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Trade Policy and the Decline of the Labor Share

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Abstract

In this paper I analyze the impact of tariffs on US imports that are used as inputs to manufacturing on labor market outcomes. I develop theoretical predictions using a model of final goods production in which firms combine labor, capital, and intermediate inputs. Utilizing changes in tariff rates, input-output tables, and local employment in the input sector, I develop a sector- and state-specific measure of exposure to tariffs in input markets. I estimate the effect of input market tariff exposure on labor market outcomes with a three-way fixed effects regression. An increase in tariff exposure is associated with increases in employment and wages; however, due to larger increases in output the labor share of output declines.

1 Introduction

In the twenty-first century the decline of manufacturing employment and wages has been well documented by economists (see e.g Pierce and Schott 2016, Autor Dorn and Hanson 2013) and has drawn much attention from policymakers in the developed world. In the manufacturing sector, the replacement of labor with capital via automation, low-skilled labor with high-skill labor via job polarization, and high wage labor with low wage labor from abroad via offshoring have each been scrutinized as factors in explaining this decline. Broadly speaking, this decline has coincided with a decline in the share of national income flowing to labor in the form of wages, salaries, and other benefits. Further, policymakers concerned with job creation, rising inequality, and national security have increasingly become focused on this pattern of declining fortunes for workers in the manufacturing sector. Specifically, among other policies such as subsidies for firms and industries and the renegotiation of NAFTA, the US has recently engaged in protectionism through increases in bilateral tariffs.

This paper builds upon a partial equilibrium framework to study the effect of input tariffs on labor market outcomes. Specifically, I use a model featuring a two-tier CES production function consisting of three inputs to production. At the highest tier firms producing goods for final consumption combine intermediate goods with all other factors of production that enter into value-added. In the second tier, value-added is a CES production function consisting of labor and a fixed factor of production. Moreover, intermediate inputs are considered a CES aggregate of goods that are subject to trade costs. I use this model to derive predictions regarding the response to a change in the price of intermediate inputs. To take this model and predictions to the data I construct a novel measure of exposure to tariffs in input markets. I utilize national level input-output data and state

level employment data to derive the amount of exposure to tariffs faced by sectors producing goods for final consumption. Further, I establish several assumptions necessary to empirically implement this model by estimating a three-way fixed effects model. I find that while wages, employment, and capital expenditure increase (decrease) in response to a rise (fall) in tariff exposure, the share of output flowing to labor declines with an elasticity of -0.062 while the share of output flowing to capital increases with an elasticity of 0.413.

A large strand of literature has documented the decline of the share of national income flowing to labor, particularly in the United States since the second half of the 20th century. Further, researchers and policymakers have devoted significant attention to uncovering and rectifying the causes of the decline. A closely related article by Autor et al. (2020) emphasizes the role of highly concentrated industries in driving down the share of output flowing to labor in the US while dismissing the role of globalization. Karabarbounis and Neiman (2014) emphasize the role of the declining relative price of capital globally in driving this decline. Related literature focuses on inequality and skill-biased changes in earnings, see Parro (2020), Krussel et al. (2000), Song et al. (2019), Helpman et al. (2017), and Caliendo, Dvorkin, and Parro (2019). A variety of policies addressing the taxation system, social safety net, reskilling, and the impacts of globalization have been introduced since the beginning of the 21st century. In this paper, I seek to analyze the impacts of one particular set of policies, increases in US import tariff rates after 2016, on a variety of labor market outcomes including the labor share. Though tariffs are typically introduced by policymakers with the goal of protecting producers in output markets by reducing foreign competition, I leverage input-output and local employment data to quantify the effect of input market tariffs across a broad swath of manufacturing sectors. This approach, through the use of a national policy and employment in input industries, is able to leverage plausi-

bly exogenous variation in input prices for final goods sectors at the state level to identify the effects of variations in price on labor market outcomes.

Additionally, I contribute to a broad strand of literature which has sought to empirically uncover the effects of globalization on labor markets in developed countries. Autor, Dorn, and Hanson (2013) empirically measure exposure to Chinese imports across US commuting zones to uncover local labor market effects. Pierce and Schott (2016) uncover similar effects at the plant-level while further accounting for input-output linkages. Further work by Acemoglu et al. (2020) connects trade to slow employment growth more broadly across the US. Extending these empirical studies to a European setting Branstetter et al. (2019) find significant negative labor market effects as a result of import competition in Portugal. Focusing on tariff increases in 2018, Amiti et al. (2019) study the effects of the protectionist policies which I evaluate; however, they focus on prices and welfare while I focus on labor market outcomes. Lastly, Handley and Limao (2017) study the effects of globalization through the lens of trade policy uncertainty.

Lastly, measurement and the methodology documenting the decline of the labor share has drawn interest from a branch of the literature. Chari, Kehoe, and McGrattan (2007) develop a quantitative macroeconomic framework that embeds wedges for labor and investment to study US business cycles. Accounting for capitalization of intellectual property, Koh et al. (2020) argue that the decline of the labor share can be explained through changes in accounting methods. Elsby, Hobijn, and Sahin (2013) argue that while some of the decline in the labor share is a statistical artifact, exposure to trade within manufacturing sectors has also been a primary driver of the decline. An outline of the methods used to quantify the labor share and alternative measures are presented in Krueger (1999). In

my analysis I explicitly define the labor share in two ways; as the share of final sectoral output and as the share of value-added in the final goods sector.

This paper makes two primary contributions to the literature. First, this paper studies the effects of globalization and the associated policy response by studying inputs to production, instead of focusing on imports and exports or tariffs in output markets. I further focus my analysis across many manufacturing sectors and account for the input-output structure of the economy. Second, I construct a novel way of measuring exposure to tariffs in input markets across sectors and regions which allows me to exploit plausibly exogenous variation in tariff rates and local input industry employment.

My findings demonstrate that the labor share of output does decline following an increase in tariffs on inputs to production. This is primarily driven by an expansion of output at a faster rate than employment or wages. Increased prices in output markets cannot explain this expansion and the difference between highly concentrated sectors and more competitive sectors does little to shed light on this result. Instead, I find that in response to an increase in tariff exposure leads to significant increases in the share of output devoted to capital expenditure. This finding suggests that while higher input prices may yield increases in production and sales in the domestic final goods sector; much of this increase results from increased capital investment rather than improvements in employment and wages for labor. Additionally, I find that the share of output flowing to labor in low-skill occupations significantly declines relative to the share of output flowing to highly skilled workers. Thus, this paper provides evidence that increasing tariffs on inputs to production does little to protect workers more broadly, with workers in low-skilled occupations bearing a larger burden relative to highly-skilled workers.

The paper proceeds as follows. In section II, I introduce my theoretical model and derive testable predictions. In section III, I establish a way to measure exposure to tariffs in input markets and provide my empirical specification. In section IV, I discuss the data sources used in the analysis. In section V, I produce and discuss the results. Section VI concludes.

2 Theoretical Background

The economy consists of consumers located in location j. Utility of a representative consumer in state j is $U_j = log(C_j)$ where C_j is a CES aggregate of final good varieties produced in state j. There are S final good varieties produced by sector s. Consumers inelastically supply labor in j such that $\bar{L}_j$ is the total amount of labor supplied to firms in j. Consumer income consists of wage labor and the revenue generated by tariffs collected by the government and distributed equally among consumers across all locations.

Final goods firms produce non-tradeable goods for consumption in sector s and state j. s produces goods using a two-tier nested CES production function with a fixed factor K_{sj}, intermediate goods, M_{sj}, and labor, L_{sj}. Labor is immobile across regions and fixed by $\bar{L}_j$; however, labor is perfectly mobile across sectors and industries. Intermediate goods are tradeable and produced by input industries i using unskilled labor. Intermediates that are sourced from abroad are subject to tariffs (τ_{ik}) and iceberg trade costs (κ_{jk}), $t_{ijk} = (1 + \tau_{ik})(1 + \kappa_{jk})$.

In order to flexibly allow for varying degrees of substitutability or complimentarity between inputs into production, consider a two-tier nested CES production function. Firms

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operating in sector s combine intermediates with an aggregate of all other factors of production as follows

$$Q_{sj} = A_{sj}\left[\gamma_{sj}^{1/\zeta_s}VA_{sj}^{\frac{\zeta_s-1}{\zeta_s}} + (1-\gamma_{sj})^{1/\zeta_s}M_{sj}^{\frac{\zeta_s-1}{\zeta_s}}\right]^{\frac{\zeta_s}{\zeta_s-1}} \tag{1}$$

M_{sj} is a CES aggregate of intermediate goods with constant elasticity of substitution μ.

$$M_{sj} = \left[\sum_i \delta_{is}^{1/\mu}m_{isj}^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{\mu-1}} \tag{2}$$

VA_{sj} is a CES aggregate of all other inputs without a loss of generality. To fix ideas, I assume that the only other inputs to production are labor and capital. Each factor of production enters VA_{sj} with constant elasticity of substitution ρ.

$$VA_{sj} = \left[\alpha_{sj}^{1/\rho_s}L_{sj}^{\frac{\rho_s-1}{\rho_s}} + (1-\alpha_{sj})^{1/\rho_s}K_{sj}^{\frac{\rho_s-1}{\rho_s}}\right]^{\frac{\rho_s}{\rho_s-1}} \tag{3}$$

Intermediate inputs are assumed to be produced using a linear production technology in labor,

$$m_{ij} = A_{ij}L_{ij} \tag{4}$$

where A_{ij} is labor productivity in industry i in state j. I assume that intermediates are produced by monopolistically competitive firms in industry i. Thus, the price of intermediate inputs comes from the CES aggregate of foreign and domestically sourced intermediates

$$P_{sj}^m = \left\{\sum_i \delta_{is}p_{ij}^{\frac{1}{\mu}} + \sum_i \delta_{is}\left[p_{ij}(1+\tau_{ik})(1+\kappa_{jk})\right]^{\frac{1}{\mu}}\right\}^{\frac{\mu}{\mu-1}} \tag{5}$$

firms which source intermediate inputs from a foreign location face two types of trade costs. κ_{jk} is a standard iceberg trade cost which is paid when an input i is sourced from

any location other than the home location. Tariffs are taxes collected by the national government when goods are sourced from foreign locations; $\tau_{ik} = 0$ for locations k which are other states. Workers are assumed perfectly mobile across sectors and industries but cannot move across locations. Labor markets are assumed to be perfectly competitive. Wages are then given by w_j. Firms rent capital at an exogenously determined rental rate, r_j. Intermediates are sourced from industry i from the lowest cost supplier inclusive of trade costs, p_{isj}. The unit cost function is given by

$$c_{sj} = w_j L_{sj} + r_j K_{sj} + \left(\sum_i \delta_{isj}^{1-\mu} p_{isj}^{1-\mu}\right)^{\frac{1}{1-\mu}} M_{sj} \tag{6}$$

Firm's solve the following profit maximization problem

$$argmax \Pi_{sj} = P_{sj}^f Q_{sj} - w_j L_{sj} - r_j K_{sj} - \left(\sum_i \delta_{isj}^{1-\mu} p_{isj}^{1-\mu}\right)^{\frac{1}{1-\mu}} M_{sj} \tag{7}$$

Solving the sector s firm's optimization problems yields an expression for the parameters defining the share of each input used in producing one unit of output. Recall from equation equation 1 that the intermediate share of production is defined by $1 - \gamma_{sj}$ and that the labor share of value added (see equation 3) is defined by α_{sj}. The labor share of output is given by the interaction of $\gamma_{sj}\alpha_{sj}$. Taking first order conditions and solving equation 7 yields the following expression for the labor share of output

$$\gamma_{sj}^{1/\zeta_s} \alpha_{sj}^{1/\rho_s} = (1 - \gamma_{sj})^{1/\zeta_s} M_{sj}^{1/\mu - 1/\zeta} \delta_{sj}^{1/\mu} m_{isj}^{-1/\mu} p_{isj}^{-1} V A_{sj}^{1/\zeta - 1/\rho} L_{sj}^{1/\rho} w_{sj} \tag{8}$$

For the requisite derivations see the appendix.

The use of intermediate inputs by the final goods sector is determined by share parame-

ters δ_{isj} and the constant elasticity of substitution μ. The final goods sector in a given location will source intermediate inputs from the lowest cost supplier of a given variety. The price of variety i which enters the unit cost function is thus a function of transport costs, the wage paid by producers of i in a location k, and the industry-location specific productivity. I assume that the final goods sector consists of many firms purchasing goods from monopolistically competitive input industries at competitive prices. Thus, the price of a given intermediate variety is

$$p_{ij} = \min\{p_{ij}^F, p_{ij}^H\} \tag{9}$$

where

$$p_{ij}^F = \frac{\mu}{\mu - 1} w_{ik}(\tau_{ijk} + 1)(1 + \kappa_{jk})/A_{ik} \forall k \neq j \tag{10}$$

$$p_{ij}^H = \frac{\mu}{\mu - 1} w_{ij}/A_{ij} \tag{11}$$

Recall, the aggregate price of intermediate goods used by s in j is as follows

$$P_{sj}^m = \Big[\sum_{i \in I^H} \delta_{is} p_{ij}^{H\frac{1}{\mu}} + \sum_{i \in I^F} \delta_{is} p_{ij}^{F\frac{1}{\mu}} \Big]^{\frac{\mu}{\mu-1}} \textbf{??} \tag{12}$$

the composite price of intermediates is thus a function of the costs of inputs combined with trade costs for inputs sourced from a foreign supplier industry. Sectors which source a greater proportion of inputs from abroad face larger swings in the composite intermediate price compared to a sector with a greater proportion of domestic inputs.

Under equation **??**, final goods sectors which source a greater proportion of inputs from abroad will face larger changes in the aggregate price of intermediates when faced with a

change in tariff policy. This insight is critical for forming a variety of testable predictions. For the sake of convenience when referring to a change in the price of intermediate inputs I assume that this arises from a change in trade costs based on variation in tariff rates. This implies additional assumptions regarding A_{ij} and δ_{is}; specifically I assume that relative productivity across input industries within states are constant through time which follows from the assumption of a perfectly competitive labor market. Additionally, I assume that the shares of intermediate inputs purchased by the final goods sector is constant through time. Though this assumption is strong, as it is expected that when relative tariffs change final goods firms may substitute to relatively cheaper inputs as I will show below this would bias my empirical results towards zero.

Following the production structure outlined above, in the first-tier CES production function a change in the price of intermediates faced by a firm located in j operating in sector s will result in a change in the value-added share of output. This change in γ_s is dependent on ζ_{sj}. Sectors which have outsourced a significant amount of their production process, are mainly focused on assembly of final goods, or are reliant to a significant degree on foreign rather than domestic suppliers would be expected to reduce output and value-added as a result of an increase in the price of intermediates. Alternatively, sectors in which firms have implemented a production process where workers and the fixed factor both produce intermediate inputs and assemble final goods, near-shored production along the value chain, or rely primarily on domestic suppliers would be expected to reduce their use of intermediates and increase value-added and output as a result of an increase in the price of intermediate inputs. More formally,

Proposition 1. *Firms operating in sector s and location j with $\zeta_{sj} < 0$, an increase in P_{sj}^m yields the following; $\frac{dQ_{sj}}{dP_{sj}^m} < 0$ and $\frac{dVA_{sj}}{dP_{sj}^m} < 0$*

Further, the effect of a change in the price of intermediate inputs on labor market outcomes can be analyzed. Specifically, the labor share of output is captured by the parameter $\alpha_{sj}\gamma_{sj}$ and the labor share of value added is captured by parameter α_{sj}. The change in the share of revenue and value-added flowing to labor is dependent on the elasticity of substitution between labor and intermediates and that between labor and capital. Specifically, a change in the price of intermediates will alter the share of revenue flowing to the factors of production used in generating value-added in a location j by sector s. Further, the elasticity of substitution between and relative prices of labor and capital will determine the proportion flowing to labor.

There are two cases to consider; one in which industries increase output as a result of an increase in the price of intermediate inputs, and vice versa. In the first case, the labor share of output may increase following an increase in the price of intermediates due to low reliance on intermediate inputs as outlined above and increased competitiveness, resulting in an expansion of output and employment of labor. Alternatively, the labor share may decline if these conditions hold true, yet capital and labor are highly substitutable and the cost of capital relative to labor is low. In the second case, the labor share of output may increase following an increase in the price of intermediates because the firms that decrease output as a result of this price increase may cut output while maintaining the same level of wages and employment or switching away from intermediates towards a more labor-intensive but less productive mix of inputs. Conversely, the labor share may fall as a result of high substitutability between labor and capital and a relatively low cost of capital. In each case where the labor share falls, the labor share of value-added will fall more quickly than the labor share of output.

The above intuition is captured more formally by the following proposition.

Proposition 2. *Firms operating in sector s and location j with $\zeta_{sj} > 0$, $\frac{d\gamma_{sj}\alpha_{sj}}{dP_{sj}^m} > 0$ if $\rho_s >> 0$ or γ_{sj} is small. Firms operating in sector s and location j with $\zeta_{sj} < 0$, $\frac{d\gamma_{sj}\alpha_{sj}}{dP_{sj}^m} > 0$ if $\rho_s < 0$ or $\frac{dVA_{sj}}{dP_{sj}^m} < \frac{dQ_{sj}}{dP_{sj}^m}$*

In sum, firms in final goods sectors choose a mix of labor, the fixed factor of production, and intermediate goods to produce final output under a process governed by ζ_{sj}, ρ_s, and γ_{sj}. When firms experience a change in the price of intermediate goods they alter their mix of inputs based on these three parameters which also yields a change in value added and output. After the change in output and the mix of inputs used, the share of output that flows to each input has been altered by the initial price change.

2.1 Extension: Heterogeneous Labor-Augmenting Productivity

In the baseline framework I have remained agnostic about the role of productivity in determining the response of the labor share to changes in intermediate input prices. Similar to Demirer (2022), I now introduce the term χ_{sj}^x which denotes the labor-augmenting productivity of a firm x operating in final goods sector s and state j. By introducing this additional productivity parameter I enrich the baseline model in two ways; first I now allow heterogeneity across sectors and states in labor productivity into the model and allow for within sector-state firm heterogeneity. I now derive theoretical predictions regarding changes in labor market outcomes as a result of changes in input tariffs while accounting for several new mechanisms. First, I can now test for heterogeneous effects on the basis of labor productivity and skill across sectors and states. Second, I am able to account for entry and exit of firms as well as market concentration in the final goods sectors as an explanation for my results.

I first follow Demirer (2022) in incorporating labor augmenting productivity into the original production structure by modifying equation 3.

$$VA_{sj}^x = \left[\alpha_{sj}^{1/\rho_s} \{\chi_{sj}^x L_{sj}\}^{\frac{\rho_s - 1}{\rho_s}} + (1 - \alpha_{sj})^{1/\rho_s} K_{sj}^{\frac{\rho_s - 1}{\rho_s}} \right]^{\frac{\rho_s}{\rho_s - 1}} \tag{13}$$

Now, equation 1 can be rewritten as a firm-specific production function.

$$Q_{sj}^x = A_{sj} \left[\gamma_{sj}^{1/\zeta_s} VA_{sj}^{x \frac{\zeta_s - 1}{\zeta_s}} + (1 - \gamma_{sj})^{1/\zeta_s} M_{sj}^{\frac{\zeta_s - 1}{\zeta_s}} \right]^{\frac{\zeta_s}{\zeta_s - 1}} \tag{14}$$

To introduce firm-specific heterogeneity into the model I follow the finite-firm case outlined by Eaton, Kortum, and Sotelo (2012). Firm-specific productivity is a Poisson random variable drawn from the distribution governed by the parameter $\mu_{sj}^X(\chi) = T_{sj}\chi^{-\theta}$. Further, firms now produce under the following heterogeneous unit cost function

$$c_{sj}^x = \frac{w_j L_{sj}}{\chi_{sj}^x} + r_j K_{sj} + (\sum_i \delta_{isj}^{1-\mu} p_{isj}^{1-\mu})^{\frac{1}{1-\mu}} M_{sj} \tag{15}$$

It is convenient to rank and denote firms from least to highest cost, $c_{sj}^{(1)} < c_{sj}^{(2)} < c_{sj}^{(3)}$.... Under these assumptions the total number of final goods firms producing in sector s and state j with unit cost $c_{sj}^x < \bar{c}$ is also a realization of a Poisson random variable with parameter $\mu_{sj}^{c_{sj}^x}(\bar{c}) = \Phi_{sj}\bar{c}^\theta$ where

$$\Phi_{sj} = \sum_n \Phi_{sjn} \Phi_{sjn} = T_{sj}c_{sj}^{x-\theta} \tag{16}$$

With all potential firms entering and producing in sector s and state j ordered by increasing unit-cost I can now determine the number of firms that actually enter the market.

A two-step process determines firm entry and profits. In the second stage, all firms that have chosen to enter the market partake in Cournot competition as follows. First, each firm is faced with the following profit maximization problem

$$argmax\Pi_{sj}^x = P_{sj}^f q_{sj}^x - c - sj^x q_{sj}^x \tag{17}$$

Under CES preferences for final goods, the final goods price index can be defined as follows

$$P_j^f = (\sum_s \lambda_s P_{sj}^{f\frac{1}{\sigma}})^{\frac{\sigma}{\sigma-1}} \tag{18}$$

The CES demand for the final good variety produced by sector s is

$$P_{sj}^f = \frac{\lambda_{sj}}{q_{sj}^{\frac{1}{\sigma}}} \frac{w_j \bar{L}_j}{P_j^f}^{\frac{1}{\sigma}} \tag{19}$$

Substituting equation 19 into equation 17 and solving for the Cournot equilibrium yields the following demand for q_{sj}

$$q_{sj} = c_{sj}^{x^{-\sigma}} \lambda_{sj}^\sigma w_j \bar{L}_j P_j^{f-1} \tag{20}$$

Substituting equation 20 into equation 17 yields the following expression for firm profits

$$\Pi_{sj}^f = c_{sj}^{x^{-\sigma}} \lambda_{sj}^\sigma w_j \bar{L}_j - c_{sj}^{x^{1-\sigma}} \lambda_{sj}^\sigma w_j \bar{L}_j P_j^{f-1} \tag{21}$$

The solution to the second stage of the firm's problem yields the expected result. Increased firm entry acts through the term P_j^f to reduce demand for each firm's production, thus reducing profits. The firms with the lowest costs generate larger profits and capture greater market share. Thus, denoting $x + 1$ as the next most profitable firm to enter the market,

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the following condition holds

$$\Pi_{sj}^{f^{(x)}} > \Pi_{sj}^{f^{(x+1)}} \tag{22}$$

In stage 1 of the firm's problem, firm's sequentially choose whether or not to enter the market under the zero-profit condition $\Pi_{sj}^{f^{(X+1)}} < 0$, where firm X is the last firm that profitably enters the market.

Conditional on entry into the market and the solution to the Cournot problem, firm's choose the mix of intermediates, labor, and the fixed factor of production. As in the baseline model, taking first order conditions and solving equation 17 yields a new expression for the labor share accounting for firm-specific labor augmenting productivity

$$\gamma_{sj}^{1/\zeta_s} \alpha_{sj}^{1/\rho_s} = (1 - \gamma_{sj})^{1/\zeta_s} M_{sj}^{1/\mu - 1/\zeta} \delta_{sj}^{1/\mu} m_{isj}^{-1/\mu} p_{isj}^{-1} V A_{sj}^{1/\zeta - 1/\rho} \chi_{sj}^{x \frac{\rho-1}{\rho}} L_{sj}^{1/\rho} w_{sj} \tag{23}$$

For the requisite derivations see the appendix.

Now, there are offsetting effects. On the one hand, firms with relatively more productive workers are incentivized to substitute away from intermediates towards labor. On the other hand, fewer workers can be used to produce the same output as a less productive firm. This is captured through the following intuition; a larger χ_{sj}^n increases $\gamma_{sj}\alpha_{sj}$ while simultaneously lowering L_{sj} and w_{sj}, which has a second order effect of lowering $\gamma_{sj}\alpha_{sj}$.

Further, the dynamics of firm entry under heterogeneous productivity can yield heterogeneous market toughness across sectors and locations. Highly productive firms capture a larger share of market demand, leaving smaller demand and smaller profits for less productive firms. The sectors in which a small share of highly productive firms crowd out

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less productive firms the share of output flowing to labor may diminish. Essentially, less productive firms which hire a relatively large share of labor to produce a disproportionately small share of output either leave or never enter the market, thus reducing the labor share across the sector. This effect would imply that the second order effects outweigh the increase of $\gamma_{sj}\alpha_{sj}$ due to a larger χ_{sj}^{n}.

Now, armed with the explanation outlined above a change in the price of intermediate goods may be analyzed. In the following I denote s' as a final goods sector which features X' firms relative to sector X in which X firms enter the market, which yields $X' < X$. Sector s' features fewer, but more productive firms than sector s, thus I refer to sector s' as highly concentrated relative to sector s. When faced with an increase (decrease) in the price of intermediates, firms in s' will decrease (increase) the amount of labor in their mix of inputs to a larger degree than firms in s. This is a direct result of relatively higher labor augmented productivity; if the price of intermediates falls then relatively more productive firms are reluctant to switch away from labor while in the reverse case the rise in the price of intermediate goods leads to a reduction in output (see proposition 1). As a result, when reducing output since labor is a relatively more productive input firms in s' will disproportionately reduce their input of labor relative to intermediates and capital. An alternative interpretation, in the case that labor augmenting productivity is worker-specific, the intuition outlined above can be used to argue that when switching away from (to) labor, firms respond by retaining workers who are highly productive while reducing (increasing) employment and wages of low productivity workers.

I express the intuition above in the following theoretical prediction.

Proposition 3. *Sector s' features X' firms, sector s features X firms where $X' < X$. When*

faced with $dP_{sj} < 0$, then $\frac{d\gamma_{sj}\alpha_{sj}}{dP_{sj}^m} < \frac{d\gamma_{s'j}\alpha_{s'j}}{dP_{sj}^m}$ if $\chi_{sj}^X < \chi_{s'j}^{X'}$. When faced with $dP_{sj} > 0$, then $\frac{d\gamma_{sj}\alpha_{sj}}{dP_{sj}^m} < \frac{d\gamma_{s'j}\alpha_{s'j}}{dP_{sj}^m}$ if $\chi_{sj}^X < \chi_{s'j}^{X'}$ and $\frac{dQ_{sj}}{dP_{sj}^m} < 0$.

To summarize, now allowing for heterogenous productivity across firms and firm entry I have derived several theoretical predictions. The preceding propositions allow for heterogeneous labor market outcomes resulting from changes in intermediate goods prices on the basis of concentration in the final goods sector.

3 Data Sources

In this section I provide an outline of the data sources and sample construction.

I construct a dataset consisting of state-sector observations across the United States spanning from 2008 to 2019. I utilize the Survey of Manufactures conducted by the US Census to collect data on the value of shipments and receipts for services, number of employees, total annual payroll, total capital expenditure, and total cost of materials. This data is further supplemented in 2012 and 2017 by the Economic Census. I combine this with state-level data on employment which comes from the annual County Business Patterns. Further, I use sector-level import data for NAICS 3- and 4-digit sectors which is obtained from the USA Trade database.

National level data on the use of commodities by industry are gathered from the Bureau of Economic Analysis Input-Output Accounts. Specifically, I utilize the 2012 Commodity Industry Input-Output Table, the 2012 Use of Commodities by Industry table, and the Use of Imported Commodities by Industry table. I collect national-level tariff data on HS-8 products on an annual basis from the USITC. Additionally, I gather industry-level pricing

data from the Bureau of Labor Statistics. Lastly, I obtain industry concentration data for 3- and 4-digit sectors from the 2017 Economic Census.

	Mean	Standard Deviation
Labor Share	20.57	24.45
Output (billion$)	6.35	13.91
Intermediates (billion$)	3.78	10.14
Wage bill (billion$)	0.798	1.86
$tariff_{sjt}$	0.091	0.225

Table 1: Summary statistics for the main sample.

I obtain state-level employment and occupation data from the BLS Occupational Wage and Employment Statistics. This data is used to measure wages by occupations which are defined as routine (low-skilled) and non-routine (high-skilled) following Autor and Dorn (2013) and Dvorkin and Shell (2017). Further, I gather data on state-level unionization rates in private manufacturing from the Union Membership and Coverage Database. Finally, I obtain data on NAICS sector-state specific imports spanning the entire sample from the USA Trade database.

I construct an unbalanced panel of state-sector observations across the time period from 2008 to 2019 at the NAICS 3-digit level. I supplement this with an additional sample of 4-digit sectors; however, due to data confidentiality and a lack of establishments in some states this is also an unbalanced panel. I report the mean and standard deviation for the main outcome variables and the measure of tariff exposure in table ??. Supplementing this, I also provide a summary of the change in tariff exposure, averaged across each final goods sector for each state in figure 1.
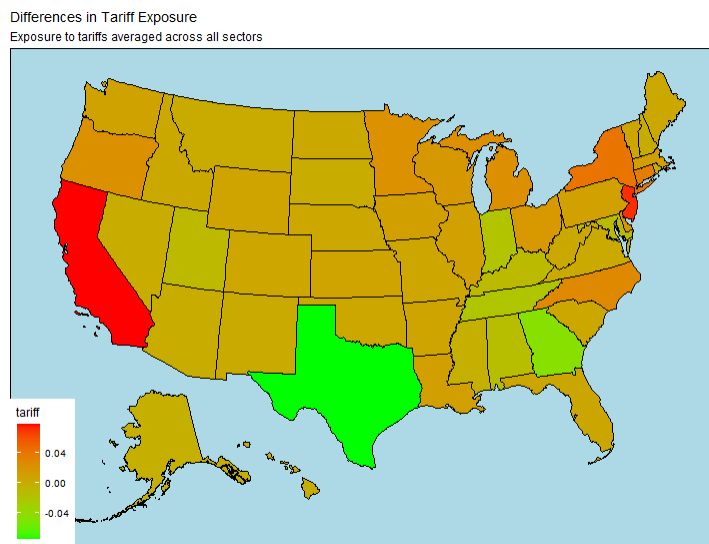
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Differences in Tariff Exposure
Exposure to tariffs averaged across all sectors

tariff
0.04
0.00
-0.04

Figure 1: *Mean difference in tariff exposure across states between 2008 and 2019.*

4   Empirical Framework

I use variation in tariff rates across intermediate inputs, states, and time to identify changes in prices of intermediates. The measure of tariff exposure that I derive below follows from Lake and Liu (2022), though instead of commuting zones I measure tariff exposure at the state level. Further, Dix-Carniero and Kovak (2017) also leverage regional employment data in Brazil to capture trade liberalization, though they do not account for input-output linkages. Lastly, Flaaen and Pierce (2019) construct a measure of increases in input tariffs for naics 6 digit industries using BEA input-output accounts without allowing for regional variation. Ideally, the precise mix of intermediate inputs purchased by firms in each sector, state, and year could be observed in the data. However, I only observe total spending on intermediate inputs at this level of observation. To identify changes in the price of intermediates I make several assumptions and construct a measure of tariff exposure for each final goods sector s in state j in year t. For notational convenience I supress the time subscript below.

I first assume that intermediate goods industries across locations have access to the same technology and that relative productivity growth in these industries is constant across locations. Under this assumption, input industry i produces a share of all intermediate goods produced in state j equivalent to input industry i's share of employment in state j.

$$\frac{M_{ij}}{\sum_i M_{ij}} = \frac{L_{ij}}{\sum_i L_{ij}} \tag{24}$$

Define M_j as the total intermediates produced in j $(M_j \equiv \sum_i M_{ij})$. Under a balanced trade assumption for all regions j then the following must hold

$$M_j = \sum_s M_{sj} \tag{25}$$

By rearranging equation 24 it is possible to solve for M_{ij}. This will be used to compute relative price changes faced by final sector-states. To compute these changes, first start with the cost for final goods sector s to produce a unit of output, given by (equation 6). The change in price of intermediates, P_{sj}^m that results from a change in trade costs is dependent on the degree to which firms in sector s and state j rely on foreign intermediate inputs. I then make several assumptions; first, final goods producers in j will source intermediates from suppliers based in j before purchasing intermediates from abroad. Second, μ is sufficiently large such that final goods producer in sector s do not respond to a change in the price of an intermediate input by substituting to an alternative intermediate. This is a strong assumption that can be revisited. Third, labor markets are perfectly competitive within states; labor is immobile across j and perfectly mobile across s and i. Lastly, I assume that in the short-run the fixed factor of production K is unchanged after a change in the price of intermediates.

Next, I define M_{sj}^H as the CES aggregate consisting of all intermediates purchased from local intermediate goods producers. Further, define M_{ij} and M_{ij}^H as the supply of intermediates available in j and the supply of intermediates produced in j, respectively. To study the effect of changes in intermediate goods prices on the share of output flowing to labor in the final goods sector the main variable of interest is P_{sj}^m. Specifically, I am interested in changes in this composite price resulting from a change in trade costs. With knowledge of M_{sj}, specifically M_{sj}^H, it is possible to calculate the amount of intermediates used by sector s which are produced in the home region. Further, I have information on national level input requirements used to produce output in s from the Input-Output Accounts.

The price of intermediate inputs, on the other hand, are not readily available. Using previous assumptions I can construct a proxy for the amount of intermediate i which is produced in j. First, I solve for M_{ij} by rearranging equation 24.

$$M_{ij}^H = \frac{L_{ij} \sum_i M_{ij}^H}{\sum_i L_{ij}} \qquad (26)$$

By using previous assumptions; I can infer the amount of intermediate i produced in j by taking the share of employment used to produce i as a proportion of total j employment. Further, I can use data on the total value of intermediate goods purchased by sector s in j to calculate the value of requirement i for each final goods sector s. This s-j specific input requirement is calculated as follows

$$M_{ij} = r_{is} M_{sj} \qquad (27)$$

where r_{is} is taken from the input-output data and serves as a proxy for δ_{is}. I can exploit

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the difference between the amount of i required by s in j and the amount of i produced in j to measure exposure to price swings as a result of tariffs. This requires the strong assumption that there is no relative change in wages paid to workers or in productivity across locations. This implies that changes in trade costs are driving any change in P_{sj}^m faced by the final goods sector. Further, I assume that changes in trade costs are primarily driven by tariffs; over the time period from 2008 to 2019 there are no significant improvements in technology that drastically reduce trade costs.

Following these assumptions, I can calculate the requirements for foreign inputs of sector s in j.

$$M_{ij}^F = \begin{cases} M_{ij} - M_{ij}^H, M_{ij}^H \leq M_{ij}^F \\ 0, M_{ij}^H > M_{ij}^F \end{cases} \tag{28}$$

For each sector, state, and year I can calculate exposure to tariffs by finding M_{ij}^F as a proportion of M_{sj}. I define τ_i as the ad-valorem tariff placed on input i at the national level. The tariff faced by sector s in j can be expressed as

$$tariff_{sj} = \sum_i (1 + \tau_i) \frac{M_{ij}^F}{M_{sj}} \tag{29}$$

Under assumptions of no relative changes in wages, productivity, and trade costs outside of tariffs, I can infer year over year changes in P_{sj}^m from changes in $tariff_{sj}$. Exploiting this variation over time I can estimate the effect of a change in price of intermediate goods used by sector s in j on the share of output flowing to labor. Estimating the elasticity of employment, wages, and the labor share with respect to changes in the price of intermediates allows me to characterize the degree of complimentarity or substitutability between intermediates and labor.

Exploiting variation over time in tariffs faced by the final goods sector to estimate the effect of a change in the price of intermediate inputs on labor market outcomes requires several assumptions. First, conditional on covariates and included fixed effects, there is no correlation between the error term and labor market outcomes. An additional assumption is that when there is a change in the tariff rate faced by the final goods sector this is actually the tariff rate that is paid. For example, if firms in the final goods sector change to another variety of inputs or source them from another country to avoid paying the tariff, this assumption could be violated. However, in this scenario the final goods sector is generally attempting to pay a lower price for intermediate inputs, so in the case of an increase in tariffs this measurement error would bias results towards zero. In the case that tariff rates are lowered, there is no reason to expect that firms would attempt to avoid paying a lower tariff rate. Lastly, I make a strong assumption that while firms may face tariffs in input markets they are simultaneously not responding to tariffs in output markets. For example, a final goods producer of cars which faces an increase in steel tariffs simultaneously with an increase in tariffs on cars is not changing its mix of inputs based on an increase in competitiveness in the output market.

I then run a panel data fixed effects model to estimate the effect of a change in tariffs faced by sector s in the intermediate goods market on output, employment, wages, and the share of output which flows to labor. I measure the labor share in two ways; as the share of employee compensation in the form of wages and salaries in proportion to the total value of shipments and receipts as well as in proportion to value-added. I study naics manufacturing sectors and use data at both the 3- and 4-digit level. I rely on changes over time in exposure to tariffs for each industry-state observation. This can be driven by either

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changes in actual tariffs applied to HS-8 products that are used as inputs to production or changes in M_{ij}^H, the amount of inputs that are supplied locally. I run the following estimating equation

$$log(Y_{j,s,t}) = \alpha_0 + \beta log(tariff_{j,s,t}) + X_{j,s,t} + \gamma_j + \gamma_s + \gamma_t + \epsilon r, s, t \qquad (30)$$

γ_j is a state fixed effect, γ_s is a final sector fixed effect, and γ_t is a year fixed effect. In all of my results I cluster standard errors at the state level. When the labor share is the outcome variable it is scaled by 100 before taking a logarithm. Most covariates, with the exception of my control for output tariffs, are observed at the state level. I control for GDP, population, unemployment rates, and union membership rates in the private manufacturing sector. Further, I disentangle input tariffs from tariffs in output markets by controlling for state-industry specific output tariffs. To construct this variable I interact $(1 + \tau_i)$ with the sector's share of manufacturing imports flowing into each state.

Lastly, to empirically test proposition 3 I first split my sample by final goods sector into highly concentrated and non-highly concentrated sectors. At the naics 3 digit level, I choose an HHI of 110 as the cutoff; sectors which have a larger HHI are considered highly concentrated. By choosing this cutoff I ensure that roughly half of my sample is classified as highly concentrated (10 naics 3 sectors) and non-highly concentrated (11 naics 3 sectors). I rely on the 2007 Economic Census to obtain the market concentration data for each sector. I then run 30 separately for each subsample to test for heterogeneous labor market outcomes resulting from higher costs in intermediate input markets. I supplement this by running a test for equality of coefficients to verify heterogeneous effects on the basis of final goods sector concentration. Specifically, I run two regressions using seemingly unrelated estimations to flexibly allow for correlation in the error terms between each subsample. Us-

ing the estimation results a Wald test for the equality of coefficients $\beta_{highHHI} = \beta_{lowHHI}$ is conducted.

5 Results and Discussion

I report baseline estimates of 30 in table 2. The outcome variables of interest are wages, employment, output, the labor share of output, and the labor share of value-added. The estimates of β from 30 are found in the first row of each table.

In my baseline results I find a significant negative relationship between exposure to tariffs and the labor share of output. The results suggest that a 1 percent increase in exposure to tariffs on intermediate inputs is associated with a 0.084 percent decrease in the labor share of output. However, wages and employment are positively related to exposure to input tariffs. The decline in the labor share is thus primarily driven by a faster increase in output that is associated with increased tariff exposure. There are several possible explanations for this result; one that I investigate in table 3 is the role of pricing power in driving changes in the value of output and wages. I use industry level producer price indices to deflate the value of output and the consumer price index at the national level to deflate total wages. I otherwise run the same specifications from table 2.

After deflating for producer prices in the final goods sector the results and conclusions, for the most part, remain unchanged. Allowing for heterogeneous price increases across sectors does little to change the relationship between tariff exposure in input markets and the value of final output (0.567 vs 0.569 percent increase). This implies that the increase in the value of output is primarily a quantity effect, firms in the final goods sector are increasing the quantity of goods produced, perhaps by becoming more vertically integrated.

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Table 2: Baseline Specification

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Wages	Employment	Output	$\gamma_{sj}\alpha_{sj}$	α_{sj}	$(1-\gamma_{sj})\alpha_{sj}$
$tariff_{sjt}$	0.348***	0.306***	0.451***	-0.062**	-0.023	0.413***
	(0.059)	(0.060)	(0.057)	(0.026)	(0.029)	(0.054)
GDP	0.170	0.089	0.957**	-0.264	-0.267	0.406
	(0.230)	(0.218)	(0.338)	(0.191)	(0.195)	(0.351)
Unemployment	-0.087*	-0.087*	0.026	-0.042	-0.070	-0.026
	(0.047)	(0.046)	(0.083)	(0.051)	(0.051)	(0.085)
Population	0.362	0.314	-0.798	0.300	0.413	-0.318
	(0.361)	(0.353)	(0.519)	(0.288)	(0.329)	(0.696)
Unionization	-0.015	-0.011	-0.010	0.007	0.009	0.012
	(0.009)	(0.008)	(0.015)	(0.009)	(0.015)	(0.024)
Output Tariff	1.813***	1.603***	1.635**	-0.297	-0.166	1.475***
	(0.472)	(0.445)	(0.541)	(0.331)	(0.270)	(0.387)
N	11135	11135	10115	10054	9770	8667
R^2	0.8419	0.8480	0.8031	0.6071	0.4635	0.7431

Standard errors in parentheses are clustered at state level

* $p < .1$, ** $p < .05$, *** $p < .001$

Notes This table presents results for the baseline specification and the full sample. Columns 1 through 3 provide a decomposition of the labor share. Columns 1 and 2 enter the numerator; total wages is the average per worker wages, salaries, and other payments to workers across all firms operating in a sector, state, and year. Employment is the number of workers employed by firms operating in a state, sector, and year. Output is the reported value of sales for each sector, state, and year. Column 4 reports results for the labor share as a proportion of total sales, while column 5 reports results for the labor share as a proportion of total sales less the cost of intermediate inputs. Column 6 reports results with for the outcome as the capital share of final sales.

Table 3: Baseline Specification Deflated by Price Indices

	(1)	(2)	(3)	(4)	(5)
	Total Wages	Output	$\gamma_{sj}\alpha_{sj}$	α_{sj}	$(1-\gamma_{sj})\alpha_{sj}$
$tariff_{sjt}$	0.348***	0.457***	-0.067**	-0.0278	0.450***
	(0.059)	(0.057)	(0.026)	(0.029)	(0.065)
GDP	0.170	0.973**	-0.280	-0.273	0.130
	(0.230)	(0.337)	(0.188)	(0.196)	(0.265)
Unemployment	-0.087*	0.024	-0.041	-0.071	0.022
	(0.047)	(0.083)	(0.051)	(0.050)	(0.095)
Population	0.362	-0.832	0.334	0.450	0.008
	(0.361)	(0.514)	(0.288)	(0.328)	(0.652)
Unionization	-0.015	-0.011	0.008	0.009	-0.027
	(0.009)	(0.015)	(0.009)	(0.014)	(0.031)
Output Tariff	1.813***	1.594**	-0.255	-0.118	1.812***
	(0.472)	(0.534)	(0.324)	(0.267)	(0.419)
N	11135	10115	10054	9770	9111
R^2	0.8431	0.8048	0.5546	0.3971	0.7718

Standard errors in parentheses are clustered at state level

* $p < .1$, ** $p < .05$, *** $p < .001$

Notes This table reproduces the results from the baseline specification while deflating the value of output by the national level, industry specific Producer Price Index. Further, average per worker wages are deflated by the national level CPI. This robustness check is designed to account for the potential of increased pricing power in output markets and to ensure that nominal wage growth is not influencing the results.

An alternative explanation is that highly concentrated industries are driving the results. Autor et al. (2020) conclude that superstar firms, operating in highly concentrated industries, have been a driving force behind the decline of the labor share, independent of globalization. One hypothesis is firms operating in highly concentrated sectors, when faced with an increase in input prices, rather than passing these on to the final consumer instead offer lower wages or require longer work hours without an increase in wage. I test for this by splitting my sample into two subsamples; consisting of final goods sectors that are highly concentrated and those that are not. I use data from the 2017 Economic Census, which includes sector level HHI data. I define the cutoff for a sector to be highly concentrated by requiring an HHI larger than 90. This allows for roughly half of the final goods sectors to be considered highly concentrated. I re-run the baseline specification for the high concentration and low concentration subsamples, with results presented in tables 4 and 6, respectively.

From the results, I have shown that sectors that are considered highly concentrated do experience slower employment and total wage bill growth, and experience a larger decrease in the labor share after experiencing an increase in tariff exposure, relative to sectors that experience low levels of concentration. These highly concentrated industries could also encompass firms which have a greater capacity to invest in automation and other inputs considered as a fixed factor in my analysis, which is corroborated by the larger, though insignificant, coefficient on the response in the labor share of value-added.

Lastly, I conduct a heterogeneity check by re-running my baseline specification; however, I now run this on the labor share of high and low skilled workers, respectively. I use the definitions by Dvorkin and Shell (2017) to classify occupations as high and low skilled then

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Table 4: High Concentration Subsample

	(1) Total Wages	(2) Employment	(3) Output	(4) $\gamma_{sj}\alpha_{sj}$	(5) α_{sj}	(6) $(1-\gamma_{sj})\alpha_{sj}$
$tariff_{sjt}$	0.284**	0.252**	0.395***	-0.050	-0.024	0.376***
	(0.092)	(0.088)	(0.094)	(0.054)	(0.063)	(0.084)
GDP	0.443	0.321	1.805**	-0.752**	-0.904**	0.780
	(0.374)	(0.373)	(0.537)	(0.232)	(0.277)	(0.576)
Unemployment	-0.063	-0.066	0.049	-0.045	-0.096	-0.033
	(0.089)	(0.085)	(0.114)	(0.074)	(0.099)	(0.140)
Population	-0.209	-0.288	-2.116**	0.793	0.790	-1.273
	(0.756)	(0.719)	(0.898)	(0.488)	(0.630)	(1.284)
Unionization	-0.017	-0.017	0.0002	0.009	0.004	0.002
	(0.019)	(0.017)	(0.036)	(0.019)	(0.024)	(0.041)
Output Tariff	2.126**	1.804**	1.959**	-0.420	-0.216	1.661**
	(0.677)	(0.585)	(0.763)	(0.491)	(0.421)	(0.544)
N	4981	4981	4384	4342	4167	3598
R^2	0.8184	0.8168	0.7625	0.5913	0.4594	0.7132

Standard errors in parentheses are clustered at state level

* $p < .1$, ** $p < .05$, *** $p < .001$

Notes This table reproduces the baseline specification for the sub-sample of final goods sectors I classify as highly concentrated, featuring an HHI greater than 110. This includes the following NAICS sectors; 312, 313, 314, 316, 322, 324, 325, 331, 334, 336.

Table 5: Low Concentration Subsample

	(1) Total Wages	(2) Employment	(3) Output	(4) $\gamma_{sj}\alpha_{sj}$	(5) α_{sj}	(6) $(1-\gamma_{sj})\alpha_{sj}$
$tariff_{sjt}$	0.388***	0.338***	0.486***	-0.096***	-0.043*	0.426***
	(0.052)	(0.052)	(0.058)	(0.027)	(0.025)	(0.063)
GDP	0.073	-0.042	0.427	0.022	0.131	0.240
	(0.330)	(0.280)	(0.261)	(0.208)	(0.166)	(0.351)
Unemployment	-0.114**	-0.112**	-0.027	-0.010	-0.040	-0.062
	(0.045)	(0.041)	(0.086)	(0.065)	(0.051)	(0.099)
Population	0.698*	0.774**	0.216	0.140	0.265	0.202
	(0.385)	(0.357)	(0.504)	(0.340)	(0.374)	(0.662)
Unionization	-0.007	0.001	-0.009	0.012	0.011	0.023
	(0.011)	(0.010)	(0.014)	(0.010)	(0.012)	(0.033)
Output Tariff	1.394**	1.473**	1.156**	-0.0968	-0.0446	1.025**
	(0.566)	(0.571)	(0.428)	(0.311)	(0.249)	(0.347)
N	6154	6154	5731	5712	5603	5069
R^2	0.8840	0.8854	0.8764	0.6318	0.4937	0.8096

Standard errors in parentheses

* $p < .1$, ** $p < .05$, *** $p < .001$

Table 6: *Notes This table reproduces the baseline specification for the sub-sample of final goods sectors I classify as low concentration, featuring an HHI smaller than 110. This includes the following NAICS sectors; 311, 315, 321, 323, 326, 327, 332, 333, 335, 337, 339.*

Table 7: Baseline Specification With Skill-Biased Labor Share

	(1)	(2)
	Labor Share (Low)	Labor Share (High)
$tariff_{sjt}$	-0.332***	0.0595
	(0.0400)	(0.0393)
N	10067	10067
R^2	0.7370	0.5856

Standard errors in parentheses are clustered at state level

* $p < .1$, ** $p < .05$, *** $p < .001$

Notes This table presents results from running the baseline specification, further subdividing the labor share into the share flowing to high-skill and low-skill occupations. High- and low-skill is defined as non-routine and routine occupations according to Dvorkin and Shell (2017). The labor share is defined as the sector-state-specific high- and low-skill average wage multiplied by high- and low-skill employment, respectively. In the denominator I use sector-state-specific total sales. The specification is run with all controls; however, I suppress the results for the control variables.

use state level wage-occupation data to impute employment levels by state, sector, and skill level. The results from this specification are found in table 7.

These results indicate that the wages and employment of low-skilled occupations in manufacturing sectors are much more negatively impacted by higher tariffs in input markets. When these sectors face increased costs in intermediate input markets, they appear to be expanding output not by raising wages and employment in low-skill occupations but instead relying on high-skill, and perhaps more productive workers.

As a robustness check, I run two specifications; the baseline and a specification with time and state-sector fixed effects on 4 digit rather than 3 digit NAICS sectors. When running the baseline specification on 4 digit sectors the coefficients do decrease in magnitude; however, the main conclusion remains unchanged. With the interacted fixed effects, the significance on the coefficient for the labor share of output disappears. The results for this robustness check can be found in the appendix.

6   Conclusion

In this paper I have explored the effects of a policy response to increased globalization on labor markets. I have linked increases in US tariffs on intermediate imports to a decline in wages and employment relative to output of final goods industries. Using a panel data fixed effects model with a novel measure of exposure to input tariffs I have found that, though wages and employment are rising despite these tariffs, they do not match the simultaneous expansion in output of final goods, thus a decline in the labor share is associated with an increase in input tariffs. Though prices of final goods and high concentration do not explain this decline, I do find that there is significant heterogeneity in the effects of tariffs on high and low skilled workers.

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A Appendix A: Derivations

This appendix presents the solution to the final goods firm's problem. I use this to derive an analytical expression for the parameters governing the labor share.

The final good producer's problem is

$$argmax\Pi_{sj} = P_{sj}^f Q_{sj} - w_j L_{sj} - r_j K_{sj} - (\sum_i \delta_{isj}^{1-\mu} p_{isj}^{1-\mu})^{\frac{1}{1-\mu}} M_{sj} \tag{31}$$

Taking first order conditions yields the following;

$$\frac{d\Pi_{sj}}{dVA_{sj}} \frac{dVA_{sj}}{dL_{sj}} = A_{sj}^{\frac{\zeta-1}{\zeta}} Q_{sj}^{\frac{1}{\zeta}} \gamma_{sj}^{\frac{1}{\zeta}} VA_{sj}^{\frac{1}{\rho_s}-\frac{1}{\zeta}} \alpha_{sj}^{\frac{1}{\rho_s}} L_{sj}^{\frac{-1}{\rho_s}} = w_{sj} \tag{32}$$

$$\frac{d\Pi_{sj}}{dM_{sj}} \frac{dM_{sj}}{dm_{isj}} = P_{sj}^f A_{sj}^{\frac{\zeta-1}{\zeta}} Q_{sj}^{\frac{1}{\zeta}} (1-\gamma_{sj})^{\frac{1}{\zeta}} M_{sj}^{\frac{1}{\zeta}} [\sum_i \delta_{is}^{1/\mu} m_{isj}^{\frac{\mu-1}{\mu}}]^{\frac{\mu}{\mu-1}} \delta_{isj}^{\frac{1}{\mu}} m_{isj}^{\frac{-1}{\mu}} = p_{isj} \tag{33}$$

Solving the firm's optimization problem yields

$$(1-\gamma_{sj})^{\frac{1}{\zeta}} M_{sj}^{\frac{1}{\mu}-\frac{1}{\zeta}} \delta_{isj}^{\frac{1}{\mu}} m_{isj}^{\frac{-1}{\mu}} p_{isj}^{-1} = \gamma_{sj}^{\frac{1}{\zeta}} VA_{sj}^{\frac{1}{\rho_s}-\frac{1}{\zeta}} \alpha_{sj}^{\frac{1}{\rho_s}} L_{sj}^{\frac{-1}{\rho_s}} w_{sj}^{-1} \tag{34}$$

Rearranging the above equation yields the following expression for γ_{sj} and α_{sj}, the parameters which I use to define the labor share.

$$\gamma_{sj}^{\frac{1}{\zeta}} \alpha_{sj}^{\frac{1}{\rho_s}} = (1-\gamma_{sj})^{\frac{1}{\zeta}} M_{sj}^{\frac{1}{\mu}-\frac{1}{\zeta}} \delta_{isj}^{\frac{1}{\mu}} m_{isj}^{\frac{-1}{\mu}} p_{isj}^{-1} VA_{sj}^{\frac{1}{\zeta}-\frac{1}{\rho_s}} L_{sj}^{\frac{1}{\rho_s}} w_{sj} \tag{35}$$

B Appendix B: Tables and Graphs

Figure B.2: Differences in tariff exposure for each naics 3 digit sector. Ordered left-to-right then top-down.

	(1) Labor Share	(2) Labor Share	(3) Labor Share	(4) Labor Share
$tariff_{sjt}$	-0.00381	-0.0409**	-0.00481	-0.0409**
	(0.0124)	(0.0129)	(0.0127)	(0.0129)
GDP			-0.180**	-0.310**
			(0.0813)	(0.123)
Unemployment			-0.0159	-0.0199
			(0.0256)	(0.0408)
Population			0.375**	0.710**
			(0.185)	(0.230)
Income			-0.0237	-0.0805
			(0.0398)	(0.0611)
Year, State-Sector FE	X		X	
Year, Sector, State FE		X		X
N	25797	25797	25797	25797

Standard errors in parentheses are clustered at state level

* $p < .1$, ** $p < .05$, *** $p < .001$

Table 8: Result for the labor share of output as the outcome variable for 4-digit NAICS final goods sectors.

In the tables below I replicate the baseline regressions for NAICS 4 digit sectors.