}\frac{p_m}{B_i\, p_i}\right)^{\sigma-1} - 1\right]^{-1}}, \tag{27}$$

where p_i is given in the model by $p_i = \frac{\eta}{\eta-1}\left(\left(\tilde{c}_{G,i}\, w_i\right)^{1-\sigma} + \left(\frac{p_m}{B_i}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$. Therefore, when $\sigma < 1$, the labor share in country i is negatively related to the relative price of materials in that country p_m/p_i, even when there is a global freely-traded commodity market and all countries face the same nominal price of materials.

Comparative statics. We consider two types of shocks to the above system, representing the common narratives for the 2000s commodity boom. For convenience, we set the price of materials p_m as the numéraire, so that wages are measured in terms of material inputs, and a higher wage w_i captures a lower relative price of materials p_m/p_i. Using equations (25) and (26), we can rewrite the market clearing for materials in terms of the labor shares in all countries:

$$\bar{m} = \sum_i \frac{A_i}{B_i} L_i^{\alpha} K_i^{1-\alpha} \left(\frac{1}{(\eta - 1)\,\alpha\,(\lambda_i)^{-1} - \eta}\right)^{\frac{\sigma}{1-\sigma}}. \tag{28}$$

Equation (28) reveals that the labor share remains constant if the global supply of materials $\bar{m}$ grows at the same rate as the composite $\frac{A_i}{B_i} L_i^{\alpha} K_i^{1-\alpha}$ in all countries. When the global supply of materials declines relative to these endowments, at least one country's labor share must fall. More generally, the adjustment need not be homogeneous across countries, and depends on their initial labor shares, endowments of L_i and K_i, and productivity parameters A_i and B_i. We summarize the above results in the following proposition:

Proposition 2. *In the multi-country model with a global commodities market, positive markups ($\eta \in (1, \infty)$) and complementarities in production ($\sigma < 1$): (a) The labor share of income in each country is negatively related to the relative price of materials in that country. (b) A negative shock to the global supply of materials $\bar{m}$ leads to a decline in the labor share in at least one country. (c) A small proportional increase in both primary-augmenting and materials-augmenting productivity (A_j, B_j) in some country j – equivalent to a Hicks-neutral productivity gain – raises the labor share in that country and lowers it in at least one other country.*

Proof. See Appendix A.3. □

To conclude, the above model suggests that the response of the global labor share to a commodity boom depends on the nature of the shock. A supply-driven boom lowers the labor share in at least some countries, while a demand-driven boom reflecting asymmetric productivity growth raises the labor share in the growing country at the expense of others. In both cases, we should expect heterogeneous adjustment of the labor share across countries, in line with differential trends in their relative price of materials.

5.2 International Evidence

The data confirm the model's key prediction: the relative price of materials displays substantial cross-country variation over the 2000s (Appendix Figure F.2). While the U.S. and Japan experienced large increases in relative materials prices, European countries saw more modest movements, in part because the concurrent appreciation of the Euro dampened the local-currency impact of the (dollar-denominated) commodity boom.

We base our analysis on the 2025 release of EU-KLEMS, supplemented with World KLEMS data for Canada and South Korea, covering 23 countries over 1995–2019 at the manufacturing-industry level (Appendix F). We construct a shift-share instrument paralleling the U.S. analysis: $\text{IV}_{c,j,t} = \sum_k s_{c,j,k} \, \Delta \log(p_{k,t} \cdot e_{c,t})$, where $s_{c,j,k}$ are country-specific input-output shares from the WIOD year-2000 tables, $\Delta \log p_{k,t}$ are global commodity price shocks from ComTrade, and $e_{c,t}$ is the bilateral exchange rate vis-à-vis the U.S. dollar, so that commodity prices are expressed in local currency. We estimate the cross-country analog of specification (7), controlling for log wages and absorbing country×industry and year fixed effects.

Table 4: Material Prices and the Labor Share Across Countries

	Unweighted			Weighted		
	(1) OLS	(2) 2SLS	(3) 2SLS	(4) OLS	(5) 2SLS	(6) 2SLS
Materials Intensity × Log Materials Price	-0.0715***	-0.124***	-0.120***	-0.0763***	-0.173***	-0.176***
	(0.0128)	(0.0204)	(0.0224)	(0.0188)	(0.0368)	(0.0398)
First-stage F-stat (KP-Wald)		30.83	26.72		25.38	26.02
N	6201	4782	4557	6201	4782	4557
Country×Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Wage	Yes	Yes	Yes	Yes	Yes	Yes
Excl. US			Yes			Yes

Note: This table reports results from the regression of the log manufacturing labor share on materials intensity × log materials price across 23 countries. The instrument is a shift-share IV constructed from WIOD year-2000 IO shares and ComTrade commodity price shocks, adjusted for bilateral exchange rate movements. All specifications control for log wage and include country×industry and year fixed effects. The 2SLS sample is smaller because the instrument requires matched IO and commodity price data for each country-sector-year. Standard errors in parentheses, clustered at the country×industry level. * p<0.1, ** p<0.05, *** p<0.01.

Table 4 presents the results for the cross-country estimation. Column 1 presents the OLS specification, demonstrating a negative relationship between materials prices and the labor share. Columns 2–3 present the 2SLS results using the shift-share IV, with and without the U.S. Columns 4–6 repeat the same specifications weighted by baseline value-added shares. The results remain negative and significant across all specifications, robust to the inclusion or exclusion of the U.S. and to weighting. Overall, the results confirm that the negative relationship between intermediate prices and the labor share holds in the cross-country panel, in line with our suggested mechanism. Appendix F provides supplementary figures including the first-stage relationship, a binscatter of the OLS relationship, and trends in materials prices across countries.

6 Conclusion

We propose a mechanism that relates the labor share to the relative price of materials in the economy. We show that when materials and primary inputs are complements and the profit share is positive, a higher price of materials lowers the labor share and raises the profit share of value added, without requiring changes in markups or returns to scale. Noting that the aggregate labor share mirrors the evolution of the relative price of materials in the U.S. economy, we provide evidence for this mechanism across broad sectors, narrowly defined U.S. manufacturing industries, U.S. commuting zones, and countries. In doing so, we utilize exogenous variation from the 2000s global commodities boom and the 1970s oil crisis, and exploit natural-disaster shocks affecting major commodity exporters, consistently finding a negative effect of rising materials prices on the labor share. We quantify the aggregate importance of our mechanism by a back-of-the-envelope calculation from our reduced-form estimates and by developing a dynamic quantitative model with capital accumulation that we invert to match U.S. manufacturing data. In both cases, we attribute an important portion of the labor share's decline to movements in the relative price of materials and argue that this decline would have been smaller and smoother absent those fluctuations.

We conclude by noting a few additional implications of our mechanism. First, it implies that part of the downward trend in the labor share has a medium-term cyclical component that varies with global commodity prices. Second, it suggests that aggregate profit shares may vary without any changes in firms' market power or conduct. Finally, it suggests caution when inferring markups from factor shares, highlighting the importance of accounting for fluctuations in the cost-share of intermediates.

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Online Appendices

Contents of the Online Appendix

A Derivations

A.1 Total Differential of the Labor Share

This appendix derives the total differential of the labor share under the general production environment of Section 2.1, and then specializes to obtain Proposition 1 and its generalizations.

A.1.1 General case

Recall that $\lambda = (1-\pi)\theta_l/(1-(1-\pi)\theta_m)$, where $\theta_i \equiv p_i x_i/C$ are cost shares, $\pi \equiv (R-C)/R$ is the profit share, $M \equiv p_m m$, $Y \equiv R-M$, and $\alpha \equiv wl/(wl+rk) = \theta_l/(1-\theta_m)$. Since F is CRS, cost shares depend on factor prices and technology only through the effective prices $\tilde{w} \equiv w/A_L$, $\tilde{r} \equiv r/A_K$, $\tilde{p}_m \equiv p_m/B$. Totally differentiating:

$$d\log\lambda = d\log\theta_l + \frac{M}{Y}\,d\log\theta_m - \frac{R}{Y}\,d\log\left(\frac{1}{1-\pi}\right), \tag{A.1}$$

where we used $(1-\pi)\theta_m/(1-(1-\pi)\theta_m) = M/Y$ and $1 + M/Y = R/Y$.

Changes in cost shares are governed by the substitution structure of the production function. Let $\varepsilon_{ij} \equiv \partial\log x_i/\partial\log\tilde{p}_j$ denote constant-output demand elasticities. Totally differentiating $\theta_i = \tilde{p}_i x_i/C$ and using $d\log C = \sum_j \theta_j\,d\log\tilde{p}_j$:

$$d\log\theta_i = \sum_j H_{ij}\,d\log\tilde{p}_j, \qquad H_{ij} \equiv \mathbf{1}\{i=j\} + \varepsilon_{ij} - \theta_j. \tag{A.2}$$

Substituting into (A.1), define $a_j \equiv H_{lj} + \frac{M}{Y}H_{mj}$, so that

$$d\log\lambda = a_l\,d\log(w/A_L) + a_k\,d\log(r/A_K) + a_m\,d\log(p_m/B) - \frac{R}{Y}\,d\log\left(\frac{1}{1-\pi}\right). \tag{A.3}$$

By homogeneity ($\sum_j H_{ij} = 0$), we have $a_l + a_k + a_m = 0$: only relative effective price changes matter.

Morishima elasticities. Define the Morishima elasticity of input i for input j as $\sigma_{ij} \equiv \partial\log(x_i/x_j)/\partial\log\tilde{p}_j\big|_{y,\tilde{p}_{-j}}$ for $i \neq j$. Using $\varepsilon_{ij} = \sigma_{ij} + \varepsilon_{jj}$ and $\sum_i \theta_i\varepsilon_{ij} = 0$, the

H matrix entries can be written as:

$$H_{ij} = \theta_j(\sigma_{ij} - 1) + \theta_n(\sigma_{ij} - \sigma_{nj}), \qquad i \neq j,\ n = \text{third factor}, \tag{A.4}$$

$$H_{jj} = (1 - \theta_j)(1 - \bar{\sigma}_j), \qquad \bar{\sigma}_j \equiv \frac{\sum_{i \neq j} \theta_i \sigma_{ij}}{1 - \theta_j}. \tag{A.5}$$

Coefficients. The coefficient on the materials price admits a clean two-term decomposition. Using (A.4)–(A.5) and the identity $\frac{M}{Y}(1 - \theta_m) - \theta_m = -\frac{\pi}{1-\pi}\frac{M}{Y}$:[40]

$$a_m = \frac{\theta_k}{1 - \theta_m}\big(\sigma_{lm} - \sigma_{km}\big) - (1 - \bar{\sigma}_m)\frac{\pi}{1 - \pi}\frac{M}{Y}. \tag{A.6}$$

The first term captures differential substitution between labor and capital; the second is the profit-share-of-value-added channel from Proposition 1, generalized to a non-separable production function, F. The remaining coefficients are:

$$a_l = (1 - \theta_l)(1 - \bar{\sigma}_l) + \frac{M}{Y}\Big[\theta_l(\sigma_{ml} - 1) + \theta_k(\sigma_{ml} - \sigma_{kl})\Big], \tag{A.7}$$

$$a_k = \Big[\theta_k(\sigma_{lk} - 1) + \theta_m(\sigma_{lk} - \sigma_{mk})\Big] + \frac{M}{Y}\Big[\theta_k(\sigma_{mk} - 1) - \theta_l(\sigma_{lk} - \sigma_{mk})\Big], \tag{A.8}$$

with $a_l + a_k = -a_m$. In each, the first bracket captures the direct effect on θ_l and the second the indirect effect through θ_m, scaled by M/Y.

Summary. Combining (A.3) with (A.6)–(A.8), the full total differential of the labor share under a general production function F is:

$$\begin{aligned} d\log\lambda = {} & \left[\frac{\theta_k}{1 - \theta_m}(\sigma_{lm} - \sigma_{km}) - (1 - \bar{\sigma}_m)\frac{\pi}{1 - \pi}\frac{M}{Y}\right] d\log\frac{p_m}{B} \\ & + \left[(1 - \theta_l)(1 - \bar{\sigma}_l) + \frac{M}{Y}\big(\theta_l(\sigma_{ml} - 1) + \theta_k(\sigma_{ml} - \sigma_{kl})\big)\right] d\log\frac{w}{A_L} \\ & + \left[\theta_k(\sigma_{lk} - 1) + \theta_m(\sigma_{lk} - \sigma_{mk}) + \frac{M}{Y}\big(\theta_k(\sigma_{mk} - 1) - \theta_l(\sigma_{lk} - \sigma_{mk})\big)\right] d\log\frac{r}{A_K} \\ & - \frac{R}{Y}\, d\log\left(\frac{1}{1 - \pi}\right). \end{aligned} \tag{A.9}$$

[40] To verify: $\frac{M}{Y} = \frac{(1-\pi)\theta_m}{1-(1-\pi)\theta_m}$, so $\frac{M}{Y}(1 - \theta_m) - \theta_m = \frac{-\pi\theta_m}{1-(1-\pi)\theta_m} = -\frac{\pi}{1-\pi}\frac{M}{Y}$.

This expression is fully explicit in cost shares $(\theta_l, \theta_k, \theta_m)$, Morishima elasticities (σ_{ij}), the profit share (π), and the ratio of materials expenditure to value added (M/Y). It nests all the results in Section 2 as special cases.

An equivalent representation decomposes the labor share into three channels: changes in the within-primary labor share α, changes in the relative price of materials versus primary inputs (scaled by the profit share), and changes in the profit share itself:

$$\begin{aligned} d\log\lambda = d\log\alpha \; - \; & \frac{\pi}{1-\pi}\frac{M}{Y}\Bigg[(1-\bar{\sigma}_m)\Big(d\log\frac{p_m}{B} - d\log c_G\Big) \\ & + \frac{\theta_l(\sigma_{ml}-1)+\theta_k(\sigma_{ml}-\sigma_{kl})+\alpha(1-\theta_m)(1-\bar{\sigma}_m)}{1-\theta_m}\, d\log\frac{w}{A_L} \\ & + \frac{\theta_k(\sigma_{mk}-1)+\theta_l(\sigma_{mk}-\sigma_{lk})+(1-\alpha)(1-\theta_m)(1-\bar{\sigma}_m)}{1-\theta_m}\, d\log\frac{r}{A_K}\Bigg] \\ & - \frac{R}{Y}\, d\log\left(\frac{1}{1-\pi}\right), \end{aligned} \tag{A.10}$$

where $d\log c_G \equiv \alpha\, d\log(w/A_L) + (1-\alpha)\, d\log(r/A_K)$ is the Divisia index of effective primary-input prices and $\bar{\sigma}_m = (\theta_l\sigma_{lm} + \theta_k\sigma_{km})/(1-\theta_m)$. The second and third lines inside the bracket capture the effect of non-separability: when materials and the primary bundle are not separable, changes in within-primary prices $(w/A_L, r/A_K)$ also shift the materials cost share. Under CES separability $(\sigma_{lm} = \sigma_{km} = \sigma)$, these terms vanish, $\bar{\sigma}_m = \sigma$, and the expression reduces to equation (6) in the main text.

A.1.2 Special cases

Single materials-price change (Section 2.4). Setting $d\log\tilde{p}_l = d\log\tilde{p}_k = d\log(1/(1-\pi)) = 0$ in (A.3) gives $d\log\lambda/d\log p_m = a_m$, which is the general-production-function result in the main text. Under CES $(\sigma_{lm} = \sigma_{km} = \sigma)$, the first term vanishes and $\bar{\sigma}_m = \sigma$, recovering Proposition 1.

Variable markup (Section 2.4). If the profit share varies endogenously under non-constant demand elasticity ϵ with super-elasticity $\xi \equiv d\log\epsilon/d\log p$, the derivation proceeds in three steps. First, from the definition of Morishima elasticities and cost minimization, $d\log(\theta_i/\theta_m)/d\log p_m = -1 + \sigma_{im}$. Second, combining this with $\sum_i \theta_i = 1$ gives $d\log\theta_m/d\log p_m = 1 - \theta_l\sigma_{lm} - \theta_k\sigma_{km} - \theta_m$, which determines how the materials cost share responds to a change in p_m. Third, under variable markups, the profit share adjusts: from $\mu = \epsilon/(\epsilon-1)$ and $\pi = 1 - 1/\mu$, we obtain $d\log(1/(1-\pi))/d\log p_m = -\theta_m\xi/(\epsilon - 1 + \xi)$, where the sign reflects the fact that a higher materials price raises the output price, which under Marshall's second law ($\xi > 0$) raises the demand elasticity and hence lowers the markup. Substituting these into the expression for $d\log\lambda$ yields the materials-price elasticity:

$$\frac{d\log\lambda}{d\log p_m} = \frac{\theta_k}{1-\theta_m}(\sigma_{lm} - \sigma_{km}) - (1-\bar{\sigma}_m)\frac{\pi}{1-\pi}\frac{M}{Y} + \frac{M}{Y}\frac{\xi}{(1-\pi)(\epsilon-1+\xi)}, \tag{A.11}$$

where the last term captures the endogenous markup adjustment, partially offsetting the baseline effect when $\xi > 0$.

CES production with separability (equation (6)). Under the CES production function (4), materials are separable from the primary bundle G, so $\sigma_{lm} = \sigma_{km} = \sigma$. The dual unit-cost function is $c = (c_G^{1-\sigma} + \tilde{p}_m^{1-\sigma})^{1/(1-\sigma)}$, where $c_G(\tilde{w}, \tilde{r})$ is the unit cost of G. Cost shares satisfy

$$d\log\theta_m = (1-\sigma)(1-\theta_m)(d\log\tilde{p}_m - d\log c_G), \tag{A.12}$$

and separability implies $\theta_l = \alpha(1-\theta_m)$, so

$$d\log\theta_l = d\log\alpha - \theta_m(1-\sigma)(d\log\tilde{p}_m - d\log c_G). \tag{A.13}$$

Substituting into (A.1), the general total differential simplifies to

$$d\log\lambda = d\log\alpha - (1-\sigma)\frac{\pi}{1-\pi}\frac{M}{Y}\Big(d\log p_m - d\log B - d\log c_G\Big) - \frac{R}{Y}\,d\log\left(\frac{1}{1-\pi}\right), \tag{A.14}$$

which is equation (6) in the main text, with $d\log c_G = \alpha\,d\log\tilde{w} + (1-\alpha)\,d\log\tilde{r}$. Holding all terms except p_m constant recovers Proposition 1.

Fixed costs (Section 2.4). With fixed labor costs F_C and isoelastic demand (markup $\mu \equiv \epsilon/(\epsilon-1)$), $\omega \equiv F_C/C$, and $\pi = 1 - (1+\omega)/\mu$. Since $d\log C/d\log p_m =$

$(1-\epsilon)\theta_m$ and $d\log\omega/d\log p_m = (\epsilon-1)\theta_m$:

$$\frac{d\log\lambda}{d\log p_m} = \left[-(1-\sigma)\frac{\pi}{1-\pi} + \omega\left(\frac{(\epsilon-\sigma)(\mu-\theta_m)}{\theta_l+\omega} - \frac{1-\sigma}{1-\pi}\right)\right]\frac{M}{Y}.$$

When $\omega = 0$, this recovers Proposition 1. When $\pi = 0$, the baseline channel vanishes but the fixed-cost channel remains. Its sign is in general ambiguous: at $\epsilon = \sigma$ the fixed-cost channel is strictly negative (amplifying the decline in the labor share), it amplifies the baseline effect when ϵ is low, and dampens it only when ϵ is sufficiently larger than σ.

A.2 General Equilibrium Derivations

A.2.1 A roundabout production economy

Consider an economy with production function $y = \left((A_L l)^{\frac{\sigma-1}{\sigma}} + (Bm)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$, where firms source units of the final good as materials subject to a sourcing friction $1/\kappa$, and have a positive profit share π. The price of materials is $p_m = \kappa p$. The unit cost of output is

$$c = \left[\left(\frac{w}{A_L}\right)^{1-\sigma} + \left(\frac{\kappa p}{B}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

and $p = c/(1-\pi)$, yielding

$$p = \left[\frac{(w/A_L)^{1-\sigma}}{(1-\pi)^{1-\sigma} - \left(\frac{\kappa}{B}\right)^{1-\sigma}}\right]^{\frac{1}{1-\sigma}}.$$

Normalizing $w = 1$:

$$p_m = \frac{B}{A_L}\left[\left(\frac{(1-\pi)B}{\kappa}\right)^{1-\sigma} - 1\right]^{-\frac{1}{1-\sigma}}.$$

The labor share is

$$\lambda = \frac{wL}{wL+\Pi} = \frac{1}{1+\frac{\pi/(1-\pi)}{1-\left(\frac{\kappa}{(1-\pi)B}\right)^{1-\sigma}}},$$

where we used $\Pi = \frac{\pi}{1-\pi} C$ and the ratio $p_m m/(wL) = 1/\left[\left(\frac{(1-\pi)B}{\kappa}\right)^{1-\sigma} - 1\right]$.

A.2.2 A two-sector economy

The extractive sector is endowed with $\bar{m}$ units of materials; the manufacturing sector has the same production function and profit share π. With $w = 1$ normalized:

$$p_m = \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{-\frac{1}{\sigma}}.$$

The manufacturing labor share is

$$\lambda^{manuf} = \frac{1}{1 + \frac{\pi}{1-\pi}\left(1 + \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{\frac{\sigma-1}{\sigma}}\right)}.$$

The aggregate labor share, incorporating extractive-sector rents $p_m \bar{m}$, is

$$\lambda^{agg} = \frac{wL}{wL + \Pi^{manuf} + p_m \bar{m}} = \frac{1-\pi}{1 + \left(\frac{A_L}{B}\right)^{\frac{1-\sigma}{\sigma}} \left(\frac{\bar{m}}{L}\right)^{\frac{\sigma-1}{\sigma}}},$$

which is increasing in $\bar{m}/L$ when $\sigma < 1$, even with $\pi = 0$ in manufacturing.

A.2.3 A small open economy

Materials are sourced at world price p_m; output sold at world price p. The unit cost satisfies

$$p = \frac{1}{1-\pi}\left[\left(\frac{w}{A_L}\right)^{1-\sigma} + \left(\frac{p_m}{B}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

pinning down w. The labor share is

$$\lambda = \frac{\theta_l}{\frac{1}{1-\pi} - \theta_m} = \frac{(1-\pi)(1-\theta_m)}{1-(1-\pi)\theta_m},$$

where

$$\theta_m = \left(\frac{p_m}{B(1-\pi)p}\right)^{1-\sigma}, \qquad \theta_l = 1 - \theta_m.$$

Hence λ is decreasing in p_m/p when $\sigma < 1$ and $\pi > 0$.

A.3 Multi-Country Model

Setting. Consider a world of $N+1$ countries. N industrial countries produce output with endowments of labor and capital and with imported raw materials; they also export and import final goods. The remaining country (indexed by 0) is endowed with the global stock of raw materials and exports them, lacking industrial capabilities. Each country has an exogenous measure F_i of identical firms engaged in monopolistic competition with a CES demand system, ensuring a constant profit share $\pi = 1/\eta$ (where η is the demand elasticity). Since completely free entry in a static model would eliminate profits, we maintain the assumption of no entry.

Preferences. The representative consumer in country n has CES preferences:

$$U_n \equiv \left[\sum_{i=1}^{N} F_i C_{ni}{}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{A.15}$$

where C_{ni} is consumption of country-i output and η is the elasticity of substitution across varieties.

Production. Each industrial country is endowed with L_n units of labor and K_n units of capital. The production function has the nested-CES structure from Section 2:

$$y_i = \left(\left(A_i l_i^{\alpha} k_i^{1-\alpha}\right)^{\frac{\sigma-1}{\sigma}} + (B_i m_i)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{A.16}$$

where A_i is primary-augmenting and B_i is materials-augmenting productivity. Standard iceberg trade costs τ_{ni} apply to final goods; materials trade freely at a global price p_m with perfectly inelastic supply $\bar{m}$.

Prices. Define $\tilde{c}_{G,i} \equiv \frac{1}{A_i \alpha}\left(\frac{L_i}{K_i}\right)^{1-\alpha}$, so that $\tilde{c}_{G,i} w_i$ is the unit cost of the primary-input bundle in country i. The delivered price from i to n is

$$p_{ni} = \frac{\eta}{\eta-1}\tau_{ni}\left(\left(\tilde{c}_{G,i}\, w_i\right)^{1-\sigma} + \left(\frac{p_m}{B_i}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \tag{A.17}$$

where $\mu = \eta/(\eta-1)$ is the common markup (so that the profit share is $\pi = 1 - 1/\mu = 1/\eta$).

Materials market clearing.

$$\bar{m} = \frac{(p_m)^{-\sigma}}{\alpha} \sum_i B_i^{\sigma-1} \tilde{c}_{G,i}^{\sigma-1} L_i w_i^{\sigma}. \tag{A.18}$$

The labor share. In country i:

$$\begin{aligned}\lambda_i &= \alpha \times \frac{(\tilde{c}_{G,i}\, w_i)^{1-\sigma}}{(\tilde{c}_{G,i}\, w_i)^{1-\sigma} + (p_m/B_i)^{1-\sigma}} \times \frac{1}{\mu - \frac{(p_m/B_i)^{1-\sigma}}{(\tilde{c}_{G,i}\, w_i)^{1-\sigma} + (p_m/B_i)^{1-\sigma}}} \\ &= \alpha \frac{(\tilde{c}_{G,i}\, w_i)^{1-\sigma}}{\frac{\eta}{\eta-1}(\tilde{c}_{G,i}\, w_i)^{1-\sigma} + \frac{1}{\eta-1}(p_m/B_i)^{1-\sigma}}. \end{aligned} \tag{A.19}$$

When the profit share vanishes ($\pi \to 0$, i.e. $\eta \to \infty$), the labor share becomes the "neoclassical" share α. When $\sigma = 1$, the labor share is independent of the price of materials.

Equivalently, in terms of the domestic output price p_i:

$$\lambda_i = \alpha \frac{\eta - 1}{\eta + \left[\left(\frac{\eta}{\eta-1} \frac{p_m}{B_i p_i} \right)^{\sigma-1} - 1 \right]^{-1}}. \tag{A.20}$$

Goods market clearing. Industrial-country expenditure on final goods equals value added, not gross revenue, since expenditures on materials are paid to country 0. Therefore

$$\frac{\eta}{\eta - 1} \frac{w_i L_i}{\theta_{l,i}} = \sum_{n=1}^{N} S_{ni} \frac{w_n L_n}{\lambda_n} + S_{0i} p_m \bar{m}, \tag{A.21}$$

where $S_{ni} = F_i(p_{ni})^{1-\eta} / \sum_j F_j(p_{nj})^{1-\eta}$, $\theta_{l,i} = \alpha \frac{(\tilde{c}_{G,i}\, w_i)^{1-\sigma}}{(\tilde{c}_{G,i}\, w_i)^{1-\sigma} + (p_m/B_i)^{1-\sigma}}$, and $\lambda_n \equiv w_n L_n / Y_n$ so that $Y_n = w_n L_n / \lambda_n$ is value added in country n.

Together with (A.19), equations (A.21) and (A.18) yield $N+1$ equations in $N+1$ unknowns ($\{w_i\}_{i=1}^N, p_m$), fully characterizing the equilibrium.

Comparative statics. Setting p_m as numéraire and using (A.18) and (A.19):

$$\bar{m} = \sum_i \frac{A_i}{B_i} L_i^{\alpha} K_i^{1-\alpha} \left(\frac{1}{(\eta - 1)\alpha(\lambda_i)^{-1} - \eta} \right)^{\frac{\sigma}{1-\sigma}}. \tag{A.22}$$

The labor share remains constant in all countries if $\bar{m}$ grows at the same rate as the productivity-adjusted composite $A_i B_i^{-1} L_i^{\alpha} K_i^{1-\alpha}$. If $\bar{m}$ declines relative to these endowments, at least one country's labor share must fall.

A.3.1 Proof of Proposition 2

We prove each statement under the maintained assumptions $\eta \in (1, \infty)$ and $\sigma < 1$, implying a positive profit share $\pi = 1/\eta \in (0, 1)$ and complementarities between materials and primary inputs.

λ_i is negatively related to the relative price of materials. From (A.19), dividing numerator and denominator by $(\tilde{c}_{G,i}\, w_i)^{1-\sigma}$:

$$\lambda_i = \frac{\alpha(\eta - 1)}{\eta + \left(\frac{p_m}{B_i\, \tilde{c}_{G,i}\, w_i}\right)^{1-\sigma}}.$$

Since $\sigma < 1$, the exponent $1 - \sigma > 0$, and the term $(p_m/(B_i\, \tilde{c}_{G,i}\, w_i))^{1-\sigma}$ is strictly increasing in the relative price of materials $p_m/(B_i\, \tilde{c}_{G,i}\, w_i)$. It appears in the denominator with a positive sign, so λ_i is strictly decreasing in $p_m/(B_i\, \tilde{c}_{G,i}\, w_i)$.

To express this in terms of the domestic output price p_i, note from the pricing equation (A.17) that

$$\frac{p_m}{p_i} = \frac{\eta - 1}{\eta} \frac{p_m}{((\tilde{c}_{G,i}\, w_i)^{1-\sigma} + (p_m/B_i)^{1-\sigma})^{1/(1-\sigma)}},$$

which is strictly increasing in $p_m/(B_i\, \tilde{c}_{G,i}\, w_i)$ when $\sigma < 1$. Hence λ_i is also negatively related to p_m/p_i. □

A decrease in $\bar{m}$ lowers at least one country's labor share. Setting p_m as numéraire and substituting the expression for w_i as a function of λ_i (obtained by inverting (A.19)) into the materials market clearing (A.18) yields (A.22):

$$\bar{m} = \sum_i \frac{A_i}{B_i} L_i^{\alpha} K_i^{1-\alpha}\, h(\lambda_i),$$

where

$$h(\lambda) \equiv \left(\frac{1}{(\eta - 1)\alpha\lambda^{-1} - \eta}\right)^{\sigma/(1-\sigma)} = \left(\frac{\lambda}{(\eta - 1)\alpha - \eta\lambda}\right)^{\sigma/(1-\sigma)}.$$

For any equilibrium labor share $\lambda_i \in (0, \alpha(\eta-1)/\eta)$, the argument of h is strictly positive. Since

$$h'(\lambda) = \frac{\sigma}{1-\sigma}\left(\frac{\lambda}{(\eta-1)\alpha-\eta\lambda}\right)^{\sigma/(1-\sigma)-1}\frac{(\eta-1)\alpha}{((\eta-1)\alpha-\eta\lambda)^2} > 0,$$

h is strictly increasing. The coefficients $c_i \equiv \frac{A_i}{B_i}L_i^\alpha K_i^{1-\alpha} > 0$ depend only on exogenous parameters.

If $\bar{m}$ decreases while all (L_i, K_i, A_i, B_i) remain fixed, then $\sum_i c_i h(\lambda_i)$ must decrease in the new equilibrium. Since h is strictly increasing, the labor shares $\{\lambda_i\}$ cannot all weakly increase; at least one must decline.

The individual responses are in general heterogeneous, as the equilibrium adjustment of wages $\{w_i\}$ depends on country-specific characteristics through the goods market clearing conditions (A.21). □

A small proportional increase in (A_j, B_j) raises λ_j and lowers at least one other λ_i. Consider a small proportional shock to country j such that

$$d\log A_j = d\log B_j > 0, \qquad d\log A_i = d\log B_i = 0 \text{ for all } i \neq j.$$

This is a Hicks-neutral productivity improvement in country j.

The coefficients in (A.22) are unchanged. Recall that

$$c_i \equiv \frac{A_i}{B_i}L_i^\alpha K_i^{1-\alpha}.$$

Since the shock is proportional, the ratio A_j/B_j is unchanged, so

$$d\log c_i = 0 \qquad \text{for all } i.$$

There is no direct effect on λ_j holding wages fixed. From (A.19), the labor share in country j depends on the relative price of materials

$$\frac{p_m}{B_j \tilde{c}_{G,j} w_j}.$$

Using the definition of $\tilde{c}_{G,j}$,

$$B_j \tilde{c}_{G,j} = \frac{B_j}{A_j \alpha} \left(\frac{L_j}{K_j} \right)^{1-\alpha},$$

which is unchanged under a proportional shock to (A_j, B_j). Hence, holding w_j fixed, the labor share λ_j is unchanged.

The wage in country j rises locally. A proportional increase in (A_j, B_j) lowers country j's unit cost proportionally and therefore lowers its delivered prices in all markets. For a small Hicks-neutral productivity shock, standard first-order comparative statics in constant-elasticity trade and economic-geography models imply that this increase in competitiveness raises nominal income, and hence the wage, in the shocked country. Therefore,

$$d \log w_j > 0$$

when wages are measured relative to the materials numéraire.

λ_j rises. Since $d \log(B_j \tilde{c}_{G,j}) = 0$ and $d \log w_j > 0$, the relative price of materials in country j,

$$\frac{p_m}{B_j \tilde{c}_{G,j} w_j},$$

falls. Because (A.19) implies that λ_j is strictly decreasing in this relative price when $\sigma < 1$, it follows that

$$d\lambda_j > 0.$$

At least one other λ_i falls. Using (A.22),

$$\bar{m} = \sum_i c_i h(\lambda_i),$$

where $c_i > 0$ is unchanged by the shock and $h'(\lambda) > 0$. Since $\bar{m}$ is fixed and $c_j h(\lambda_j)$ rises when λ_j rises, it cannot be that all other $h(\lambda_i)$ weakly rise as well. Therefore at least one country $i \neq j$ must satisfy

$$d\lambda_i < 0.$$

This proves the claim locally. □

B Data

B.1 Aggregate trends.

Aggregate labor share. Our baseline measure for the aggregate labor share is a simple average of four key measures used in the literature. The first measure is the main specification suggested in Gomme and Rupert (2004), constructed from BEA National Income and Product Accounts (henceforth NIPA). We divide aggregate compensation (NIPA series A033RC) by the sum of compensation, rental income (A048RC), corporate profits (A051RC) and net interest (W255RC), minus depreciation (A262RC). The second measure is the labor share of U.S. non-financial corporations, constructed as the ratio of NIPA series A460RC (compensation in non-financial corporations) to A455RC (gross value added of non-financial corporations). The third measure is the series computed by Fernald (2014), taken from `https://www.frbsf.org/economic-research/files/quarterly_tfp.xlsx`. The final measure is the definition of the BLS for non-farm business-sector labor share, taken from the FRED portal, series PRS85006173.

Aggregate relative price of materials. Figure 1 plots two relative price series: the ratio of the PPI for unprocessed goods for intermediate demand (FRED series WPSID62) to the PCE price index for goods (FRED series DGDSRG3M086SBEA), and the ratio of the PPI for processed goods for intermediate demand (FRED series WPSID61) to the same PCE deflator.

Sector-level outcomes. We rely on data from the BEA Integrated Industry-Level Production Account - the U.S. official KLEMS (capital, labor, energy, materials and service) accounts. See Garner, Harper, Howells, Russell, Samuels et al. (2018) for additional details. We define the labor share as the ratio of total labor compensation to the difference between gross output and expenditure on intermediates. Additional measures of sector-level labor share are obtained from the BEA income accounts, dividing industry-level compensation (Table 6.2) by industry-level national income without capital consumption adjustment (Table 6.1).

B.2 Industry-Level Outcomes in the Manufacturing Sector

NBER-CES Manufacturing Industry Database. Our main data source for the cross-industry analysis is the NBER-CES Manufacturing Industry Database (Becker et al. 2021). This database is a joint effort between the National Bureau of Economic Research (NBER) and U.S. Census Bureau's Center for Economic Studies (CES), containing annual industry-level data from 1958-2016. We use the NAICS version of the dataset with 364 6-digit 2012 NAICS industries, of which 361 have the commodity exposure data needed for the shift-share instrumental variable in the 1991–2016 sample.

Comparison of NBER-CES to BEA data. The raw time series for the ratio of wages to value added in the NBER-CES dataset results in a steady decline since the 1960s. This is in contrast to the path of manufacturing labor-share in other data sources. We have identified three reasons for this discrepancy.[41] First, the census data underestimates expenditure on intermediates (captured in the variable "matcost"), resulting in too high levels of value added, especially in the 1980s and 1990s. This is probably due to the exclusion of most purchased services from expenditures on materials. Note that the sales part of value added is very similar across both datasets. Secondly, the NBER-CES measure of payments to employees captures wages, but misses some other aspects of compensation that have grown in importance over time. Finally, the gap between the NBER-CES measure of wages to the BEA measure of wages and salaries (W&S) has grown over time as well. Figure B.1 shows these discrepancies over time.

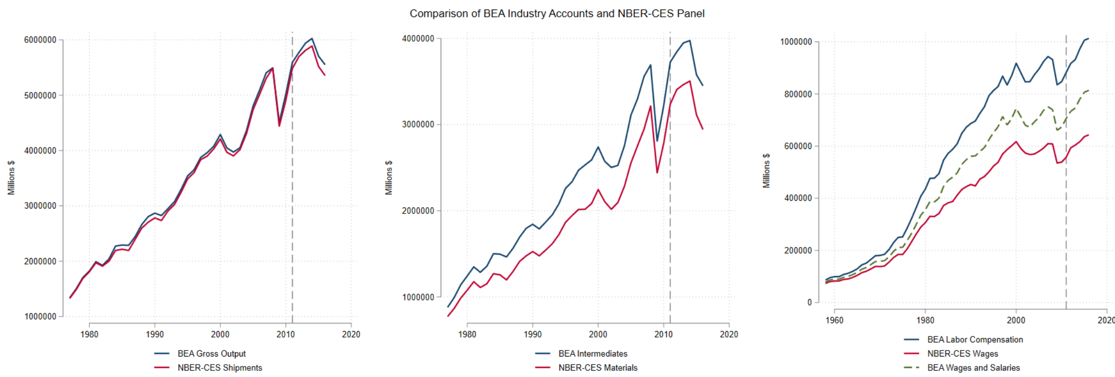
Exposure to Global Commodity Prices. We instrument the industry-level price index of material from the NBER-CES panel using industry exposure to global commodity prices. We follow Fally and Sayre (2022) in defining a list of commodities[42] that correspond to a significant share of the total global commodity trade.

We construct commodity-level price proxies from UN COMTRADE as FOB trade unit values at the HS6-year level. Following standard practice in the literature (e.g. Berthou and Emlinger 2011), we clean the raw series to address reporting-unit changes and obvious outliers rather than smooth genuine price movements. We drop observa-

[41] We have communicated on these findings with researchers in Census CES and BEA.

[42] See https://are.berkeley.edu/~fally/Data/commodity_names.xlsx.

Figure B.1: Comparison of BEA and NBER-CES



Note: This figure compares key aggregates for the manufacturing sector between the BEA industry accounts and the NBER-CES manufacturing panel. The vertical dashed line marks the year in which the NBER-CES data ends. All data from later years is taken from the Annual Survey of Manufacturers (ASM), upon which the NBER-CES panel is based. The left panel compares sales; the middle panel compares expenditure on intermediates in BEA to expenditure on materials (”matcost”) in Census data; and the right panel compares various measures of payments to employees.

tions with missing or nonpositive quantities or trade values, remove very small flows, correct a set of known quantity-scale breaks, impose unit consistency for non-energy codes relative to their 1997 reporting unit, and screen out extreme year-to-year jumps in unit values for non-energy codes.

A very small number of series receive additional treatment. For crude oil and natural gas, we use kilogram-based net weights when available rather than reported quantities. For LNG (HS 271111) and gaseous natural gas (HS 271121), whose reporting units shift sharply over time, we replace the raw annual price path with official EIA import price series, using the external data only for within-code time variation since each code is later normalized to its own 1997 level. Finally, for 11 residual problematic HS6 codes out of 4,281 codes surviving the standard filters, we keep the observed series through 1999 and, from 2000 onward, use median year-to-year growth from the CEPII Trade Unit Values Database, which starts in 2000, anchoring the resulting path to the observed 1999 level. Four of these residual series are subsequently dropped because, even after these corrections, they still imply implausibly large price increases in at least one observation.[43]

To compute the weight of each commodity in the production process of each

[43] The four dropped products are sugar beet (HS 121291), tin ores and concentrates (HS 260900), alloy pig iron (HS 720130), and cement copper (HS 740120). These series are quantitatively negligible as they account for less than 0.003% of global HS6 trade value in any year.

industry, we utilize the 1997 BEA Input-Output (henceforth I-O) table for the U.S. economy.[44] We first assign each commodity to the I-O industry that produces it, using the concordance provided by the BEA.[45] Since each industry is associated with multiple commodities, we take an average of the changes in the different commodity prices within each industry. Finally, since the 1997 I-O classification of industries is a slight aggregation of 1997 NAICS industries, we assign the same measure of commodity prices to all NAICS industries within each I-O industry.

B.3 Regional Data

We obtain county-level manufacturing GDP and baseline county economic characteristics from the BEA regional economic accounts. We obtain county-level manufacturing labor compensation from the BLS Quarterly Census of Employment and Wages (QCEW). We aggregate counties to U.S. 1990 commuting zones according to the U.S. Census Bureau definitions.

B.4 International Data

EU KLEMS. We use the 2025 EU-KLEMS release, run by the Vienna Institute for International Economic Studies, supplemented with the 2020 vintage for gap-filling. This dataset includes measures of economic growth, productivity, employment, capital formation, and technological change at the industry level for all European Union member states, Japan, and the U.S. over the period 1995–2019. We further supplement this with World KLEMS data for Canada (2012 release, 1995–2008) and South Korea (2015 release, 1995–2012). See Appendix F for details on the cross-country sample construction.

B.5 Summary of Data Sources and Samples

Table B.1 summarizes the data sources, materials price measures, and time periods used across the main empirical exercises in the paper.

[44] https://www.bea.gov/industry/input-output-accounts-data

[45] https://apps.bea.gov/industry/zip/NDN0317.zip

Table B.1: Summary of Data Sources Across Empirical Exercises

Exercise	Data source	Materials price measure	Period
Aggregate trends (Fig. 1)	NIPA, BLS	PPI (unproc. & proc.)	1970–2023
Sectoral evidence (Fig. 3)	BEA-KLEMS	Törnqvist of KLEMS prices (materials + energy)	1987–2019
Manufacturing trends (Fig. 4)	BEA-KLEMS	Törnqvist of KLEMS prices (materials + energy)	1987–2019
Baseline IV (Table 1, Figs. 5–6)	NBER-CES	Industry materials price index (materials + energy)	1991–2016
Local labor markets (Table 2)	BEA Regional, QCEW	Weighted industry prices	2001–2016
1970s oil shock (Table 3)	NBER-CES	Industry materials price index (materials + energy)	1970–1980
Counterfactual (Fig. 8)	BEA-KLEMS	Törnqvist of KLEMS prices (materials + energy)	1987–2019
Quantitative model (Sec. 4)	BEA-KLEMS	Törnqvist of KLEMS prices (materials + energy)	1998–2019
Cross-country (Sec. 5)	EU-KLEMS 2025	Törnqvist of KLEMS prices (materials + energy)	1995–2019

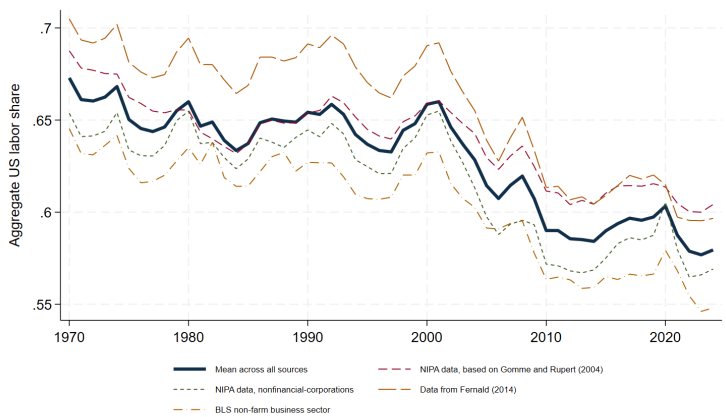
Note: This table summarizes the main data sources and materials price measures used across the empirical exercises in the paper. The NBER-CES industry materials price index (`pimat`) covers the full materials bundle inclusive of energy. KLEMS price indexes aggregate materials and energy prices using Törnqvist (expenditure-share) weights. See the text of this appendix for additional details on each data source.

C Additional Empirical Results

This appendix collects supplementary figures and tables referenced in the main text. We first present additional descriptive evidence on aggregate and sectoral trends, then report robustness checks for our baseline regression results.

C.1 Descriptive Evidence

Figure C.1: U.S. Aggregate Labor Share



Note: This figure shows four different measures for the aggregate historical labor share out of income in the U.S.: (1) The main specification suggested in Gomme and Rupert (2004); (2) The labor share in U.S. non-financial corporations, constructed based on NIPA data; (3) The series computed by Fernald (2014); (4) The definition of the Bureau for Labor Statistics (BLS) for non-farm business-sector labor share, constructed from NIPA data.

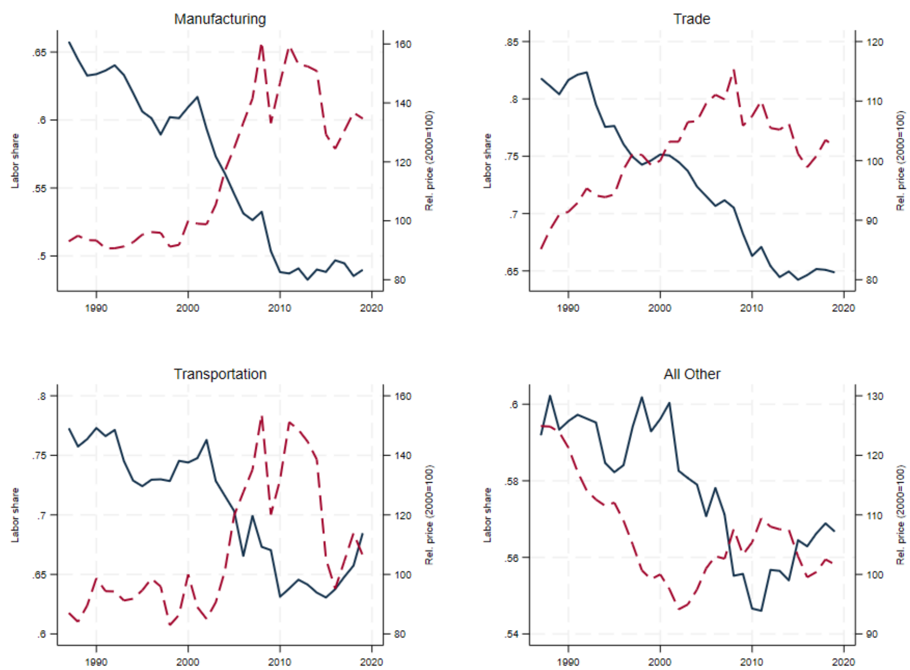
C.2 Dynamic Evidence

To investigate the timing and persistence of the effect, we estimate a non-parametric event-study specification that does not rely on variation in prices, and instead leverages only cross-industry heterogeneity in ex-ante commodity intensity:

$$y_{jt} = \delta_t + \delta_j + \sum_{\ell=1991,\ell\neq 1997}^{2016} \beta_\ell \mathbf{1}\left[\ell = t\right] \times \theta^{comm}_{j1997} + \varepsilon_{jt} \tag{C.1}$$

where θ^{comm}_{j1997} is the commodity cost share of industry j in the 1997 Input-Output Table defined in Equation 9. The coefficients β_ℓ flexibly estimate the effect of baseline industry commodity intensity on the outcome of interest in each year, setting 1997 as the omitted year.

Figure C.2: Labor Share and Relative Price of Materials Across U.S. Sectors

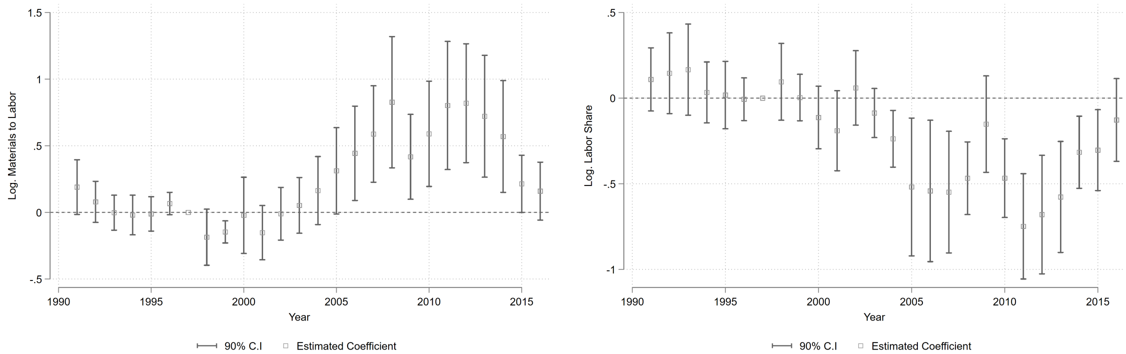


Note: Each panel plots the labor share (solid line, left axis) and the relative price of materials and energy inputs to value added (dashed line, right axis) for a broad sector of the U.S. economy between 1987 and 2019. Data are from BEA's Integrated Industry-Level Production Account (KLEMS). Manufacturing includes all 19 NAICS manufacturing subsectors. Trade includes wholesale and retail trade. Transportation includes air, rail, water, truck, transit, pipeline, other transportation, and warehousing. All Other includes mining, construction, information, finance, real estate, professional and business services, education, health care, arts, accommodation, food services, and other services (excluding government, agriculture, and utilities). Both the materials-and-energy and value added price indexes are Törnqvist chain-type indexes, aggregated across industries within each sector using time-varying nominal expenditure shares as weights. Each industry's implicit price is computed as nominal compensation divided by the corresponding quantity index. The relative price series are normalized to 100 in 2000. The labor share is computed as total labor compensation (college and non-college) divided by nominal value added within each sector.

Figure C.3a shows results for the case of expenditure on materials relative to expenditure on labor in logs. Industries with higher ex-ante exposure to commodities experienced an increase in the expenditure on materials relative to labor during the 2000s, coinciding with the timing of the rise in commodity prices. This specification does not use any information on prices, indicating that an industry's ex-ante reliance on commodities is a key characteristic for the path of its allocation of costs across inputs during the covered period. Figure C.3b shows the corresponding results for the log labor share. Industries with higher ex-ante commodity intensity experienced a larger relative decline in their labor share, with the trend coinciding with the timing of the commodity boom. The decline was briefly overturned in 2009 during the Great Recession.

Figure C.3: The Effect of Commodity Intensity on Materials-to-Labor Expenditure Ratio and on the Labor Share

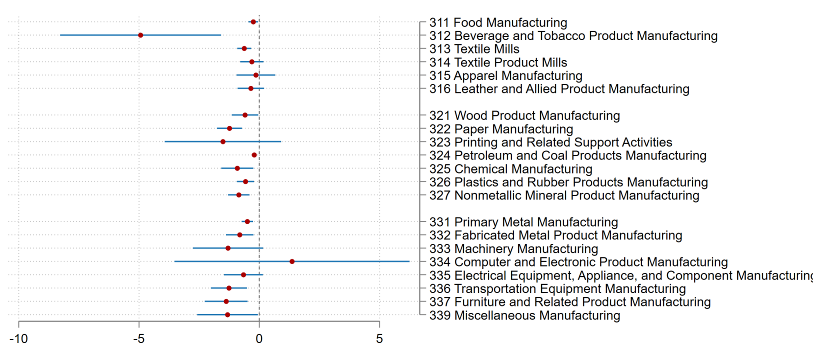
(a) Material-to-Labor Expenditure Ratio. **(b)** Labor Share.



Note: Panel (a) plots the set of coefficients β_ℓ from the estimation of Equation C.1, when the outcome variable is industry-level log expenditure on materials relative to expenditure on labor. Panel (b) plots the set of coefficients β_ℓ from the estimation of Equation C.1, when the outcome variable is industry-level log labor share. The gray lines capture a 90% confidence interval.

C.3 Additional Figures

Figure C.4: Effect of Material Prices on the Labor Share by 3-digit NAICS Sectors



Note: This figure plots the estimated coefficients for the effect of exposure to rising materials prices on the log of labor share from Section 3 for each 3-digit NAICS manufacturing subsector, with their corresponding 90% confidence intervals. We instrument the interaction between the 3-digit NAICS sectors dummy and the materials price index with the analogous interaction between these dummies and the shift-share instrument defined in Equation 10.

C.4 Descriptive Tables

Table C.1 lists the individual commodities with the largest price increases between 2000 and 2010. Table C.2 reports the manufacturing industries most exposed to these price changes, along with the corresponding change in the labor share and baseline commodity intensity.

Table C.1: Commodities with Largest Price Increases

HS96	Commodity	% Δ Price (00'–10')
180200	Cocoa shells, husks, skins and other cocoa	2333.1
260300	Copper ores and concentrates	1889.9
520644	Combed cabled cotton yarn, with <85%	1072.8
741022	Foil, copper alloy, backed	867.1
740312	Wire bars, copper, unwrought	612.1
260111	Non-agglomerated iron ores and concentrates	598.2
740500	Master alloys of copper	491.5
120720	Cotton seeds	457.3
721129	Flat rolled prod, i/nas, hr, <600mm wide	439.8
721190	Flat rolled prod, i/nas, <600mm wide, not	426.8

C.5 Robustness and Extensions

The following tables present robustness checks for the baseline regression results reported in Section 3. Table C.3 examines the effect of materials prices on other industry-level outcomes. Table C.4 reports an augmented reduced form that includes both the non-interacted log materials price and its interaction with baseline materials intensity. Table C.5 reports auxiliary empirical moments used for structural identification in Section 3.10. Table C.6 adds 3-digit NAICS × year fixed effects. Table C.7 aggregates to the BEA subsector level. Tables C.8 and C.9 consider alternative instrument constructions. Table C.10 controls for industry concentration. Table C.11 decomposes the instrument into energy and non-energy components.

Table C.2: Industries with the Largest Increase in Commodity Prices

Rank	NAICS Code	Description	% Δ Commodity Price (00'–10')	Δ Labor Share (00'–10')	Commodity Intensity (00')
1	331410	Nonferrous Metal (except Aluminum)	96.3	-0.189	0.660
2	331420	Copper Rolling, Drawing, Extruding, and	93.4	-0.061	0.524
3	324110	Petroleum Refineries	87.5	-0.031	0.641
4	311224	Soybean and Other Oilseed Processing	59.1	-0.105	0.695
5	331491	Nonferrous Metal (except Copper and	50.0	-0.126	0.493
6	331210	Iron and Steel Pipe and Tube	44.2	-0.019	0.512
7	325314	Fertilizer (Mixing Only) Manufacturing	43.3	-0.110	0.323
8	331222	Steel Wire Drawing	38.4	-0.051	0.476
9	331221	Rolled Steel Shape Manufacturing	37.7	-0.112	0.474
10	332114	Custom Roll Forming	32.9	-0.044	0.441
11	331110	Iron and Steel Mills and Ferroalloy	32.0	-0.159	0.315
12	325311	Nitrogenous Fertilizer Manufacturing	30.4	-0.211	0.274
13	325312	Phosphatic Fertilizer Manufacturing	29.8	-0.155	0.326
14	311211	Flour Milling	29.4	-0.057	0.511
15	332112	Nonferrous Forging	29.2	-0.032	0.375

Note: Commodity price change is the percentage change in the shift-share commodity price index (Equation 10) between 2000 and 2010. Commodity intensity is total expenditure on commodities as a share of total costs in 2000 (Equation 9).

Table C.3: The Effect of the Price of Materials on Other Industry Outcomes

	(1) Log M/Y	(2) Log Y/R	(3) Log M/W	(4) Log M/K	(5) Log K/Y	(6) Log K/L
Materials Intensity × Log. Materials Price	0.0963**	-0.0696***	0.216***	0.223***	-0.126***	-0.00224
	(0.0407)	(0.0183)	(0.0596)	(0.0598)	(0.0238)	(0.00382)
First-stage F-stat (KP-Wald)	12.82	12.82	12.82	12.82	12.82	12.82
N	9386	9386	9386	9386	9386	9386
Industry controls (see notes)						
Industry and Year FE						
Weighted	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports results from the regression of selected industry outcomes on exposure to materials prices as in Table 1, using the same instrument, the same sample restrictions, and the same controls as in Column 9 of Table 1. Column 1 reports results for the log of expenditure on materials over value added; Column 2 for the log of value added over sales; Column 3 for the log of expenditure on materials over total payroll; Column 4 for the log of expenditure on materials over the real stock of capital; Column 5 for the log of the real stock of capital over value added; Column 6 for the log of the real stock of capital over the total number of employees. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.4: The Effect of Material Prices on the Labor Share – Augmented Reduced Form

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS
Materials Intensity × Log. Materials Price	-0.119***	-0.119***	-0.278***	-0.275***	-0.202***	-0.211***	-0.185***
	(0.0281)	(0.0279)	(0.0764)	(0.0743)	(0.0360)	(0.0377)	(0.0569)
Log. Materials Price	-0.0494	-0.0640	0.189	0.156	0.122*	0.149	0.350*
	(0.0663)	(0.0657)	(0.115)	(0.105)	(0.0695)	(0.0922)	(0.197)
First-stage F-stat (KP-Wald)			15.23	16.64	28.60	30.30	19.70
N	9386	9386	9386	9386	9386	9386	9386
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	No	No	Yes	Yes	Yes
Industry-Specific Trends	No	No	No	No	No	No	Yes

Note: This table reports regressions of the industry-level log labor share on two terms: the non-interacted log materials price and its interaction with baseline materials intensity. Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset for the period between 1991 and 2016. All specifications include industry and year fixed effects. Columns (1) and (2) report OLS results. Columns (3) to (7) instrument the interaction term with the shift-share commodity price instrument defined in Equation 10. Columns (5) to (7) are weighted by industry value added in 1990. Columns (2), (4), (6), and (7) control for the log of the average wage and the log of the investment price. Columns (6) and (7) additionally control for import penetration overall and from China. Column (7) further adds industry-specific linear time trends. We do not add controls such as $\log(K/L)$ or the production-worker share in this exercise, since those variables may mediate the independent effect of the non-interacted materials-price term. Standard errors clustered at the industry level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.5: The Effect of Material Prices on the Materials Intensity and the Value-Added Share

	(1) Log M/Y	(2) Log M/Y	(3) Log Y/R	(4) Log Y/R
Log. Materials Price	0.498***	0.529***	-0.397***	-0.382***
	(0.159)	(0.150)	(0.121)	(0.0491)
First-stage F-stat (KP-Wald)	29.76	72.54	29.76	72.54
N	9386	9386	9386	9386
Industry controls (see notes)	Yes	Yes	Yes	Yes
Industry and Year FE	Yes	Yes	Yes	Yes
Weighted	Yes	Yes	Yes	Yes

Note: This table reports results from the regression of additional industry outcomes on the log of the price index of materials, instrumented with the shift-share IV defined in Equation 10. Columns (1) and (2) use $\log(M/Y)$ as the dependent variable, where M is materials expenditure and Y is value added. Columns (3) and (4) use $\log(Y/R)$, where R is gross output. Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset between 1991 and 2016. All specifications control for industry and year fixed effects, the log of the average wage, the log of the price of investment, the share of production workers, the log of the capital-labor ratio, and import penetration overall and from China. All regressions are weighted by industry value added in 1990. Columns (2) and (4) additionally include industry-specific linear time trends. Standard errors clustered at the industry level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.6: The Effect of Material Prices on the Labor Share – Three Digits NAICS – Year Fixed Effects

	Log Industry Labor Share				
	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.135***	-0.220***	-0.201***	-0.217***	-0.218***
	(0.0278)	(0.0562)	(0.0563)	(0.0572)	(0.0571)
First-stage F-stat (KP-Wald)		33.92	46.92	46.41	45.96
N	9386	9386	9386	9386	9386
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	No	Yes	Yes
Import Penetration Controls	No	No	No	No	Yes
Industry and Year FE ×NAICS-3 Sector FE	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes

Note: This table is a replication of our baseline results Table 1 in Section 3, controlling also for Year × NAICS-3 sector fixed effects. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.7: The Effect of Material Prices on the Labor Share – BEA Subsectors

	Industry Log Labor Share						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.0949***	-0.104***	-0.0908***	-0.0943***	-0.0942***	-0.0943***	-0.101***
	(0.00733)	(0.0138)	(0.0143)	(0.0127)	(0.0128)	(0.0130)	(0.0162)
Sourced Services Share						-0.134	-0.135
						(0.254)	(0.263)
Log. Services Price Index							0.427
							(0.685)
First-stage F-stat (KP-Wald)		79.96	60.03	64.40	61.64	62.11	54.36
N	494	494	494	494	494	494	494
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	No	Yes	Yes	Yes	Yes
Import Penetration Controls	No	No	No	No	Yes	Yes	Yes
BEA Subsector and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes	Yes	Yes

Note: This table is a replication of our baseline results Table 1 in Section 3 when aggregating the data to the 19 BEA (Bureau of Economic Analysis) manufacturing summary-level sub-sectors. Labor share is now defined as total labor compensation to value added in the BEA-KLEMS dataset, and the materials price index is taken from there as the ratio of total material compensation to material quantity. Column (6) extends the baseline analysis by controlling also for the share of sourced services compensation of total intermediates, and Column (7) adds the log price index of sourced services. Both variables are constructed from the BEA-KLEMS dataset. * p<0.1, ** p<0.05, *** p<0.01.

Table C.8: The Effect of Material Prices on the Labor Share – Leontief Inverse

	Log Industry Labor Share				
	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.135***	-0.228***	-0.197***	-0.189***	-0.188***
	(0.0219)	(0.0486)	(0.0344)	(0.0279)	(0.0278)
First-stage F-stat (KP-Wald)		37.89	22.53	21.60	21.51
N	9386	9386	9386	9386	9386
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	No	Yes	Yes
Import Penetration Controls	No	No	No	No	Yes
Industry and Year FE	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes

Note: This table is a replication of our baseline results Table 1 in Section 3, with an instrument constructed from the Leontief Inverse of the Input-Output table to account for exposure to changing commodity prices through input-output linkages, as described in Section 3.11. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.9: The Effect of Material Prices Using Only Variation in Prices

	Log Industry Labor Share				
	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.135***	-0.298***	-0.192***	-0.156***	-0.156***
	(0.0219)	(0.0598)	(0.0456)	(0.0317)	(0.0313)
First-stage F-stat (KP-Wald)		21.62	3.554	3.262	3.261
N	9386	9386	9386	9386	9386
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	No	Yes	Yes
Import Penetration Controls	No	No	No	No	Yes
Industry and Year FE	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes

Note: This table is a replication of our baseline results Table 1 in Section 3, with an instrument that utilizes only variation coming from changes in commodity prices, independently of overall exposure to commodities, as described in Section 3.11. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.10: Controlling for Industry Concentration

	Log Industry Labor Share					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	2SLS	OLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.187***	-0.261***	-0.260***	-0.178***	-0.252***	-0.251***
	(0.0237)	(0.0288)	(0.0270)	(0.0222)	(0.0293)	(0.0263)
% Sales Top-4				-0.234	-0.162	-0.155
				(0.291)	(0.296)	(0.259)
Log. HHI-50				-0.0697	-0.0759*	-0.0749*
				(0.0445)	(0.0452)	(0.0421)
First-stage F-stat (KP-Wald)		48.35	46.69		51.17	48.84
N	1390	1390	1390	1390	1390	1390
Average Wage and Investment Price Controls	Yes	Yes	Yes	Yes	Yes	Yes
Production Workers Share and K/L Ratio Controls	No	No	Yes	No	No	Yes
Import Penetration Controls	No	No	Yes	No	No	Yes
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table replicates our baseline specification with two industry concentration measures – the sales share of the largest 4 firms in each industry ("% Sales top 4") and the Log. Herfindahl–Hirschman index for the largest 50 firms ("Log. HHI-50"). Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset for the years 1997, 2002, 2007 and 2012. All specifications control for industry and year fixed effects and are weighted by 1990 value-added. Columns 1-3 report OLS results and 2SLS results without industry concentration measures, and Columns 4-6 repeat these regressions with them. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table C.11: The Effect of Material Prices on the Labor Share – Energy vs. Non-energy Instruments

	Energy IV				Non-energy IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Materials Intensity × Log. Materials Price	-0.162***	-0.171***	-0.174***	-0.101***	-0.266**	-0.334**	-0.317*	-0.371*
	(0.00867)	(0.0123)	(0.0105)	(0.00561)	(0.104)	(0.153)	(0.164)	(0.193)
Log. Average Wage		0.0516	0.0203	0.00212		0.124	0.0952	0.0814
		(0.149)	(0.135)	(0.111)		(0.178)	(0.181)	(0.178)
Log. Investment Price		0.271	0.513**	0.473		0.667	0.791**	0.576
		(0.168)	(0.211)	(0.458)		(0.443)	(0.400)	(0.532)
Production Workers Share			-0.636**	-0.478			-0.701**	-0.531
			(0.268)	(0.303)			(0.293)	(0.334)
Log. Capital-Labor Ratio			0.0633	-0.0113			0.0345	-0.0657
			(0.0398)	(0.0424)			(0.0576)	(0.0939)
Import Penetration			0.0223	-0.0226			0.0241	-0.00957
			(0.0505)	(0.0470)			(0.0484)	(0.0529)
Import Penetration - China			0.180	0.408*			0.109	0.374
			(0.136)	(0.243)			(0.142)	(0.279)
First-stage F-stat (KP-Wald)	8466.6	4158.7	4878.0	17756.8	9.661	6.199	4.363	4.161
N	9386	9386	9386	9386	9386	9386	9386	9386
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Specific Trends	No	No	No	Yes	No	No	No	Yes

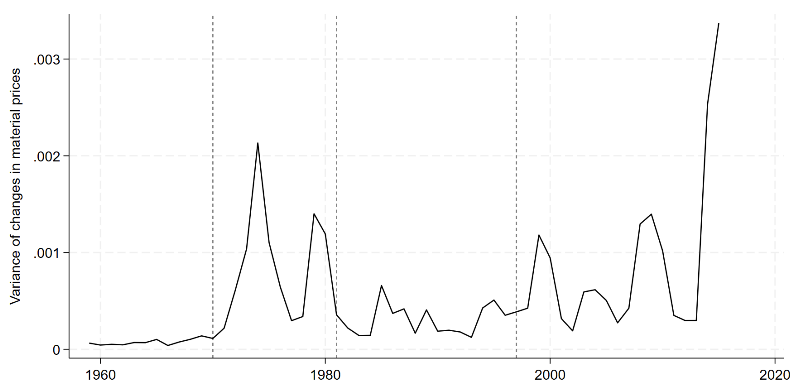
Note: All specifications include industry and year fixed effects and are weighted by value added in 1990. Standard errors clustered at the industry level are in parentheses. Columns (1)–(4) instrument with the energy component of the shift-share IV; columns (5)–(8) instrument with the non-energy component. Columns (4) and (8) further include industry-specific linear time trends. * p<0.1, ** p<0.05, *** p<0.01.

C.6 Analysis of Periods with no Variation in Prices

In the main text, we exploit the 2000s commodity boom and the 1970s oil shocks as sources of exogenous variation. In other periods, our ability to test the mechanism is constrained by limited cross-industry variation in materials prices. Appendix Figure C.5 shows the variance of materials price growth across manufacturing industries: it is negligible before the 1970s (possibly due to Bretton Woods exchange-rate stability or measurement issues) and modest in the 1980s and early 1990s.

Despite this limited variation, Appendix Table C.12 replicates the OLS version of our baseline specification – the same controls as Column (7) of Table 1 – across four sub-periods. The coefficient on materials prices is negative in all periods and statistically significant in three of four, with the noisiest estimate in 1958–1970 where price variation is most limited. The coefficients are smaller in magnitude in the earlier periods relative to the most recent period, consistent with both lower cross-industry price variation (which reduces statistical power) and lower profit rates in earlier decades (which, per Proposition 1, attenuate the transmission of materials prices to the labor share). The coefficient on the materials-to-labor expenditure ratio is positive and highly significant in all periods, confirming complementarity between materials and primary inputs across episodes. In all cases, the estimated relationship provides correlational evidence only.

Figure C.5: Dispersion in the Growth of Residual Materials Prices



Note: This figure plots the variance of the growth of materials prices across all 6-digit NAICS manufacturing industries after controlling for industry fixed effects, year fixed effects, the log of average wage and the log price of investment goods. Industries are weighted by value added. The vertical dashed lines correspond to the years 1970, 1981 and 1997.

Table C.12: The Effect of Material Prices – Different Periods (A)

	Labor Share				Log. Materials to Wage-Bill			
	(1) 1958-1970	(2) 1970-1980	(3) 1980-1997	(4) 1997-2016	(5) 1958-1970	(6) 1970-1980	(7) 1980-1997	(8) 1997-2016
Materials Intensity × Log. Materials Price	-0.0165	-0.0127***	-0.00806**	-0.0197***	0.157***	0.110***	0.136***	0.171***
	(0.0100)	(0.00481)	(0.00409)	(0.00721)	(0.0374)	(0.0335)	(0.00798)	(0.0301)
N	4693	3971	6498	7280	4693	3971	6498	7280
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports OLS results from the regression of industry-level outcomes on materials intensity (materials expenditure over value added at the beginning of the period) interacted with the log materials price index, controlling for the log average wage, the log price of investment goods, the production-worker share, and the log capital-labor ratio (the same controls as Column 7 of Table 1). Import penetration controls are omitted because they are unavailable before 1991. Columns (1)–(4) report results for the labor share, and columns (5)–(8) report results for the log of expenditure on materials to wage bill ratio. Observations correspond to industry-year pairs for the 364 NAICS industries in the NBER-CES dataset. All specifications control for industry and year fixed effects and weight observations by value added at the beginning of the corresponding period. Standard errors clustered at the industry level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

D Alternative Instrument: Natural Disaster Shocks

In this appendix, we develop an alternative instrumental variable for changes in industry materials prices that exploits supply disruptions caused by natural disasters around the world. Intuitively, an industry is highly exposed to disasters in some period t if it heavily relies on inputs that tend to be exported by countries that experience disasters in that period. We describe the construction of this instrument and present results below.

D.1 Construction of the Disaster Instrument

The construction of the disaster-based instrument proceeds in four steps.

Step 1: Natural disaster data. We obtain data on natural disasters from EM-DAT, the International Disaster Database maintained by the Centre for Research on the Epidemiology of Disasters (CRED). The database provides comprehensive records of disasters worldwide, including information on the type of event (earthquake, flood, storm, extreme temperature, volcanic activity, wildfire, etc.), location, date, and human impact. We focus on natural disasters between 1990 and 2016, excluding epidemics, infestations, and animal incidents. For each country, we define a "large" disaster as one with a death toll at or above the 80th percentile of that country's distribution of positive-death disaster events. This country-specific threshold accounts for the fact that disaster severity varies substantially across countries due to differences in exposure, infrastructure, and population density. We then construct a dummy variable D_{kt} that equals one if country k experienced a large disaster in year t or year $t-1$, reflecting the potentially persistent effects of disasters on production and exports. This yields 56 countries with at least one qualifying disaster event during our sample period.

Step 2: Identifying products exposed to disasters. For each country that experiences large disasters, we use bilateral trade data from BACI (HS92 classification, 1997) to identify the products in which that country plays a central role in global trade. Specifically, we flag a product h as exposed to disasters in country k if two conditions are met: (i) country k accounts for more than 5% of global exports in product h, and (ii) product h constitutes at least 5% of country k's total exports.

The first condition ensures that the country is a sufficiently important supplier so that disruptions to its production capacity could plausibly affect world supply of that product. The second condition ensures that the product is economically important to the country, so that a major disaster is likely to disrupt its production. Across all disaster-affected countries, this yields 107 exposed country-product links spanning 64 products.

Step 3: Defining product-level disaster shocks. For each HS4 product h and year t, we define a product-level shock indicator S_{ht} that equals one if at least one of the major exporters of product h (as identified in Step 2) experienced a large disaster in year t or $t-1$, and zero otherwise.

Step 4: Constructing industry-level exposure to disasters. Finally, we construct each industry's exposure to the product-level disaster shocks defined in Step 3. For each NAICS industry j, we first map each HS4 product to NAICS industries using a trade-weighted concordance, and then use the input-output shares from the 1997 BEA IO table to compute how much each upstream commodity matters for each downstream using industry. Industry j's disaster instrument in year t is then a weighted average of the product-level shocks S_{ht}, where the weights reflect the importance of each product as an input to industry j. The resulting instrument is

$$Z_{jt}^{dis} = \sum_{c} \sum_{h \in c} \alpha_{cj} w_{hc} S_{ht}, \tag{D.1}$$

where α_{cj} is the input-output share of commodity c in industry j's input bundle, and w_{hc} is the trade-weighted mapping from HS product h to IO commodity c. An industry that relies heavily on inputs whose major exporters experienced disasters will thus have a higher value of Z_{jt}^{dis}. This structure is analogous to the baseline instrument in Equation 10, but replaces the continuous variation in commodity prices with a binary indicator for disaster-induced supply disruptions.

Table D.1 provides illustrative examples of the types of variation exploited by this instrument. The table lists selected countries alongside their major export products and examples of qualifying disaster events. As can be seen, the instrument leverages a wide variety of disaster types – earthquakes, floods, storms, and extreme temperatures – across diverse geographies and commodity categories, ranging from primary commodities (copper, coal, petroleum) to agricultural products (coffee, cotton, cocoa).

Table D.1: Examples of Major Disasters and Associated Export Products

Country	Disaster Example	Deaths	Major Export Product (HS4)	Global Share (%)	Export Share (%)
Indonesia	2004 Tsunami	165,708	Plywood (4412)	40.6	6.3
			Petroleum gases (2711)	8.6	9.0
Bangladesh	1991 Tropical cyclone	138,866	Men's shirts (6205)	7.7	12.9
Myanmar	2008 Tropical cyclone	138,366	Leguminous vegetables (0713)	6.6	17.5
Pakistan	2005 Earthquake	73,338	Cotton yarn (5205)	17.5	18.9
			Bed linen (6302)	8.9	8.0
			Leather apparel (4203)	6.8	5.5
			Cotton fabrics (5209)	5.0	5.2
Sri Lanka	2004 Tsunami	35,399	Tea (0902)	11.9	7.7
Venezuela	1999 Flash flood	30,000	Refined petroleum (2710)	5.2	21.0
			Crude petroleum (2709)	5.0	49.6
Iran	2003 Earthquake	26,796	Crude petroleum (2709)	5.5	76.0
India	2001 Earthquake	20,005	Diamonds (7102)	10.6	10.2
Japan	2011 Tsunami	19,846	Motor vehicles (8703)	20.1	11.8
			Integrated circuits (8542)	16.4	6.0
Nepal	2015 Earthquake	8,831	Carpets (5701)	8.3	36.6
Philippines	2013 Tropical cyclone	7,354	Integrated circuits (8542)	5.5	27.6
Algeria	2003 Earthquake	2,266	Petroleum gases (2711)	9.3	39.7
Russia	1995 Earthquake	1,989	Petroleum gases (2711)	23.8	17.1
			Crude petroleum (2709)	7.4	20.7
			Refined petroleum (2710)	6.7	7.7
Guatemala	2005 Tropical cyclone	1,513	Coffee (0901)	5.1	22.5
Colombia	1999 Earthquake	1,186	Coffee (0901)	14.2	18.4
			Bananas (0803)	11.1	5.9
Brazil	2011 Flood	900	Oil-cake residues (2304)	32.7	5.4
			Iron ores (2601)	26.9	5.9
Ukraine	2006 Severe winter	801	Steel semi-finished (7207)	9.8	7.3
			Steel coils (7208)	6.9	9.0
Morocco	1995 Flood	730	Phosphorus pentoxide (2809)	34.7	8.7
			Calcium phosphates (2510)	30.9	7.5
			Molluscs (0307)	7.6	5.2
Ecuador	2016 Earthquake	672	Bananas (0803)	26.2	28.4
			Crustaceans (0306)	7.9	16.0
Peru	2007 Earthquake	593	Fish meal (2301)	33.9	15.2
			Zinc ores (2608)	13.9	6.0
			Refined copper (7403)	5.5	11.2

Note: This table shows the 20 deadliest qualifying natural disasters (from EM-DAT, 1990–2016, excluding epidemics, infestations, and animal incidents) among countries used in the construction of the disaster instrumental variable, showing one disaster per country (the deadliest). For each country, the table lists the products for which it is a major global exporter. A disaster qualifies as "large" if its death toll exceeds the 80th percentile of the country's positive-death disaster distribution. The instrument is activated in the disaster year and the following year. Products listed are those for which the country has a global export share $\geq 5\%$ and a product share of country exports $\geq 5\%$ (BACI HS92, 1997). The full set of 56 countries with qualifying disasters is available in the replication materials.

D.2 Results

We use the disaster instrument Z_{jt}^{dis} to instrument for the interaction of materials intensity and the log materials price index, following the same regression specification as in our baseline analysis. Table D.2 replicates Table 1 using this alternative instrument. The structure of the table is identical to the baseline: Columns (1) and

Table D.2: The Effect of Material Prices on the Labor Share – Disaster IV

	Industry Log Labor Share							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Mat. Int. × Log Mat. Price	-0.132***	-0.135***	-0.176**	-0.212*	-0.151***	-0.219***	-0.215***	-0.183**
	(0.0212)	(0.0219)	(0.0816)	(0.109)	(0.0547)	(0.0690)	(0.0742)	(0.0858)
Log. Average Wage		-0.0335		-0.0178		0.0733	0.0355	0.0253
		(0.0742)		(0.0776)		(0.159)	(0.162)	(0.158)
Log. Investment Price		0.0421		0.194		0.389	0.541**	0.531**
		(0.115)		(0.234)		(0.264)	(0.243)	(0.232)
Log. Capital-Labor Ratio							0.0713	0.0614
							(0.0515)	(0.0498)
Production Workers Share							-0.646**	-0.640**
							(0.265)	(0.266)
Import Penetration								0.0224
								(0.0504)
Import Penetration - China								0.175
								(0.149)
First-stage F-stat (KP-Wald)			25.45	30.68	21.53	32.45	32.01	24.06
N	9386	9386	9386	9386	9386	9386	9386	9386
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weighted	No	No	No	No	Yes	Yes	Yes	Yes

Note: This table replicates Table 1 using the disaster-based instrumental variable defined in Equation D.1 in place of the commodity price instrument defined in Equation 10. The dependent variable is the industry-level log labor share. Observations correspond to industry-year pairs for the 361 NAICS industries in the NBER-CES dataset for the period between 1991 and 2016. All specifications control for industry and year fixed effects. Columns (1) and (2) report OLS results. Columns (3) to (8) instrument the materials price regressor with the disaster instrument. Columns (5) to (8) are weighted by the value added of the industry in 1990. Standard errors clustered at the industry-level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

(2) report OLS results, Columns (3) and (4) report unweighted 2SLS results, and Columns (5) to (8) report weighted 2SLS results with progressively richer controls.

The OLS results in Columns (1) and (2) are mechanically identical to Table 1, as they do not depend on the choice of instrument. The 2SLS estimates using the disaster instrument are negative and statistically significant across all specifications, with point estimates ranging from -0.15 to -0.22. These estimates are broadly consistent with the baseline results in Table 1, where the 2SLS coefficients range from -0.18 to -0.23. In the preferred weighted specification with the full set of controls (Column 8), the disaster IV estimate is -0.183 (s.e. = 0.086), compared to -0.190 (s.e. = 0.028) in the corresponding column of Table 1. The larger standard errors are expected given that the disaster instrument leverages a coarser source of variation than the continuous commodity price instrument.

The first-stage Kleibergen-Paap Wald F-statistics range from 21.5 to 32.5 across specifications, well above conventional thresholds for weak instruments. Table D.3 reports the first-stage results. The disaster instrument enters positively and significantly in all specifications: a disaster affecting a major exporter of a commodity used as an input by industry j is associated with higher materials prices in that industry, consistent with a supply disruption channel.

Table D.3: First Stage – Disaster IV

	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS	(8) 2SLS
Disaster IV	1.153***	0.792***	1.744***	1.027***	0.954***	0.892***
	(0.228)	(0.143)	(0.376)	(0.180)	(0.169)	(0.182)
F-stat (KP-Wald)	25.45	30.68	21.53	32.45	32.01	24.06
N	9386	9386	9386	9386	9386	9386
Controls	No	Yes	No	Yes	Yes	Yes
Weighted	No	No	Yes	Yes	Yes	Yes

Note: This table reports the first-stage regressions corresponding to the 2SLS specifications in Columns (3) to (8) of Table D.2. The dependent variable is the interaction of materials intensity and the log of the materials price index. The excluded instrument is the disaster-based shift-share variable defined in Equation D.1. All specifications control for industry and year fixed effects. Standard errors clustered at the industry-level are in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

The similarity of the estimated effects across two fundamentally different sources of identifying variation – global commodity price movements and natural disaster shocks – provides further reassurance that our baseline estimates reflect the causal effect of materials prices on the labor share, rather than confounding factors specific to either identification strategy.

E Quantitative Model Details

This appendix provides detailed derivations for the quantitative model presented in Section 4. We begin by restating the environment, then derive the first-order conditions, characterize the transition path, and finally present the model inversion procedure.

E.1 Environment

Production technology. Firms produce output q_t using a nested CES production function F:

$$q_t = F(k_t, l_t, m_t) = \left[\left(A_t l_t^{\alpha_t} k_t^{1-\alpha_t}\right)^{\frac{\sigma-1}{\sigma}} + (B_t m_t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{E.1}$$

where l_t is labor, k_t is capital, m_t is materials, A_t is primary factor-augmenting productivity, B_t is materials-augmenting productivity, $\alpha_t \in (0,1)$ is the labor share within the capital-labor bundle, and $\sigma > 0$ is the elasticity of substitution between the capital-labor bundle and materials.

Capital accumulation. Capital evolves according to:

$$k_{t+1} = \chi_t i_t^{\gamma} k_t^{1-\gamma} + (1-\delta)k_t, \tag{E.2}$$

where i_t is investment expenditure, χ_t is investment efficiency, $\gamma \in (0,1]$ governs adjustment frictions (with $\gamma = 1$ corresponding to no adjustment costs), and $\delta \in (0,1)$ is the depreciation rate.

Demand. Firms operate under monopolistic competition with a CES demand aggregator. Letting E_t denote aggregate sectoral expenditure, P_t the sectoral price index, and $\eta_t > 1$ the time-varying demand elasticity, the firm's revenues are:

$$R_t = E_t^{\frac{1}{\eta_t}} P_t^{\frac{\eta_t-1}{\eta_t}} q_t^{\frac{\eta_t-1}{\eta_t}}, \tag{E.3}$$

where the associated gross markup is $\mu_t \equiv \eta_t/(\eta_t - 1)$. The markup captures a time-varying wedge between firms' price of output and their average unit cost, and can equivalently be viewed as a time-varying demand elasticity or return to scale. In a symmetric equilibrium with a unit mass of identical firms, $R_t = E_t$.

Firm's problem. The firm maximizes the present discounted value of profits:

$$\max_{\{l_t,m_t,i_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left\{ E_t^{\frac{1}{\eta_t}} P_t^{\frac{\eta_t-1}{\eta_t}} q_t^{\frac{\eta_t-1}{\eta_t}} - w_t l_t - p_{m,t} m_t - p_{i,t} i_t \right\}$$

$$\begin{aligned} \text{subject to:} \quad & q_t = F(k_t, l_t, m_t), \\ & k_{t+1} = \chi_t i_t^{\gamma} k_t^{1-\gamma} + (1-\delta) k_t, \\ & k_0 \text{ given,} \end{aligned} \tag{E.4}$$

where $\beta \in (0,1)$ is the discount factor, w_t is the wage, $p_{m,t}$ is the materials price, and $p_{i,t}$ is the investment goods price.

E.2 Derivation of First-Order Conditions

Output elasticities. Define the output elasticities as:

$$\theta_{x,t} \equiv \frac{\partial \ln q_t}{\partial \ln x_t} = \frac{\partial \ln F}{\partial \ln x_t}, \quad x \in \{l, k, m\}. \tag{E.5}$$

For the CES production function (E.1), we can compute these elasticities. Let $\Phi_t \equiv A_t l_t^{\alpha_t} k_t^{1-\alpha_t}$ denote the capital-labor composite. Then:

$$q_t = \left[\Phi_t^{\frac{\sigma-1}{\sigma}} + (B_t m_t)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \tag{E.6}$$

Taking the derivative with respect to m_t:

$$\frac{\partial q_t}{\partial m_t} = \frac{\sigma}{\sigma-1} \left[\Phi_t^{\frac{\sigma-1}{\sigma}} + (B_t m_t)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}-1} \frac{\sigma-1}{\sigma} (B_t m_t)^{\frac{\sigma-1}{\sigma}-1} B_t \tag{E.7}$$

$$= q_t^{\frac{1}{\sigma}} (B_t m_t)^{-\frac{1}{\sigma}} B_t = \frac{q_t}{m_t} \left(\frac{B_t m_t}{q_t} \right)^{\frac{\sigma-1}{\sigma}}. \tag{E.8}$$

Therefore, the materials output elasticity is:

$$\theta_{m,t} = \frac{\partial \ln q_t}{\partial \ln m_t} = \frac{m_t}{q_t} \frac{\partial q_t}{\partial m_t} = \left(\frac{B_t m_t}{q_t} \right)^{\frac{\sigma-1}{\sigma}}. \tag{E.9}$$

Similarly, the labor output elasticity is:

$$\theta_{l,t} = \alpha_t \left(\frac{\Phi_t}{q_t}\right)^{\frac{\sigma-1}{\sigma}} = \alpha_t \left(\frac{A_t l_t^{\alpha_t} k_t^{1-\alpha_t}}{q_t}\right)^{\frac{\sigma-1}{\sigma}}, \tag{E.10}$$

and the capital output elasticity is:

$$\theta_{k,t} = (1-\alpha_t) \left(\frac{\Phi_t}{q_t}\right)^{\frac{\sigma-1}{\sigma}} = (1-\alpha_t) \left(\frac{A_t l_t^{\alpha_t} k_t^{1-\alpha_t}}{q_t}\right)^{\frac{\sigma-1}{\sigma}}. \tag{E.11}$$

Note that $\Phi_t^{(\sigma-1)/\sigma} + (B_t m_t)^{(\sigma-1)/\sigma} = q_t^{(\sigma-1)/\sigma}$, so:

$$\left(\frac{\Phi_t}{q_t}\right)^{\frac{\sigma-1}{\sigma}} + \left(\frac{B_t m_t}{q_t}\right)^{\frac{\sigma-1}{\sigma}} = 1 \implies (1-\theta_{m,t}) = \left(\frac{\Phi_t}{q_t}\right)^{\frac{\sigma-1}{\sigma}}. \tag{E.12}$$

This yields the key relationships:

$$\theta_{l,t} = \alpha_t(1-\theta_{m,t}), \tag{E.13}$$

$$\theta_{k,t} = (1-\alpha_t)(1-\theta_{m,t}), \tag{E.14}$$

$$\theta_{l,t} + \theta_{k,t} + \theta_{m,t} = 1. \tag{E.15}$$

Static first-order conditions. Consider the firm's first-order condition for labor. Using $R_t = E_t^{1/\eta_t} P_t^{(\eta_t-1)/\eta_t} q_t^{(\eta_t-1)/\eta_t}$, the first-order condition is:

$$\frac{\partial R_t}{\partial l_t} = w_t. \tag{E.16}$$

Computing the derivative:

$$\frac{\partial R_t}{\partial l_t} = E_t^{\frac{1}{\eta_t}} P_t^{\frac{\eta_t-1}{\eta_t}} \frac{\eta_t-1}{\eta_t} q_t^{\frac{\eta_t-1}{\eta_t}-1} \frac{\partial q_t}{\partial l_t} = \frac{\eta_t-1}{\eta_t} \frac{R_t}{q_t} \frac{\partial q_t}{\partial l_t} = \frac{1}{\mu_t} R_t \frac{\theta_{l,t}}{l_t}, \tag{E.17}$$

where $\mu_t \equiv \eta_t/(\eta_t-1) > 1$ is the gross markup. In equilibrium, $R_t = E_t$, so:

$$w_t l_t = \frac{\theta_{l,t}}{\mu_t} E_t \implies s_{l,t} \equiv \frac{w_t l_t}{E_t} = \frac{\theta_{l,t}}{\mu_t}. \tag{E.18}$$

Analogously, the first-order condition for materials yields:

$$p_{m,t}m_t = \frac{\theta_{m,t}}{\mu_t}E_t \implies s_{m,t} \equiv \frac{p_{m,t}m_t}{E_t} = \frac{\theta_{m,t}}{\mu_t}. \tag{E.19}$$

Dynamic first-order condition for investment. The firm's problem can be written recursively. Define the value function:

$$V_t(k_t) = \max_{l_t, m_t, i_t} \left\{ R_t - w_t l_t - p_{m,t}m_t - p_{i,t}i_t + \beta V_{t+1}(k_{t+1}) \right\}, \tag{E.20}$$

subject to (E.2). The first-order condition for investment is:

$$p_{i,t} = \beta \frac{\partial V_{t+1}}{\partial k_{t+1}} \frac{\partial k_{t+1}}{\partial i_t}. \tag{E.21}$$

From (E.2):

$$\frac{\partial k_{t+1}}{\partial i_t} = \gamma \chi_t i_t^{\gamma-1} k_t^{1-\gamma} = \gamma \frac{k_{t+1} - (1-\delta)k_t}{i_t}. \tag{E.22}$$

By the envelope theorem:

$$\frac{\partial V_t}{\partial k_t} = \frac{\partial R_t}{\partial k_t} + \beta \frac{\partial V_{t+1}}{\partial k_{t+1}} \frac{\partial k_{t+1}}{\partial k_t}. \tag{E.23}$$

Since $\partial R_t / \partial k_t = (\theta_{k,t}/\mu_t)(E_t/k_t)$ and $\partial k_{t+1}/\partial k_t = (1-\gamma)(k_{t+1} - (1-\delta)k_t)/k_t + (1-\delta)$:

$$\frac{\partial V_t}{\partial k_t} = \frac{\theta_{k,t}}{\mu_t} \frac{E_t}{k_t} + \beta \frac{\partial V_{t+1}}{\partial k_{t+1}} \left[(1-\gamma) \frac{k_{t+1} - (1-\delta)k_t}{k_t} + (1-\delta) \right]. \tag{E.24}$$

Define $\dot{k}_{t+1} \equiv k_{t+1}/k_t$ as the gross growth rate of capital. Substituting and rearranging, we can express the investment share $s_{i,t} \equiv p_{i,t}i_t/E_t$ recursively. After some algebra:

$$s_{i,t} = \beta \frac{E_{t+1}}{E_t} \left(\frac{\dot{k}_{t+1} - (1-\delta)}{\dot{k}_{t+1}} \right) \left\{ \gamma \frac{\theta_{k,t+1}}{\mu_{t+1}} + s_{i,t+1} \left(\frac{1-\delta}{\dot{k}_{t+2} - (1-\delta)} + (1-\gamma) \right) \right\} \tag{E.25}$$

Using $\theta_{k,t} = (1-\alpha_t)(1-\theta_{m,t}) = 1 - \theta_{m,t} - \theta_{l,t}$, this becomes equation (18) in the main text.

Labor share of value added. Value added is defined as revenues minus materials expenditure: $VA_t = E_t - p_{m,t}m_t = E_t(1 - s_{m,t})$. The labor share of value added is:

$$\lambda_t \equiv \frac{w_t l_t}{VA_t} = \frac{s_{l,t}}{1 - s_{m,t}} = \frac{\theta_{l,t}/\mu_t}{1 - \theta_{m,t}/\mu_t} = \frac{\theta_{l,t}}{\mu_t - \theta_{m,t}}. \tag{E.26}$$

Using $\theta_{l,t} = \alpha_t(1 - \theta_{m,t})$:

$$\lambda_t = \frac{\alpha_t(1 - \theta_{m,t})}{\mu_t - \theta_{m,t}}. \tag{E.27}$$

E.3 Solving the Transition Path

Given paths of fundamentals $\{A_t, B_t, \alpha_t, \chi_t, \mu_t, E_t\}_{t=0}^T$ and prices $\{w_t, p_{m,t}, p_{i,t}\}_{t=0}^T$, we solve for the equilibrium path of allocations. The key state variable is capital k_t.

Factor demands given capital. Given the capital stock k_t, we can express factor demands as functions of $\theta_{m,t}$. From the first-order conditions:

$$l_t = \frac{\theta_{l,t}}{\mu_t}\frac{E_t}{w_t} = \frac{\alpha_t(1 - \theta_{m,t})}{\mu_t}\frac{E_t}{w_t}, \tag{E.28}$$

$$m_t = \frac{\theta_{m,t}}{\mu_t}\frac{E_t}{p_{m,t}}. \tag{E.29}$$

However, $\theta_{m,t}$ itself depends on factor demands through equation (E.9). This creates a fixed-point problem: given k_t, we solve for $\theta_{m,t}$ such that:

$$\theta_{m,t} = \left(\frac{B_t m_t(\theta_{m,t})}{F(k_t, l_t(\theta_{m,t}), m_t(\theta_{m,t}))}\right)^{\frac{\sigma-1}{\sigma}}, \tag{E.30}$$

where $l_t(\theta_{m,t})$ and $m_t(\theta_{m,t})$ are given by (E.28)–(E.29). We solve this fixed-point problem by iteration for each period t.

Capital dynamics. Given the investment share $s_{i,t}$, investment is:

$$i_t = s_{i,t}\frac{E_t}{p_{i,t}}. \tag{E.31}$$

The capital accumulation equation (E.2) can be written as:

$$k_{t+1} = (1 - \delta)k_t + \chi_t \left(s_{i,t}\frac{E_t}{p_{i,t}}\right)^\gamma k_t^{1-\gamma}. \tag{E.32}$$

Define $\bar{\chi}_t \equiv \chi_t(E_t/p_{i,t})^\gamma$. Then:

$$k_{t+1} = (1-\delta)k_t + \bar{\chi}_t s_{i,t}^\gamma k_t^{1-\gamma}. \tag{E.33}$$

Steady state. In steady state, $k_{t+1} = k_t = k^{SS}$, $\dot{k} = 1$, and all fundamentals are constant. From (E.33):

$$k^{SS} = (1-\delta)k^{SS} + \bar{\chi}(s_i^{SS})^\gamma (k^{SS})^{1-\gamma} \implies \delta k^{SS} = \bar{\chi}(s_i^{SS})^\gamma (k^{SS})^{1-\gamma}. \tag{E.34}$$

This yields:

$$(k^{SS})^\gamma = \frac{\bar{\chi}}{\delta}(s_i^{SS})^\gamma \implies k^{SS} = \left(\frac{\chi}{\delta}\right)^{\frac{1}{\gamma}} \frac{E}{p_i} s_i^{SS} = \left(\frac{\chi}{\delta}\right)^{\frac{1}{\gamma}} i^{SS}. \tag{E.35}$$

From the Euler equation (E.25) in steady state with $\dot{k} = 1$:

$$s_i^{SS} = \beta\delta \left\{ \gamma \frac{\theta_k}{\mu} + s_i^{SS} \left(\frac{1-\delta}{\delta} + (1-\gamma) \right) \right\}. \tag{E.36}$$

Solving for s_i^{SS}:

$$s_i^{SS} \left[1 - \beta\delta \left(\frac{1-\delta}{\delta} + 1 - \gamma \right) \right] = \beta\delta\gamma \frac{\theta_k}{\mu}. \tag{E.37}$$

The term in brackets simplifies to $1 - \beta(1-\delta\gamma)$, so:

$$s_i^{SS} = \bar{\beta} \frac{\theta_k}{\mu} = \bar{\beta} \frac{1-\theta_m-\theta_l}{\mu}, \quad \text{where} \quad \bar{\beta} \equiv \frac{\beta\delta\gamma}{1-\beta(1-\delta\gamma)} \tag{E.38}$$

Transition path algorithm. We solve for the transition path using the following algorithm:

1. **Compute steady state**: Given terminal fundamentals and prices, compute θ_m^{SS} from the fixed-point problem, then s_i^{SS} from (E.38), and k^{SS}.

2. **Initialize**: Guess a path $\{k_t\}_{t=1}^T$ interpolating from k_0 to k^{SS}.

3. **Iterate**:

   (a) For each t, solve the fixed-point problem (E.30) to obtain $\theta_{m,t}$ given k_t.

(b) Compute $\theta_{k,t}/\mu_t = (1-\theta_{m,t} - \alpha_t(1-\theta_{m,t}))/\mu_t$ for each t.

(c) Solve backwards for $s_{i,t}$ using (E.25), starting from $s_{i,T} = s_i^{SS}$.

(d) Update the capital path forward using (E.33), starting from k_0.

(e) Apply dampening: $k_t^{new} = \rho\, k_t^{old} + (1-\rho)\, k_t^{update}$.

4. **Check convergence**: If $\max_t |k_t^{new} - k_t^{old}| < \epsilon$, stop. Otherwise, return to step 3.

E.4 Model Inversion

The inversion procedure recovers the time-varying fundamentals $\{\mu_t, \alpha_t, A_t, B_t, \chi_t\}$ from observed data. We observe: revenue shares $\{s_{l,t}, s_{m,t}, s_{i,t}\}$, capital stock $\{k_t\}$, output $\{q_t\}$, prices $\{w_t, p_{m,t}, p_{i,t}\}$, and revenues $\{E_t\}$.

Recovering $\theta_{k,t}/\mu_t$ from the Euler equation. Rearranging (E.25):

$$\frac{\theta_{k,t+1}}{\mu_{t+1}} = \frac{1}{\gamma}\left[\frac{s_{i,t}}{\beta(E_{t+1}/E_t)\,(\dot{k}_{t+1}-(1-\delta))/\dot{k}_{t+1}} - s_{i,t+1}\left(\frac{1-\delta}{\dot{k}_{t+2}-(1-\delta)} + (1-\gamma)\right)\right]. \tag{E.39}$$

This allows us to recover $\theta_{k,t}/\mu_t$ from observed investment shares and capital growth rates.

Recovering markups μ_t. From the first-order conditions, factor payments satisfy:

$$s_{l,t} + s_{m,t} + \frac{\theta_{k,t}}{\mu_t} = \frac{\theta_{l,t}+\theta_{m,t}+\theta_{k,t}}{\mu_t} = \frac{1}{\mu_t}. \tag{E.40}$$

Therefore:

$$\mu_t = \frac{1}{s_{l,t} + s_{m,t} + \theta_{k,t}/\mu_t} \tag{E.41}$$

where $\theta_{k,t}/\mu_t$ is obtained from (E.39).

Rearranging the same identity,

$$1 - s_{l,t} - s_{m,t} = \frac{\theta_{k,t}}{\mu_t} + \left(1 - \frac{1}{\mu_t}\right). \tag{E.42}$$

Thus, revenue net of labor and materials is split between the capital output elasticity relative to the markup, $\theta_{k,t}/\mu_t$, and a profit share of revenues, $1 - 1/\mu_t$. Since (E.39) recovers the former from the investment Euler equation, (E.41) then recovers the latter residually through the lens of the model.

Equivalently, free cash flow as a share of revenue,

$$\frac{FCF_t}{E_t} \equiv 1 - s_{i,t} - s_{l,t} - s_{m,t}, \tag{E.43}$$

satisfies

$$1 - s_{i,t} - s_{l,t} - s_{m,t} = \frac{\theta_{k,t}}{\mu_t} + \left(1 - \frac{1}{\mu_t}\right) - s_{i,t}. \tag{E.44}$$

Hence, free cash flow is informative about the markup only jointly with the model-implied capital-income component.

Recovering α_t. From the labor share of value added (E.26):

$$\lambda_t = \frac{s_{l,t}}{1 - s_{m,t}} = \frac{\alpha_t(1 - \theta_{m,t})}{\mu_t - \theta_{m,t}}. \tag{E.45}$$

Note that $\theta_{m,t} = s_{m,t}\mu_t$. Substituting:

$$\lambda_t = \frac{\alpha_t(1 - s_{m,t}\mu_t)}{\mu_t - s_{m,t}\mu_t} = \frac{\alpha_t(1 - s_{m,t}\mu_t)}{\mu_t(1 - s_{m,t})}. \tag{E.46}$$

Solving for α_t:

$$\alpha_t = \frac{\lambda_t\mu_t(1 - s_{m,t})}{1 - s_{m,t}\mu_t} \tag{E.47}$$

Recovering B_t. From the ratio of first-order conditions for labor and materials:

$$\frac{w_t l_t}{p_{m,t} m_t} = \frac{\theta_{l,t}}{\theta_{m,t}} = \frac{\alpha_t(1 - \theta_{m,t})}{\theta_{m,t}}. \tag{E.48}$$

Using (E.9) and (E.10):

$$\frac{s_{l,t}}{s_{m,t}} = \alpha_t \left(\frac{\Phi_t}{B_t m_t}\right)^{\frac{\sigma-1}{\sigma}}, \tag{E.49}$$

where $\Phi_t = A_t l_t^{\alpha_t} k_t^{1-\alpha_t}$. Taking powers and rearranging:

$$\left(\frac{s_{l,t}}{s_{m,t}\alpha_t}\right)^{\frac{\sigma}{\sigma-1}} = \frac{\Phi_t}{B_t m_t}. \tag{E.50}$$

Using $l_t = s_{l,t}E_t/w_t$ and $m_t = s_{m,t}E_t/p_{m,t}$:

$$B_t = \frac{A_t(s_{l,t}E_t/w_t)^{\alpha_t}k_t^{1-\alpha_t}}{(s_{m,t}E_t/p_{m,t})}\left(\frac{s_{m,t}\alpha_t}{s_{l,t}}\right)^{\frac{\sigma}{\sigma-1}}. \tag{E.51}$$

Simplifying:

$$B_t = A_t\left(\frac{1}{\alpha_t}\right)^{\frac{\sigma}{1-\sigma}}\left(\frac{s_{l,t}}{s_{m,t}}\right)^{\frac{1}{1-\sigma}}\frac{p_{m,t}}{w_t\left(\frac{s_{l,t}E_t}{w_tk_t}\right)^{1-\alpha_t}} \tag{E.52}$$

Recovering χ_t. From the capital accumulation equation (E.2):

$$k_{t+1} - (1-\delta)k_t = \chi_t i_t^{\gamma} k_t^{1-\gamma}. \tag{E.53}$$

Using $i_t = s_{i,t}E_t/p_{i,t}$:

$$\chi_t = \frac{k_{t+1} - (1-\delta)k_t}{(s_{i,t}E_t/p_{i,t})^{\gamma}k_t^{1-\gamma}}. \tag{E.54}$$

This can be written as:

$$\chi_t = \left(\frac{E_t}{p_{i,t}}\right)^{-\gamma}\frac{k_{t+1} - (1-\delta)k_t}{s_{i,t}^{\gamma}k_t^{1-\gamma}} \tag{E.55}$$

Recovering A_t. We normalize A_t to match observed output. Given l_t, k_t, m_t, and B_t:

$$A_t = \frac{q_t}{\left[\left(l_t^{\alpha_t}k_t^{1-\alpha_t}\right)^{\frac{\sigma-1}{\sigma}} + \left(\frac{B_t}{A_t}m_t\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}} \tag{E.56}$$

Note that A_t appears on both sides of this expression. In practice, we substitute the expression for B_t/A_t from (E.52) (which does not depend on A_t).

Inversion algorithm. The full inversion algorithm iterates on the capital path:

1. **Initialize**: Set $k_t = k_t^{data}$ for $t \leq T_{data}$. Guess continuation path for $t > T_{data}$.

2. **Iterate**:

   (a) Compute $\theta_{k,t}/\mu_t$ from (E.39) for all t.

   (b) Recover μ_t from (E.41).

(c) Recover α_t from (E.47).

(d) Recover B_t from (E.52).

(e) Recover χ_t from (E.55).

(f) Recover A_t from (E.56).

(g) For $t > T_{data}$: set fundamentals to terminal values and update capital path using (E.33).

(h) Apply dampening and check convergence.

Recovery of $\tilde{c}_{G,t}$. Given the recovered output elasticity of materials $\theta_{m,t}$ and materials-augmenting productivity B_t, the unit cost of the *unaugmented* primary-input bundle ($l_t^{\alpha_t} k_t^{1-\alpha_t}$) can be recovered from CES duality:

$$\tilde{c}_{G,t} = A_t \left(\frac{\theta_{m,t}}{1 - \theta_{m,t}} \right)^{-\frac{1}{1-\sigma}} \frac{p_{m,t}}{B_t}. \tag{E.57}$$

This is the unit cost of the unaugmented bundle, related to the augmented unit cost c_G in Section 2 by $\tilde{c}_{G,t} = A_t \cdot c_G$.

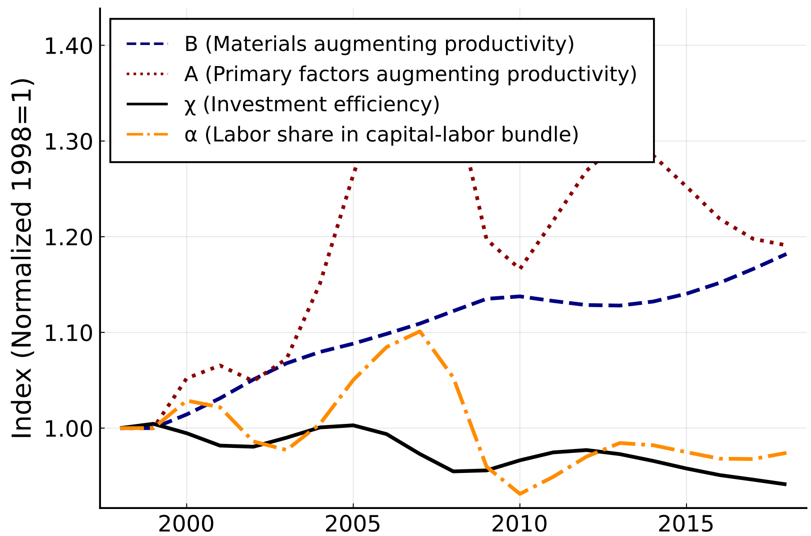
E.5 Data Sources and Construction

Our data come from the Bureau of Economic Analysis (BEA) industry accounts. We use compensation of employees (wages and salaries plus supplements) as our measure of labor costs; intermediate inputs expenditure as materials; gross private domestic investment in the manufacturing sector as investment; the real capital stock computed using the perpetual inventory method; and gross output by industry. Prices include compensation per full-time equivalent employee (wages), the intermediate inputs price index (materials price), and the investment goods price index. All nominal variables are converted to real terms using appropriate deflators. The sample period is 1998–2019, with data smoothed using an HP filter (with smoothing parameter equal to 5) to focus on medium-run trends.

E.6 Additional Inversion Results

Figure E.1 shows the recovered productivity parameters and the labor share parameter from the model inversion. Materials-augmenting productivity B_t increased steadily over the sample period. Primary factor-augmenting productivity A_t rose sharply through the mid-2000s before partially reverting, ending the sample at a similar cumulative growth rate as B_t. Investment efficiency χ_t declined modestly over the period. The labor share within the capital-labor bundle α_t rose in the mid-2000s before falling back, ending somewhat below its initial level.

Figure E.1: Recovered Fundamentals



Note: Materials-augmenting productivity B_t (dashed blue), primary factor-augmenting productivity A_t (dotted red), investment efficiency χ_t (solid black), and labor share in the capital-labor bundle α_t (dash-dotted orange). All series normalized to 1 in 1998.

E.7 Capital Share of Value Added

The model allows us to decompose value added into three components: a labor share λ_t, a capital share κ_t, and a profit share. Specifically, defining the capital share as the marginal revenue product of capital relative to value added:

$$\kappa_t = \frac{(1-\alpha_t)(1-\theta_{m,t})}{\mu_t - \theta_{m,t}}, \tag{E.58}$$

the three shares satisfy $\lambda_t + \kappa_t + (\mu_t - 1)/(\mu_t - \theta_{m,t}) = 1$. In the data, only $1 - \lambda_t$ is directly measurable, combining the capital share and profits. The model's inversion of μ_t allows us to separate them.

It is useful to distinguish this decomposition from the free-cash-flow ratio plotted in Panel (e) of Figure 9. Free cash flow net of value added is given by

$$\frac{FCF_t}{VA_t} = \kappa_t + \frac{\mu_t - 1}{\mu_t - \theta_{m,t}} - \frac{s_{i,t}}{1 - s_{m,t}}, \tag{E.59}$$

where $FCF_t \equiv E_t - w_t l_t - p_{m,t} m_t - p_{i,t} i_t$. Thus, free cash flow is not the same as the model's profit share: it combines capital's marginal contribution to revenue and pure profits, and then subtracts current investment expenditure.

Figure E.2 plots all three components under the baseline (solid) and the constant-$p_{m,t}$ counterfactual (dashed). Both the labor and capital shares decline in the baseline, with the difference absorbed by a rising profit share. In the counterfactual, the labor and capital shares are higher, while the profit share is lower – indicating that the rise in materials prices contributed to an increase in profits at the expense of both labor and capital.

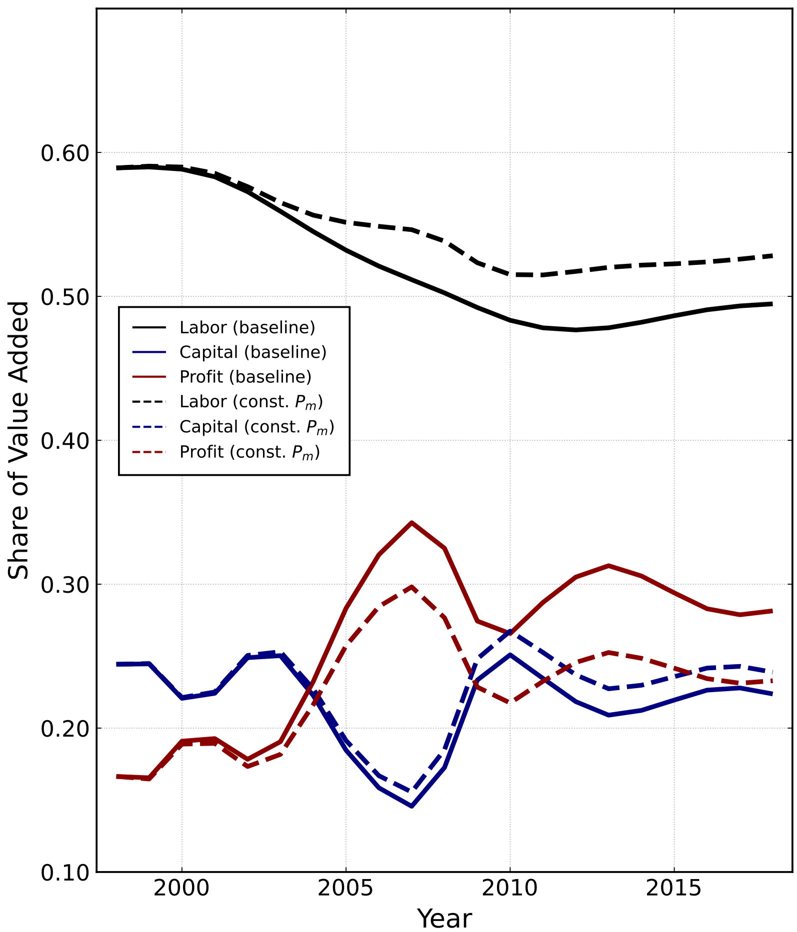
E.8 Subsector Counterfactuals

We repeat the counterfactual analysis for each manufacturing subsector individually. Figure E.3 displays the labor share of value added under the baseline equilibrium and the two counterfactual scenarios for each of the 19 manufacturing subsectors. The analysis applies the same inversion procedure, calibration, and counterfactual experiments described in Section 4 to subsector-specific data from the BEA industry accounts. Counterfactual 1 holds the materials price $p_{m,t}$ constant at its 1998 level, while Counterfactual 2 holds constant the effective relative price of materials $p_{m,t}/c_{G,t}$ and the ratio B_t/A_t.

The results show that the contribution of materials prices to the labor share dynamics varies substantially across subsectors. In most subsectors, holding materials prices constant (dashed red) or holding effective materials prices constant (dotted blue) attenuates the decline in the labor share relative to the baseline (solid black). However, the magnitude of this attenuation differs considerably, reflecting heterogeneity in the initial materials intensity, the recovered markups, and the extent of materials price changes across industries.

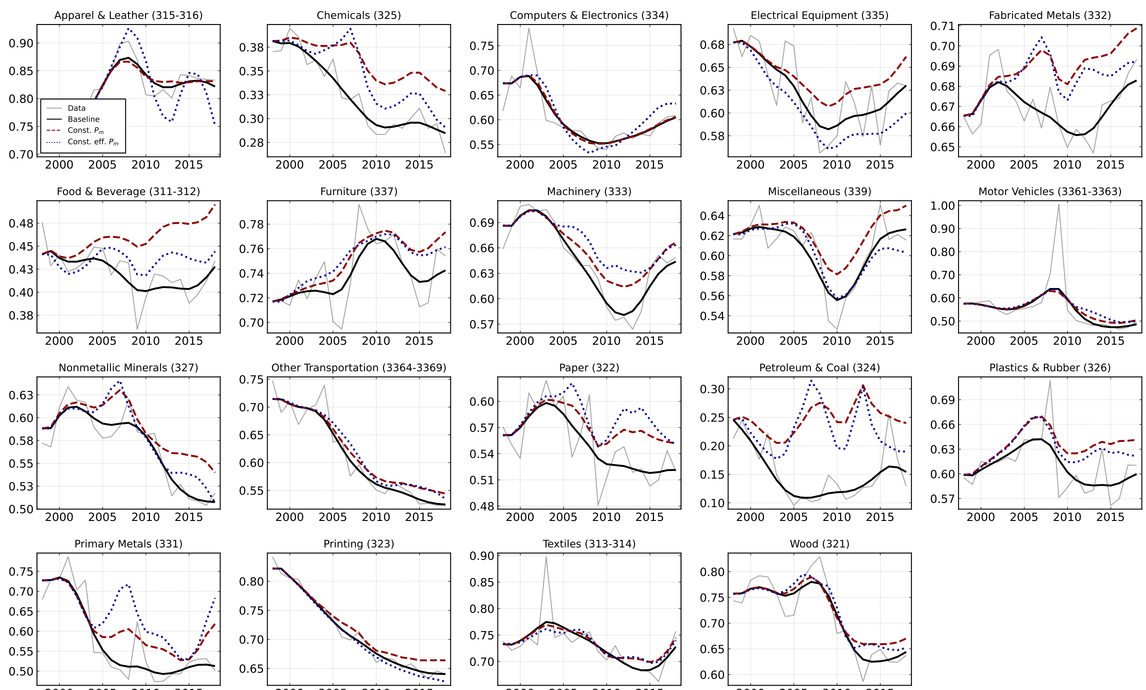
Table E.1 reports the effect of materials prices on the labor share for each subsector. For each subsector, the table shows the total change in the labor share in the data alongside the change attributable to materials price changes and effective

Figure E.2: Decomposition of Value Added



Note: Labor share $\lambda_t = \alpha_t(1-\theta_{m,t})/(\mu_t - \theta_{m,t})$, capital share $\kappa_t = (1-\alpha_t)(1-\theta_{m,t})/(\mu_t - \theta_{m,t})$, and profit share $(\mu_t - 1)/(\mu_t - \theta_{m,t})$. Solid lines: baseline. Dashed lines: counterfactual with constant $p_{m,t}$.

Figure E.3: Subsector Counterfactual Results – Labor Share of Value Added



Note: Each panel shows results for one of 19 manufacturing subsectors (NAICS codes in parentheses). Gray line: raw (unsmoothed) data. Solid black line: baseline equilibrium (HP-filtered data). Dashed red line: counterfactual with constant materials prices $p_{m,t}$. Dotted blue line: counterfactual with constant effective materials prices $p_{m,t}/\tilde{c}_{G,t}$. Data are from the BEA industry accounts, 1998–2019.

materials price changes. These are reported both for the end period (comparing the last sample year to the first) and on average across all sample years. Subsectors are ranked by the average effect of materials prices (column 3), from largest to smallest.

Table E.1: Effect of Materials Prices on Subsector Labor Shares

Subsector (NAICS)	VA Share	Average			End Period		
		$\Delta\lambda$ Data	Due to ΔP_m	Due to Δ Eff. P_m	$\Delta\lambda$ Data	Due to ΔP_m	Due to Δ Eff. P_m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Petroleum & Coal (324)	6.3	-9.7	-9.9	-7.9	-9.2	-8.6	-3.6
Primary Metals (331)	3.1	-15.5	-4.0	-6.8	-21.5	-10.6	-17.1
Food & Beverage (311-312)	11.7	-2.1	-3.9	-1.4	-1.4	-6.8	-1.7
Chemicals (325)	15.2	-5.6	-3.6	-2.3	-9.7	-4.4	-0.6
Plastics & Rubber (326)	3.7	1.0	-2.6	-2.0	0.1	-4.1	-2.2
Paper (322)	3.1	-1.0	-2.1	-3.0	-4.0	-3.0	-2.9
Nonmetallic Minerals (327)	2.6	-1.9	-2.0	-1.0	-8.1	-3.2	0.1
Fabricated Metals (332)	7.1	0.4	-1.9	-1.5	1.7	-2.6	-0.9
Electrical Equipment (335)	2.8	-5.4	-1.8	1.8	-4.7	-3.2	3.0
Miscellaneous (339)	4.1	-1.6	-1.7	0.1	0.5	-2.4	2.3
Machinery (333)	7.2	-4.2	-1.5	-2.2	-4.2	-2.3	-2.0
Furniture (337)	1.6	2.1	-1.2	-1.2	2.5	-3.1	-1.9
Wood (321)	1.6	-4.3	-1.1	-1.1	-11.3	-2.6	-0.8
Other Transportation (3364-3369)	6.2	-10.5	-1.1	-1.2	-19.0	-2.0	-1.0
Printing (323)	2.3	-11.0	-1.0	0.5	-18.1	-2.4	1.3
Motor Vehicles (3361-3363)	7.1	-2.7	-0.6	-1.2	-8.9	-1.8	-1.4
Textiles (313-314)	1.1	-0.4	-0.4	-0.3	-0.5	-1.7	-1.3
Apparel & Leather (315-316)	0.7	7.2	-0.1	0.5	8.6	-0.9	7.0
Computers & Electronics (334)	12.2	-7.1	-0.0	-0.6	-6.9	-0.1	-2.8

Note: All values are in percentage points. Columns (2) and (5) report the change in the labor share in the data. Columns (3)–(4) and (6)–(7) report the change in the labor share attributable to changes in materials prices and effective materials prices, respectively. "Average" averages across all sample years; "End period" compares the last sample year to the first. Subsectors are ranked by column (3).

F Cross-Country Empirical Analysis

This appendix provides additional details on the data sources, sample construction, and instrumental variable strategy for the cross-country analysis of Section 5.

F.1 Data

EU-KLEMS. Our primary data source for the cross-country analysis is the 2025 release of EU-KLEMS, run by the Vienna Institute for International Economic Studies. This dataset provides industry-level measures of gross output, intermediate inputs, value added, compensation, employment, hours worked, and price indices for all European Union member states, Japan, and the U.S. at the NACE Rev. 2 classification level. We use data over the period 1995–2019. Where the 2025 vintage has gaps in price indices — particularly for newer member states — we splice with the 2020 EU-KLEMS vintage. Where the two vintages overlap, we compute a splice ratio at the country×industry level and apply it to fill gaps; for country-sector pairs with very sparse 2025 coverage (≤ 3 non-missing observations), we replace entirely with the 2020 vintage. Level variables (compensation, hours) are filled directly from the 2020 vintage where the 2025 vintage is missing.

World KLEMS. We supplement the EU-KLEMS data with industry-level data for Canada and South Korea from the World KLEMS project. For Canada, we use the 2012 release covering 1995–2008, which reports data at the ISIC Rev. 3 level. We map sectors to NACE Rev. 2 manufacturing industries, aggregating sub-sectors as needed (e.g., wood and paper products into C16–C18) using value-added-weighted price indices and summing level variables. For South Korea, we use the 2015 release covering 1995–2012. Since the Korean data are reported at a finer sub-industry level than EU-KLEMS, we compute implicit price deflators from nominal and real series (normalized to 2000) and aggregate to NACE Rev. 2 sectors. In both cases, we drop sectors for which the ISIC classification does not permit a clean separation into EU-KLEMS industries (e.g., C21 and C27 for Canada).

Sample construction. We restrict the sample to 13 manufacturing sectors at the NACE Rev. 2 level (C10–C12 through C31–C33). We drop Luxembourg and Slovakia, which exhibit extreme price outliers driven by small manufacturing sectors and vintage-splicing artifacts. We further drop observations where compensation exceeds value added; intermediate inputs exceed gross output; the materials-to-value-added ratio exceeds 10 (mostly petroleum refining with volatile margins); or the labor share falls below 0.05 or above 0.95. Country-sector pairs with fewer than 5 observations are also excluded. The resulting estimation sample contains 6,201 observations across 23 countries.

F.2 Instrumental Variable

We construct a shift-share instrument for industry-level materials prices at the country level, following a strategy that parallels the instrument used in the U.S. analysis (Section 3). The construction proceeds in three steps.

Step 1: Input-output shares. For each country c and using sector j, we extract the share of supplying sector k in j's intermediate input bundle from the year-2000 national input-output table in the WIOD (World Input-Output Database). Specifically,

$$s_{c,j,k} = \frac{\text{flow}_c(k \to j)}{\sum_{k'} \text{flow}_c(k' \to j)},$$

where flows sum both domestic and imported intermediates. We use the year-2000 table so that shares are predetermined with respect to subsequent price changes. The WIOD covers 43 countries at a 56-sector level, providing country-specific input structures that reflect heterogeneity in production technologies across economies.

Step 2: Commodity price shocks. We measure global commodity price shocks using trade unit values from UN ComTrade at the HS6 product level, following the same source used in our U.S. analysis. To aggregate HS-level prices to WIOD sectors, we construct a chained concordance from HS92 to HS96 (using the correspondence in our commodity dataset), from HS96 to ISIC Rev. 3 4-digit (using the WITS concordance), and from ISIC Rev. 3 to WIOD sectors via a 2-digit mapping, with a 4-digit carve-out for pharmaceuticals (ISIC3 2423 → C21). We collapse to simple averages within each WIOD sector-year cell and interpolate linearly to fill gaps. This yields price series for 9 WIOD sectors over 30 years.

Step 3: Shift-share instrument. The instrument for country c, sector j, year t is

$$Z_{c,j,t} = \sum_k s_{c,j,k} \log\left(\frac{p_{k,t}}{p_{k,\text{base}}}\right),$$

where $s_{c,j,k}$ are IO expenditure shares, constructed analogously to Equation 8: the expenditure of sector j on inputs from sector k, divided by sector j's total costs (intermediate inputs plus labor compensation), using WIOD year-2000 values and KLEMS compensation data. Since commodity prices are only available for a subset of supplying sectors, the shares sum to less than one, capturing both the composition and overall intensity of each industry's commodity exposure. The instrument is analogous to Equation 10.

Exchange rate adjustment. For countries outside the U.S., changes in the bilateral exchange rate affect the transmission of dollar-denominated commodity price shocks to domestic materials costs. We convert commodity prices to local currency before applying the IO weights:

$$Z_{c,j,t}^{fx} = \sum_k s_{c,j,k} \log\left(\frac{p_{k,t} \cdot e_{c,t}}{p_{k,\text{base}} \cdot e_{c,\text{base}}}\right),$$

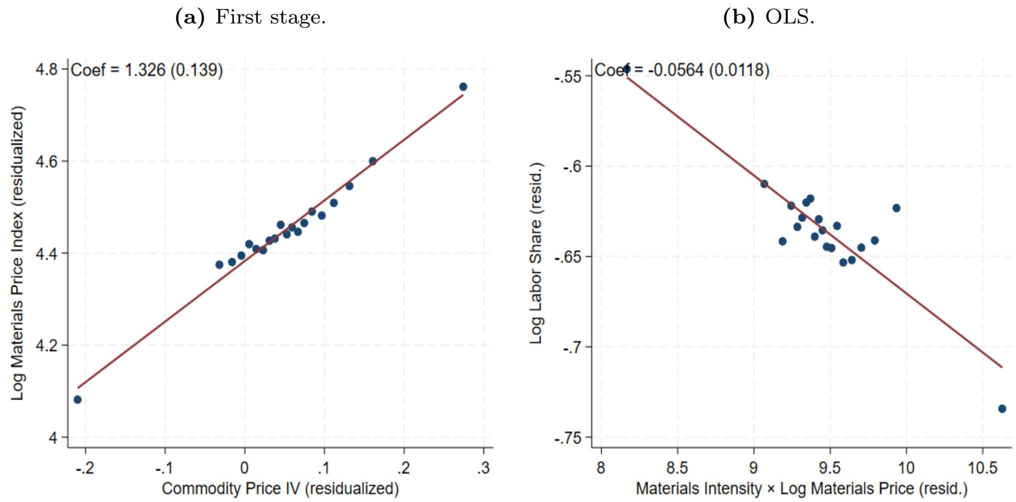
where $e_{c,t}$ is the bilateral exchange rate vis-à-vis the U.S. dollar from the BIS (units of local currency per dollar). A country whose currency appreciated relative to the dollar will have experienced a smaller increase in domestic materials costs than the raw commodity price movement would suggest.

F.3 Supplementary Figures

Figure F.1 presents binned scatter plots for the cross-country panel, analogous to the binscatter evidence shown for the U.S. in the main text. Panel (a) plots the first-stage relationship between the FX-adjusted shift-share instrument and the log materials price index. The positive and significant relationship confirms that the instrument has predictive power for materials prices in the cross-country setting. Panel (b) plots the OLS relationship between the treatment variable (baseline materials intensity $\times$ log materials price) and the log labor share. The negative slope is consistent with the results in Table 4 and with the U.S. evidence.

Figure F.2 documents the heterogeneous trends in the relative price of intermediates across countries. Panel (a) plots the ratio of materials to value-added price indices by country, normalized to unity at 2000. Each country's index is computed as a Törnqvist chain across manufacturing sectors, weighted by materials expendi-

Figure F.1: Cross-Country Binscatter

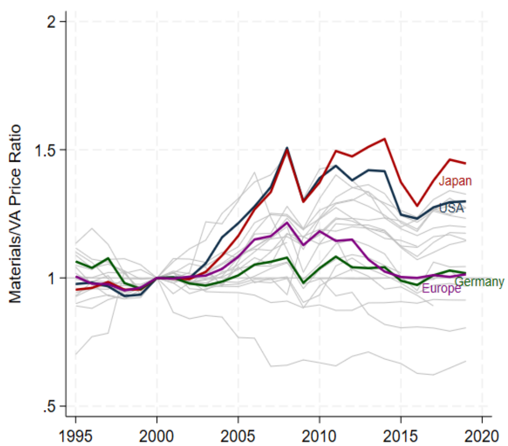


Note: Both panels show binned scatter plots with 20 quantile bins, residualized with respect to country×industry and year fixed effects, weighted by baseline value-added shares. Panel (a) shows the first-stage relationship between the FX-adjusted shift-share IV and the log materials price index. Panel (b) shows the OLS relationship between materials intensity × log materials price and the log labor share. Regression coefficients and standard errors are reported in each panel.

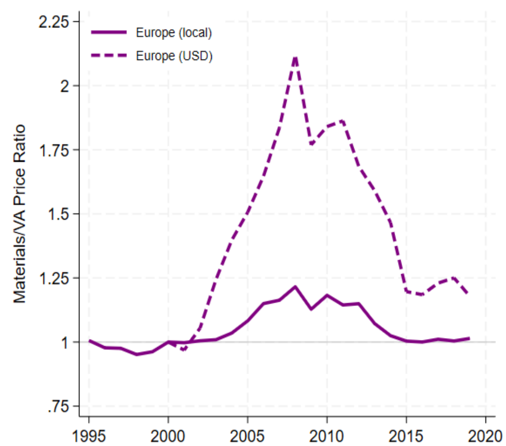
ture. Despite the global rise in commodity prices during the 2000s, the country-level trend exhibits vast heterogeneity. Moreover, the increase in the U.S. and Japan is greater than in all European countries. One reason behind this more timid European increase is that concurrently with the rise in global raw material prices, most European economies adopted the Euro, which quickly appreciated against the dollar. Panel (b) confirms this mechanism: the European aggregate in local currency (solid line) is essentially flat, while the same aggregate adjusted to U.S. dollars (dashed line) exhibits a substantially larger increase that is more comparable to the U.S. and Japanese experience.

Figure F.2: Materials Prices Across Countries

(a) All countries.



(b) Europe: local currency vs. USD.



Note: Panel (a) shows the ratio of materials to value-added price indices by country, normalized to unity at 2000. Each gray line is a separate country. Bold lines highlight the U.S. (navy), Japan (red), Germany (green), and a Törnqvist-weighted European aggregate (purple). Panel (b) shows the European aggregate in local currency (solid) and adjusted to U.S. dollars using bilateral exchange rates from the BIS (dashed).