Trade and Market Power in Product and Labor Markets

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Acknowledgements

Abstract

This paper studies the effects of endogenous firm-level market power in input and product markets on equilibrium prices and wages as well as the gains from trade using a general equilibrium model with heterogeneous firms. Firm-level prices and wages are functions of two endogenous distortions: (i) a markup of price over marginal cost that depends on product market shares and (ii) a markdown of wages relative to marginal revenue product that depends on labor market shares. Both distortions cause large firms to be too small relative to local labor market competitors compared to a setting with perfect competition in input and product markets. Opening product markets up to trade reallocates market shares in product and labor markets towards countries' large firms, which can reduce misallocation but also increases the labor market power of these firms. After estimating the structural parameters of the model using Indian plant-level data, I show that accounting for endogenous labor market power implies only small welfare losses due to misallocation and therefore a negligible increase in the gains from trade. Trade has significantly larger effects on firms' markups than on their markdowns. Nevertheless, because of the increase in large firms' input market power, there is a redistribution of the gains from trade from wages to firm profits.

Topics: Economic models, Labour markets, Market structure and pricing, Productivity, Trade integration

JEL codes: D43, F12, F6, J, L13

1   Introduction

Globalization plays an important role in determining the allocation of resources across firms. Trade economists emphasize the importance of trade-induced reallocations of economic activity from small and unproductive firms to large and better-performing firms as an important source of welfare and aggregate productivity gains from trade.[1] However, the relationship between market concentration and market power has also become a topic of growing concern. Recent research has documented how global economic activity is increasingly concentrated in a small number of large firms.[2] Greater concentration in national product markets has been tied to the growth of large firms' profits (Barkai, 2020), markups (De Loecker and Eeckhout, 2020), and a lower labor share of national income (Autor et al., 2017, 2020).[3] These aggregate trends may be a cause of rising inequality.

While the concentration of activity in input markets has received less attention than in product markets, an increasing number of papers have found a high degree of concentration in labor markets and a negative association between concentration and wages.[4] Azar et al. (2020a) estimate a negative relationship between the concentration of vacancies and posted wages. Benmelech et al. (2020) show that within U.S. manufacturing sectors, employment concentration at the county-industry level increased between 1977 and 2009, and they document a negative relationship between employment concentration and wages paid by firms. They also show that labor markets that were more exposed to Chinese import competition became more concentrated relative to those less exposed and that import-induced increases in concentration were negatively associated with changes in firms' wages.

Combining these insights and facts from both the trade and labor literatures, I examine an underexplored implication of trade-induced product market reallocations: by reallocating output from smaller to larger firms, trade can also cause reallocations in input markets that increase the concentration of purchases in the largest firms and therefore their potential market

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[1]A large literature, following the empirical evidence in Pavcnik (2002) and the theory developed by Melitz (2003), studies across-firm reallocative gains from trade. Reviews of this literature can be found in Melitz and Trefler (2012) and Melitz and Redding (2014).

[2]The Council of Economic Advisers (CEA) show that the share of sales in the top 50 firms has increased in most NAICS sectors in the U.S. between 1997 and 2012 (CEA, 2016a). Increasing sales concentration within sectors is also found within four-digit U.S. industries in Autor et al. (2017, 2020). Trade flows are also highly concentrated within a small number of large firms both in terms of imports and exports (Bernard et al., 2009).

[3]Other research has questioned the contribution of product market concentration to these trends: Edmond et al. (2018), Karabarbounis and Neiman (2019), and Traina (2018) find moderately increasing to flat trends in markups over time, and Rossi-Hansberg et al. (2018) show that concentration in local product markets has declined at the same time as the increase in national concentration.

[4]Azar et al. (2020b) find that online job vacancies in at least one third of U.S. commuting zones by six-digit SOC occupation labor markets are highly concentrated relative to U.S. horizontal merger guidelines. Labor market concentration and monopsony power have also attracted the attention of policymakers (CEA, 2016b).

power in input markets. Specifically, I evaluate whether accounting for firms' oligopsony power in input markets can affect equilibrium outcomes such as prices and wages, the aggregate gains from trade, and the allocation of those gains between factor income and firm profits.

To conduct this exercise, this paper develops a quantitative general equilibrium model in which firms have endogenous market power in both national product and local labor markets. The model features two countries, many sectors, and many locations. In each location-sector pair there are a finite number of heterogeneous firms. Workers choose which firm to work for subject to idiosyncratic match-specific productivities and firms' posted effective wages. Analogously to the results in Thisse and Toulemonde (2015) and Card et al. (2018), firms face firm-level upward sloping labor supply curves derived from these choices. This causes firms to have market power in labor markets, leading them to offer workers a wage *markdown* relative to their marginal revenue products. With a finite number of local competitors, wage markdowns are variable and depend on firms' size as employers within their local labor markets. Similarly, a finite number of sellers compete in product markets and charge variable price markups over their marginal costs that depend on their size as sellers. Since firms simultaneously compete as oligopolists in product markets and oligopsonists in labor markets, concentration of activity in both types of markets affects aggregate welfare.[5]

Because firms offer effective wages to their workers that are less than their marginal revenue products, the equilibrium allocation of sales and employment across firms involves two distortions for each firm: one due to market power in product markets and one due to market power in labor markets. Both cause firms' relative sizes to be distorted compared to a world in which firms do not have endogenous market power: the most productive firms are too small compared to their local labor market competitors. Accounting for firms' endogenous labor market power therefore implies an additional source of misallocation across heterogeneous firms that can negatively affect aggregate productivity.

I start by quantitatively examining how accounting for employers' market power affects equilibrium outcomes such as prices and wages. I then examine how a reduction in trade costs affects both market power and also welfare in the presence of market power relative to competitive factor markets.

To do this, I estimate the model's key product demand and labor supply elasticity parameters using Indian plant-level data from the Annual Survey of Industries for the years 2008–2009 and sectoral import data. These parameters govern the relationship between a firm's market power and size within each market. The elasticity parameters are estimated

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[5]In my model, oligopoly refers to competition between a small and finite number of product market competitors while oligopsony analogously refers to competition between a small and finite number of labor market competitors.

using the model-implied relationship between the share of firm-level value added paid to workers as wages and their national product market and local labor market shares.[6] I then recover the model-implied distribution of firm productivity in the Indian data using a fixed point algorithm.

I find that when factor markets are characterized by oligopsony, aggregate welfare in autarky is 0.4% lower than when there are perfectly competitive factor markets. While this welfare loss is small, the composition of real income diverges greatly between the two models. In autarky, aggregate real wages with oligopsony are only 84% of their level under perfect competition in factor markets while real profits are 11% higher with oligopsony. Exposure to trade reduces firms' market power in domestic product markets but has little effect in labor markets. Moving from autarky to free trade causes the average domestic markup to decrease by 7% while the corresponding average markdown of wages decreases by just 0.2%, which represents a small increase in the distortions caused by oligopsony. I show that the finding of negligible effects of trade on firms' labor market power is robust to a wide range of reasonable parameter values and alternative model assumptions. This confirms that trade has only small effects on firms' labor market power.

This result is driven by the fact that the most productive firms need only increase their relative employment by a small amount to accommodate their increase in relative sales. In part this is because the baseline model abstracts from endogenous entry into both domestic and export markets.[7] This enables an investigation of the intensive margin reallocation effects of trade but implies that trade primarily affects firms' labor market power indirectly through its effects on firms' product market power. Domestic markups fall more in proportional terms for large firms than for small firms, which reallocates relative sales towards large firms. However, because large firms are more productive there is a relatively small reallocation of employment and only a small increase in the distortions caused by oligopsony.

Since the magnitude of the reallocations in labor markets induced by trade are small, trade has very similar effects on aggregate welfare whether I account for endogenous labor market power or not. Gains from trade are very slightly higher (0.14%) with oligopsony competition in labor markets because trade reduces the extent of misallocation that originates from firms' variable wage markdowns. While the gains from trade are much the same with

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[6]This method of recovering the elasticity parameters is closely related to the empirical strategy used in Kikkawa et al. (2018) in a similar environment with oligopoly in product markets.

[7]As I discuss below, these margins of adjustment are held fixed because monopsony power makes markets interdependent through firms' increasing marginal costs. As in other models featuring extensive margin interdependence, such as Antràs et al. (2017) and Arkolakis and Eckert (2017), determining extensive margins endogenously in general equilibrium is a computationally involved combinatorial problem. Solution techniques used to endogenize market entry in oligopoly models with perfectly competitive factor markets do not apply for reasons that will become clear below.

and without labor market power, oligopsony power redistributes these gains across workers and firms. Because wage markdowns of the largest employers in a labor market decrease as trade causes them to grow in relative size, firms' profits grow faster in a world with oligopsony competition in labor markets at the expense of real wage gains from trade. In the calibrated model, the growth of real profits is 2% higher and the growth of real wages is 0.4% smaller with oligopsony competition relative to perfect competition in labor markets.

Next, I extend the model to incorporate extensive margin reallocation effects of trade by exogenously varying the set of firms that export. When fewer firms export, trade increases the average labor market power of exporters by a larger amount. This causes the growth of real wages to be even smaller under oligopsony competition relative to perfect competition than in the baseline model. Furthermore, the additional gains from trade under oligopsony due to the reduction of misallocation are smaller with fewer exporters because exporters' labor market power increases by more. With the 10% most productive firms in each sector exporting, real wage growth is 0.5% smaller and the gains from trade are 0.05% higher under oligopsony compared to perfect competition.

The framework developed in this paper combines an open economy model of oligopoly in product markets with elements of labor supply models drawn from the labor literature. In product markets, firms face demand derived from the multi-sector nested constant elasticity of substitution (CES) models of Atkeson and Burstein (2008) and Edmond et al. (2015) in which firms compete as oligopolists within sectors. In labor markets, firms' market power originates from a Roy (1951) model of workers' idiosyncratic match-specific productivities, which results in firm-level upward sloping labor supply curves based on recent models developed by Thisse and Toulemonde (2015) and Card et al. (2018).[8] Building on these models, the heterogeneous sizes of a finite number of employers play an important role since employers compete as oligopsonists in location-sector pair labor markets. By introducing endogenous labor market power, this paper extends a number of recent Roy-style models of workers' idiosyncratic productivities with perfectly competitive labor markets to a setting of oligopsonistic labor markets.[9]

In combining these two literatures, I show that trade can cause markdown distortions at the largest employers to increase as they increase their labor market share, while the markdown distortions at the smallest employers decrease. This consequence of trade-induced

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[8]Whereas these papers model workers' idiosyncrasies as arising from non-pecuniary benefits, I model them as match-specific productivities. I discuss the differences between these environments in Appendix C.1. Workers' idiosyncrasies are an important source of firms' labor market power, as discussed in Manning (2011).

[9]See Lagakos and Waugh (2013), Galle et al. (2018), Tsivanidis (2018), Burstein et al. (2019), Hsieh et al. (2019), and Lee (2020) for Roy-style models of labor demand and supply with perfectly competitive labor markets.

reallocations implies a redistribution of the gains from trade away from workers' wages and towards firm profits.[10]

More generally, this paper adds to the literatures studying oligopoly power and trade in product markets and monopsony power in labor economics. On the product market side, Edmond et al. (2015) use the Atkeson and Burstein (2008) model to measure the pro-competitive gains from reducing the endogenous dispersion of firms' markups.[11] Ashenfelter et al. (2010) and Manning (2011) offer surveys of the monopsony literature. Monopsony has been used to explain a variety of phenomena that are at odds with models of perfectly elastic labor supply, most relevant of which to my paper are the relationship between firm size and wages and the role of firms in the dispersion of earnings across similar workers (see Bhaskar and To (2003) and Card et al. (2018) for a theoretical discussion, and Card et al. (2013), Barth et al. (2016), and Song et al. (2019) for recent evidence on how firms influence the dispersion of earnings). I contribute to this literature by modelling the effects of trade on the dispersion of effective wages across heterogeneous firms and the importance of endogenous oligopsony power for these effects.

Closely related to my work is the paper by Berger et al. (2019). These authors develop a model with oligopsony competition in labor markets and perfect competition in product markets. Using U.S. data, they find welfare losses due to labor market power that are substantially larger than the ones I document in this paper.[12] Relative to their paper, I examine a setting that also features oligopoly competition and use it to study the effects of product market trade liberalizations. Another recent paper close to mine is by Brooks et al. (2019), who empirically examine the effects of oligopsony in India and China. They find an effect of oligopsony on aggregate wages in India that is similar in magnitude to the one I calculate below.

In modelling strategic competition between firms in both product and labor markets and trade, this paper is closely related to Heiland and Kohler (2018). In both that model and the one in this paper, firms' market power in product and labor markets is endogenous, derived from match-specific productivities, and a function of the set of competitors firms face.

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[10]As a result, this paper is related to the literature explaining the decline of the labor share of national income documented by Elsby et al. (2013), Karabarbounis and Neiman (2013), Furman and Orszag (2015), and others. The model developed in this paper provides a mechanism linking trade and the labor share of income through changes in large firms' oligopsony power.

[11]Trade liberalizations need not have pro-competitive effects on markup dispersion. Arkolakis et al. (2019) show that within a commonly used class of models, trade has negative pro-competitive effects on markup dispersion.

[12]A significant reason for the difference is due to the inclusion of a disutility of labor supply that causes aggregate labor supply to fall when firms have labor market power. In addition, their estimates imply that firms face more inelastic labor supply than in my calibrated model, which, as I show below, can increase the welfare losses due to oligopsony.

However, firms in Heiland and Kohler (2018) are homogenous so that there are no across-firm trade-induced reallocations of market share within a country other than through firm exit.[13] Introducing labor market power into a trade model has novel effects compared to perfect competition because firms have increasing marginal costs of production, which cause sales to one market to be a substitute for sales to the other market for a given firm. Increasing marginal costs make production decisions in both markets interdependent.[14] In addition, the simulations in this paper use structural parameters estimated from micro-data to measure the quantitative importance of firms' labor market power.

This paper is also related to a large literature on the importance of misallocation in economic outcomes (e.g., Restuccia and Rogerson (2008) and Hsieh and Klenow (2009)). In this paper dispersion of markup distortions across heterogeneous firms is a source of misallocation losses, as in Epifani and Gancia (2011), Edmond et al. (2015, 2018), Dhingra and Morrow (2019), and Peters (2020). While I follow Morlacco (2019) in focusing on oligopsony power in input markets, this paper provides microfoundations for firms' variable wage markdowns and shows that trade can reduce misallocation by reallocating employment within labor markets towards the most productive firms.

This paper is organized as follows. Section 2 develops the model of endogenous market power in product and labor markets and derives outcomes for workers and firms. Section 3 characterizes the equilibrium of the model and the assumptions on the extensive margins of firm activity. Section 4 describes the data and estimates the key parameters of the model. Section 5 simulates the counterfactual effects of trade when firms have endogenous labor market power. Section 6 concludes.

2   Model Outline

I develop a static quantitative model with heterogeneous workers and firms, multiple sectors and locations, and two countries. Workers are immobile across the two countries, Home (H) and Foreign (F), but are mobile across firms, sectors, and locations within a country. There is a mass of L^H workers in Home and L^{*F} workers in Foreign, a finite number N^H of locations in Home and N^{*F} locations in foreign, and a unit continuum of sectors. Firms in

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[13]Firm homogeneity allows the authors to analytically characterize the effect of trade on the number of firms. A consequence of this assumption is that trade liberalization reduces aggregate productivity due to a decrease in average match-quality as firms exit.

[14]Most heterogeneous firm trade models assume constant marginal costs of production. Increasing marginal costs can be found in Vannoorenberghe (2012), Blum et al. (2013), Soderbery (2014), Ahn and McQuoid (2017), Almunia et al. (2018), and Liu (2018), where they are motivated by short-run fixed factors or capacity constraints. I provide the first trade model to motivate market interdependence through increasing marginal costs that are due to price setting power in input markets.

each country use a single factor of production, labor, to produce goods that are tradable across locations and countries and are imperfect substitutes for one another.

In this section I describe the preferences and labor supply decisions of workers, the labor supply curves facing firms, the production technology and trade costs, the market structure under which firms compete, and the implications of this market structure for prices, wages, and firm-level trade patterns. Throughout the discussion of the model, I focus on the Home country. Foreign variables are denoted with an asterisk.

2.1 Preferences and Labor Supply of Workers

I begin with the utility maximization problem facing a Home worker. Workers consume a final good C that is produced by domestic final good firms. To finance this consumption, workers spend dividend and labor income. Dividend income is common to all Home workers and is denoted by Π. Workers earn labor income from supplying a single unit of labor inelastically to an employer. Prospective employers are located in one of the N^H production locations and sell their output in one of the sectors. I assume that all locations are symmetric in terms of the amenities available and that goods are freely traded across domestic locations. Each worker h chooses an employer ω from the set of all firms operating in Home to maximize their nominal labor income. In choosing an employer, worker h simultaneously chooses the location n and the sector s in which to work. The effective productivity of worker h's labor when working at firm ω is match-specific and denoted by $\varepsilon_{n,s}(h,\omega)$, and nominal labor income is given by

$$w_{n,s}^H(\omega)\varepsilon_{n,s}(h,\omega),$$

where $w_{n,s}^H(\omega)$ is a wage per effective worker offered by the employer that workers take as given.[15]

Match-specific productivities $\varepsilon_{n,s}(h,\omega)$ are idiosyncratic to worker h and potentially distinct for different employers. From the perspective of worker h, heterogeneity in these productivities implies that employers are imperfect substitutes for one another and that there is a potential tradeoff between the wage per effective worker offered by employers and worker h's nominal income at different employers. When all workers share a common ranking of these match-specific productivities, they are all employed by the same firm (or set of firms in the

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[15]$w_{n,s}^H(\omega)$ is firm-specific such that the wage per effective worker is constant within a firm but differences in match-specific productivity across workers cause $w_{n,s}^H(\omega)\varepsilon_{n,s}(h,\omega)$ to vary within a firm. Assumptions on the wage posting environment that imply a single wage per effective worker for each firm are described in the next subsection.

event of a tie in nominal labor income). Otherwise, workers will choose different employers to maximize their nominal labor income.

This model of labor supply adapts the standard Roy (1951) model of occupational choice based on comparative advantage to a decision of which firm to work for. A worker's employer choice depends only on the wage offers and idiosyncratic match-specific productivities at different firms.[16] These idiosyncratic productivities could be rationalized by a richer model in which workers can only imperfectly transfer their labor across firms and locations due to migration costs or across firms and sectors due to firm- or occupation-specific human capital.

Each worker draws a match-specific productivity for every potential employer. I denote the vector of these draws for worker h by $\boldsymbol{\varepsilon}(h)$. These vectors are drawn independently across workers from a common distribution G given by the following multivariate nested Fréchet distribution function:

$$G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\sum_{n=1}^{N^H} \int_0^1 \Big(\sum_{\omega=1}^{\Omega_{n,s}^H} \varepsilon_{n,s}(h,\omega)^{-\beta} \Big)^{\alpha/\beta} \, \mathrm{d}s \right), \tag{1}$$

where $\Omega_{n,s}^H$ is the finite number of potential employers producing in location-sector pair (n,s).[17] I assume this distribution of match-specific productivities because it allows for an aggregation of workers' employer choices that leads to simple expressions for labor supply curves that are analogous to nested CES product demand equations used widely in the literature and in this model.[18] This enhances the tractability of the model and simplifies quantitative analysis of the equilibrium.

This distribution contains two parameters, α and β, that govern the dispersion of productivity draws and demarcate the nesting structure of the problem. β represents the dispersion of match-specific productivity draws within (n,s)-pairs. When β increases, draws within a given (n,s)-pair are less dispersed and workers view employers there as being more similar on average. α represents the dispersion of draws across (n,s)-pairs relative to within (n,s)-pairs. When α increases, average productivities across (n,s)-pairs become less dispersed and workers view employers across (n,s)-pairs as being more similar on average. To ensure that the first

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[16] An alternative closely related model of employer choice is to assume workers have idiosyncratic taste rather than productivity shocks for working at different firms. This variant is used by Thisse and Toulemonde (2015) and Card et al. (2018) in developing models of monopsonistic competition. I discuss this variant in Appendix C.1.

[17] The vector of productivity draws $\boldsymbol{\varepsilon}(h)$ is uncountably infinite in dimension because there is a continuum of sectors. The distribution can easily be extended to accommodate firm, sector, location, and aggregate fixed effects by incorporating them as scale parameters of the Fréchet distribution. An illustrative example of such an extension with fixed effects is shown in Appendix C.2.

[18] An alternative approach that delivers a similar set of labor supply equations is to assume a CES structure of labor supply preferences as in Berger et al. (2019). These authors also show how the CES labor supply model is formally related to models of idiosyncratic employer choice based on non-pecuniary benefits.

moment of the distribution of match-specific productivity draws is finite, I assume that $\alpha > 1$.

As long as $\alpha \neq \beta$, workers' match-specific productivity draws take on a two-layered nested structure with important patterns of symmetry. The first nest is the set of (n, s)-pairs within which lie the set of second nests, the set of employers within each (n, s)-pair. Workers view each (n, s)-pair as being equally similar on average to every other (n, s)-pair. This implies a symmetric pattern of worker substitution across sectors and across locations.[19] Furthermore, when α and β are the same for every location and sector, the similarity of productivity draws across firms within (n, s)-pairs is the same for all (n, s)-pairs.

The ordering of the dispersion parameters will be an important determinant of the relationship between an employer's size and their market power. It is natural to assume that workers' match-specific productivities are on average more similar across firms within an (n, s)-pair than across all firms. This will be the case when $\alpha < \beta$, which I will maintain through the rest of this paper.[20]

The employer choice problem facing workers is a discrete choice random utility model analogous to models of product demand used in the industrial organization literature. The solution to a given worker's problem can be described in terms of choice probabilities, which, given the wage offers of all potential employers, give the likelihood that the worker's nominal labor income is maximized at each employer. As demonstrated in Appendix A.1, the probability that firm ω is chosen by worker h is

$$\mathbb{P}_{n,s}(h, \omega) \equiv \left(\frac{w_{n,s}^H(\omega)}{W_{n,s}} \right)^\beta \left(\frac{W_{n,s}}{W} \right)^\alpha , \tag{2}$$

where $W_{n,s}$ is a wage index for the (n, s)-pair in which ω operates, and W is an aggregate wage index. The (n, s)-pair wage index is a function of the wages offered by all employers in

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[19]This pattern of symmetry across (n, s)-pairs can be broken by adding a third nest, either of sectors within locations or locations within sectors, at the cost of an additional parameter. In the former case, workers view employers from the same location as closer substitutes than those from different locations (regardless of their sector), but, as I show in Appendix C.3, this nesting structure will have no qualitative effect on firm-level variables once aggregate variables are accounted for. In the latter case, workers view employers from the same sector as closer substitutes than those from different sectors (regardless of their location), but this nesting structure only seems suitable for describing substitution patterns of highly mobile workers such as highly educated and/or specialized workers. This alternative is also discussed in Appendix C.3.

In addition, there is no sense in which workers' skills are more strongly correlated within some groups of sectors than with others, which would be the case if, for example, workers had human capital that was more useful for some group of sectors than for others. Adding a nest that groups subsets of the sectors within the continuum of sectors would better reflect this correlation pattern, but it comes at the cost of additional parameters.

[20]Such an assumption is consistent with the findings of Berger et al. (2019) and Brooks et al. (2019), which show that large employers have more market power in labor markets than small employers.

(n, s) and is given by

$$W_{n,s} = \left(\sum\nolimits_{\omega=1}^{\Omega_{n,s}^H} w_{n,s}^H(\omega)^\beta \right)^{1/\beta}, \tag{3}$$

while the aggregate wage index is a function of the set of (n, s)-pair wage indices given by

$$W = \left(\sum\nolimits_{n=1}^{N^H} \int_0^1 W_{n,s}{}^\alpha \mathrm{d}s \right)^{1/\alpha}.$$

2.2 Firm-Specific Labor Supply Curves

Firms hire workers by posting a wage per effective worker. Wages are posted by firms prior to meeting a potential worker who either accepts the offer or rejects it in favor of an alternative offer. Employers commit to paying each worker the product of the offered wage per effective worker and the worker's match-specific productivity after revenues are earned and there is no negotiation between employers and workers after wages have been posted. Because each worker draws their match-specific productivities from the same distribution, employers offer a single piece-rate wage to their workers.[21] Since this implies that the choice probabilities in equation (2) are common to all workers in H, firm ω's market share of total employment, which is denoted by $\check{\mathcal{S}}_{n,s}^L(\omega)$, is equal to the probability that each worker chooses to work for firm ω, or $\check{\mathcal{S}}_{n,s}^L(\omega) = \mathbb{P}_{n,s}(h, \omega)$.

The market share $\check{\mathcal{S}}_{n,s}^L(\omega)$ can be decomposed into the product of two different market shares that reflect the model's nested structure and can be interpreted as conditional choice probabilities. The first is the market share of ω within its (n, s)-pair denoted by $\mathcal{S}_{n,s}^L(\omega)$. It is the probability that a worker chooses ω given that they have chosen (n, s) and is given by

$$\mathcal{S}_{n,s}^L(\omega) = \left(\frac{w_{n,s}^H(\omega)}{W_{n,s}} \right)^\beta. \tag{4}$$

The second, denoted by $\mathcal{S}_{n,s}^L$, is the market share of total employment of ω's (n, s)-pair and is the probability that a worker chooses (n, s). Using equation (2), employer ω's market share can then be written as $\check{\mathcal{S}}_{n,s}^L(\omega) = \mathcal{S}_{n,s}^L(\omega)\mathcal{S}_{n,s}^L$.

The supply of effective labor to a given firm ω is the product of three factors: the probability that workers choose to work for ω, the productivity of those workers, and the total endowment of labor in the country, L^H. Although the probability that a worker chooses

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[21]One potential rationalization of this assumption is that there are barriers to perfect wage discrimination across workers. These barriers could include fairness considerations that prevent firms from paying their workers different amounts for a given amount of output produced.

employer ω is the same for all workers, the set of workers that choose ω is composed of those with heterogeneous labor productivities. As is shown in Appendix A.1, the average productivity of ω's workers is

$$E_{n,s}(\omega) = \lambda_\Gamma \frac{W}{w_{n,s}^H(\omega)}, \tag{5}$$

where $\lambda_\Gamma = \Gamma(1 - 1/\alpha)$ is the gamma function evaluated at $1 - 1/\alpha$ and can be interpreted as an aggregate labor productivity shifter.[22] The effective labor supply curve for firm ω is the product of the right hand sides of equations (2) and (5) and L^H and is given by

$$\ell_{n,s}^H(\omega) \equiv E_{n,s}(\omega)\check{S}_{n,s}^L(\omega)L^H$$
$$= w_{n,s}^H(\omega)^{\beta-1}W_{n,s}^{\alpha-\beta}\Lambda, \tag{6}$$

where $\Lambda = W^{1-\alpha}\lambda_\Gamma L^H$ is an endogenous aggregate labor supply shifter common to every firm.[23]

There are two features of the labor supply curves in equation (6) worth emphasizing. First, the curves are firm-specific because the labor supplied to firm ω depends on the wage offer of that firm, $w_{n,s}^H(\omega)$. Second, if $\alpha < \infty$ and $\beta < \infty$, labor supply curves are upward sloping and are *not* perfectly elastic with respect to firms' wage offers. Together, these imply that when a firm raises its wage offer, it will increase its employment level by a finite amount, and when it cuts its wage offer it will not lose all its employees. Furthermore, different firms can offer distinct wages per effective worker and still have non-zero employment levels, even if those firms are from the same (n, s)-pair. This is a consequence of assuming that workers are idiosyncratic and that there is variation in match-specific productivities across firms, which makes employers imperfect substitutes for one another from a worker's perspective.

Since firms offer a common piece-rate wage to each of their employees, upward sloping labor supply curves imply that there are inframarginal workers at every firm that earn rents from the employment relationship. Some workers strictly prefer working at a given firm relative to working at other firms. When firms have market power in labor markets, they will try to extract some of these rents from their employees. Therefore, upward sloping labor supply curves, which imply workers earn rents, are necessary for firms to exercise market

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[22]λ_Γ is the mean of the match-specific productivity distribution. One implication of assuming that match-specific productivities are Fréchet distributed that is reflected in equation (5) is that workers' expected nominal labor income is constant across all employers and does not depend on the chosen employer's (n, s)-pair.

[23]Notice from equation (6) that the share of total labor costs paid by firms in (n, s) that come from employer ω, which is $w_{n,s}^H(\omega)\ell_{n,s}^H(\omega)/\sum_{\omega=1,...,\Omega_{n,s}^H} w_{n,s}^H(\omega)\ell_{n,s}^H(\omega)$, is equal to the employment share of that firm in (n, s), $\mathcal{S}_{n,s}^L(\omega)$. This is an implication of the Fréchet distribution assumption.

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power in labor markets.

2.3 Final Goods and Product Demand

Final goods, which are purchased by workers, are non-traded and produced by perfectly competitive final good producers. Production of final goods uses a multi-sector CES production function that is adapted from Atkeson and Burstein (2008) and Edmond et al. (2015). In particular, final good C is a CES composite of sectoral consumption bundles

$$C = \left[\int_0^1 C_s^{\frac{\theta-1}{\theta}} \, ds \right]^{\frac{\theta}{\theta-1}}, \tag{7}$$

where θ is the elasticity of substitution across sectors. For each sector $s \in [0,1]$, the bundle C_s is itself a composite of a finite number of varieties sold by firms producing in Home and Foreign. These varieties are aggregated with a constant elasticity of substitution γ:

$$C_s = \left[\sum_{n=1}^{N^H} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} c_{n,s}^H(\omega)^{\frac{\gamma-1}{\gamma}} + \sum_{n=1}^{N^{*F}} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^F} c_{n,s}^F(\omega)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \tag{8}$$

where $\hat{\Omega}_{n,s}^j$ is the number of varieties sold in Home by firms producing in location-sector (n,s) in country $j \in \{H, F\}$.

Differences between the two substitution parameters, θ and γ, govern the substitutability of varieties from the same sector relative to varieties from different sectors. As long as $\gamma < \infty$, varieties from the same sector are imperfect substitutes. When $\theta < \gamma$, preferences take on a nested structure in which varieties from the same sector are closer substitutes than varieties from different sectors.

An important difference between the nesting structure of the labor supply model and the preferences over varieties is the treatment of locations. Varieties produced in different (n,s)-pairs enter the latter symmetrically. There is no preferential bias for varieties produced in different countries or locations. In other words, only labor markets are local while goods markets are not.

Final good producers combine varieties using the aggregators in equations (7) and (8) and take variety prices, $p_{n,s}^H(\omega)$ and $p_{n,s}^F(\omega)$, the final good price, P, and final demand as given. Profit maximization in the final goods sector implies the following demand functions for varieties sold in Home:

$$c_{n,s}^H(\omega) = p_{n,s}^H(\omega)^{-\gamma} P_s^{\gamma-\theta} \Delta \tag{9}$$

and

$$c_{n,s}^F(\omega) = p_{n,s}^F(\omega)^{-\gamma} P_s^{\gamma-\theta} \Delta, \tag{10}$$

where $\Delta = P^{\theta-1} I$ is an endogenous aggregate product demand shifter and aggregate income is I in Home. The aggregate and sectoral price indices are, respectively,

$$P = \left[\int_0^1 P_s^{1-\theta} \mathrm{d}s \right]^{\frac{1}{1-\theta}} \tag{11}$$

and

$$P_s = \left[\sum_{n=1}^{N^H} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} p_{n,s}^H(\omega)^{1-\gamma} + \sum_{n=1}^{N^{*F}} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^F} p_{n,s}^F(\omega)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}. \tag{12}$$

The source of market power in product markets is standard and analogous to the source of market power in labor markets. To emphasize the similarity, firms face upward sloping supply in their labor market while the demand for varieties in product markets is downward sloping. As described in the following subsections, firms charge a constant price for their variety in Home. Therefore, firms do not extract the full willingness to pay in product markets, which implies that there are rents that firms want to extract in product markets.

2.4 Firms and Production

Each firm produces a single unique variety in a single production location.[24] In addition, the set of firms in each (n,s)-pair is exogenously given.[25] Consequently, the finite number of varieties sold by Home firms located in (n,s) to Home final good producers, $\hat{\Omega}_{n,s}^H$, is no greater than the finite number of potential employers located in (n,s), $\Omega_{n,s}^H$. Firms that produce in location-sector pair (n,s) compete for labor in the (n,s)-pair labor market and can potentially sell their output in sectoral product market s in either country.

Firms produce output using a single input, labor, under constant returns to scale using

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[24]I assume away multi-product and multi-plant firms to focus on the role of market power in labor markets. This avoids interesting but complicated issues such as the interaction between buyer market power and the input allocation across varieties as well as potential within-firm cross-location reallocation considerations that could arise in a multi-plant trade model of strategic competition in labor markets.

[25]Introducing a decision of which production location to enter into is complicated when there is strategic competition in labor markets because the profitability of entering into any given location depends on which competitors are located there. Therefore, these entry decisions cannot be determined independently for each firm. Production location decisions with market power in product markets has been studied by Suárez Serrato and Zidar (2016) in a constant markup environment.

the following linear production function:

$$y_{n,s}^H(\omega) = \phi_{n,s}^H(\omega)\ell_{n,s}^H(\omega), \tag{13}$$

where $\phi_{n,s}^H(\omega)$ is the total factor productivity of firm ω.[26]

Within a sector, there are three exogenous sources of firm heterogeneity. First, firms differ in their productivities $\phi_{n,s}^H(\omega)$. Second, firms are exogenously located in different production locations. Competition in product markets between firms from the same sector does not directly depend on the location in which firms produce. However, since firms face exogenously different sets of local labor market competitors with potentially different productivities, the competitive environment facing two firms in the same sector with identical productivities that sell to the same set of product markets but operate in distinct locations can be very different.[27] Therefore, for those two firms with the same productivities, their competitiveness in their shared sectoral product markets can be quite different so that differences in local labor market conditions indirectly affect product market competition.[28] Looking instead within a location-sector pair (n, s), differences in firm-level outcomes across firms that sell to the same set of product markets are driven by the only remaining source of heterogeneity: firm productivity differences.

The third source of heterogeneity across firms is the set of product markets to which firms sell. While many standard trade models that build on Melitz (2003) endogenize market entry, I assume that the sets of markets to which each firm sells is exogenously given because, as I explain in Section 2.7, labor market power makes firm-level product market sales decisions interdependent and equilibrium market entry decisions highly complex.[29]

Selling a variety to a foreign country is subject to iceberg transport costs. These iceberg trade costs imply that a fraction $1 - \tau^{-1}$ of any quantity of goods shipped abroad melts away in transit. Consequently, the output market clearing constraint for a Home firm that sells to

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[26]The model can be extended to include other inputs such as capital, material inputs, or different types of labor. I use a single input to focus on buyer market power for that input and how it interacts with market power in product markets and is affected by product market trade liberalization. Morlacco (2019) examines a setting in which firms produce using domestic and imported material inputs and in which buyers have differential market power over the two sources of inputs (see also Brooks et al. (2019)).

[27]For brevity, I henceforth refer to an (n, s)-pair labor market as a local labor market and use the two terms interchangeably.

[28]In an alternative setting with a single production location in a country, this second source of firm heterogeneity is not present and differences in firm-level outcomes across firms that sell to the same set of product markets depend only on differences in those firms' productivities.

[29]I further describe the complications for market entry decisions in Appendix C.5.

both Home and Foreign is

$$y_{n,s}^H(\omega) = c_{n,s}^H(\omega) + \tau c_{n,s}^{*H}(\omega). \tag{14}$$

Trade across locations within a country is costless. Costless trade within countries implies that national sectoral product markets are integrated into a single market for each sector.

2.5 Market Structure

There are a finite number of firms in each sectoral product market and location-sector pair labor market. Active firms have non-zero market shares in both their product markets and local labor market and are therefore 'large' in these markets. Because there is a continuum of sectors, each sector is infinitesimally small relative to the aggregate economy and firms are therefore 'small' relative to the aggregate economy.[30] When firms internalize the effects of their size on competitors in their sectoral product markets and local labor markets, they engage in strategic competition. In this subsection I describe the nature of oligopoly competition in product markets and oligopsony competition in local labor markets. I then show how these affect the relationship between firms' market shares and their market power.

Firms operate as price and wage setters. The system of demand curves in equations (9) and (10) and labor supply curves in equation (6) are firm-specific and are not perfectly elastic with respect to prices and wages. In product markets, firms face more intense competition from competitors that sell in the same sector than from firms that sell in other sectors. Similarly, labor market competition is more intense between firms producing in the same local labor market than between those producing in different local labor markets.

Firms internalize the effects of their price and wage decisions on their competitors in a manner adapted from Atkeson and Burstein (2008). In product markets, firms recognize that their prices help determine the sectoral price indices P_s and P_s^* of the sectoral product markets in which they sell. This is extended to local labor markets, where firms recognize that their wages help determine the location-sector wage index $W_{n,s}$ of the local labor market in which they operate. Because there is a continuum of sectors, firms correctly understand that their price and wage decisions have no first order effect on aggregate price and wage indices. Therefore, aggregate price indices, P and P^*, and the aggregate wage index, W, are taken as given. The modelling of a finite number of employers that internalize the effects of their wages on wage indices extends the models of Thisse and Toulemonde (2015) and Card et al. (2018). In the former, employers are infinitesimal in size and do not affect wage indices;

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[30]This ensures that the general equilibrium solution of the model remains tractable.

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in the latter, the effect of firms' wages on wage indices is assumed away.[31]

I assume that firms engage in Bertrand competition in both their sectoral product markets and location-sector pair labor markets.[32] Specifically, each firm takes as given the prices and wages of all other firms and chooses a wage rate and an allocation of their total output between Home and Foreign to maximize total profits.[33] Firms do not choose their prices and wages independently. In choosing a wage rate, a firm determines its total employment level through its labor supply function and hence its total amount of output produced.[34] The allocation of this total output to the Home and Foreign product markets determines the price at which the firm's output is sold in those markets through the demand functions. Because firms take competitors' prices and wages as given, firms also take sectoral price indices in other sectors and location-sector pair wage indices in other local labor markets as given. The profit maximization problem for a Home firm selling to both Home and Foreign is given by

$$\pi_{n,s}^H(\omega) = \max_{w_{n,s}^H, c_{n,s}^{*H}(\omega)} p_{n,s}^H(\omega) c_{n,s}^H(\omega) + p_{n,s}^{*H}(\omega) c_{n,s}^{*H}(\omega) - w_{n,s}^H(\omega) \ell_{n,s}^H(\omega), \tag{15}$$

subject to product demand in equation (9), the analogous equation for demand from Foreign, labor supply in equation (6), and firm-level output market clearing in equation (14).[35]

Given product demand in equation (9) and the sectoral price index in equation (12) and assuming Bertrand competition, the price elasticity of demand facing firm ω in the Home market is

$$\eta_{n,s}^H(\omega) = \gamma \left(1 - \mathcal{S}_{n,s}^H(\omega)\right) + \theta \mathcal{S}_{n,s}^H(\omega), \tag{16}$$

where $\mathcal{S}_{n,s}^H(\omega) = (p_{n,s}^H(\omega)/P_s)^{1-\gamma}$ is the share of total sales in sector s in Home earned by firm ω. For sales to the Foreign market, this elasticity is

$$\eta_{n,s}^{*H}(\omega) = \gamma \left(1 - \mathcal{S}_{n,s}^{*H}(\omega)\right) + \theta \mathcal{S}_{n,s}^{*H}(\omega), \tag{17}$$

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[31]To compare more directly, there is no effect of firms' wages on the denominator of the employer choice probabilities analogous to equation (4) in either paper. In Thisse and Toulemonde (2015), this denominator is taken over a continuum of firms. In Card et al. (2018), this denominator is assumed to be a constant. In both papers, firms' wages only affect the numerator of these choice probabilities.

[32]I discuss Cournot competition as an extension in Appendix C.4.

[33]Firms that sell to only one national product market do not make this allocation decision.

[34]To emphasize the assumption on the competitive environment: an increase in firm ω's wage leads to an increase in ω's employment level and a decrease in the employment levels of its local competitors, whose wages are assumed to be unchanged. Firm ω also assumes that these decreases in its competitors' employment levels translate to decreases in those firms' output levels and quantities sold while their prices are unchanged.

[35]Home sales $c_{n,s}^H$ do not appear as an optimization variable because with two product markets Home sales are determined by the choice of Foreign sales and equation (14).

where $\mathcal{S}_{n,s}^{*H}(\omega) = (p_{n,s}^{*H}(\omega)/P_s^*)^{1-\gamma}$. As a firm becomes larger within its sector, its market share increases, and the firm competes more closely with firms from other sectors than with firms from its own sector. Consequently, when a firm is small, a price cut causes substitution away from its sectoral competitors with an elasticity that is close to γ, whereas when a firm is large a price cut causes substitution away from other sectors towards that firm with an elasticity that is close to θ. The ordering of these two parameters determines whether large firms or small firms have smaller price elasticities of demand and more market power in product markets. Under the natural assumption that $\theta < \gamma$, larger firms face more inelastic demand, as in Atkeson and Burstein (2008).

Given labor supply curves in equation (6) and (n, s)-pair wage indices in equation (3), wage elasticities of labor supply facing Home firms are

$$\eta_{n,s}^L(\omega) = \beta \left(1 - \mathcal{S}_{n,s}^L(\omega)\right) + \alpha \mathcal{S}_{n,s}^L(\omega) - 1. \tag{18}$$

Analogously with product markets, firms that are large within their local labor market compete for workers more closely with firms from other local labor markets than do firms that are smaller employers. Therefore, as a firm becomes a larger employer relative to its local competitors, α becomes a more relevant substitution parameter compared to β. When workers view employers from the same local labor market as being closer substitutes on average than employers from different local labor markets, as is the case under the assumption that $\alpha < \beta$, large employers face more inelastic labor supply and have more market power in labor markets. Because workers supply heterogeneous amounts of effective labor, the final term of equation (18) reflects the selection effect of a wage increase on the average productivity of a firm's workers that can be seen in equation (5).

2.6   Prices and Wages

The solution to the profit maximization problem in equation (15) is given by a system of three equations for each firm.[36] The first equation is the labor market clearing constraint that ensures that labor demand is equal to labor supply in equation (6) at the optimal wage. Second, the first order condition with respect to the firm's wage is

$$p_{n,s}^H(\omega)\phi_{n,s}^H(\omega)\left(1 - \frac{1}{\eta_{n,s}^H(\omega)}\right)\frac{\partial \ell_{n,s}^H(\omega)}{\partial w_{n,s}^H(\omega)} = \ell_{n,s}^H(\omega)\left(1 + \eta_{n,s}^L(\omega)\right). \tag{19}$$

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[36]One equation is trivial for firms that sell to only one country. I focus here on a Home firm that sells to both Home and Foreign.

The left hand side of equation (19) is the marginal revenue associated with a marginal increase in the firm's wage holding fixed the amount of output sold to Foreign, while the right hand side is the marginal cost of such a wage increase. Finally, holding fixed the wage and hence total output, the first order condition for the output allocation problem is

$$p_{n,s}^H(\omega)\left(1 - \frac{1}{\eta_{n,s}^H(\omega)}\right) = p_{n,s}^{*H}(\omega)\left(1 - \frac{1}{\eta_{n,s}^{*H}(\omega)}\right)\tau^{-1}. \tag{20}$$

In this equation, the marginal revenue of allocating a unit of output to Home is equal to the marginal revenue of allocating output to Foreign.

When markets are perfectly competitive, the equilibrium is allocatively efficient. In product markets, prices are equal to the marginal costs of serving the market, or $p_{n,s}^H(\omega) = mc_{n,s}^H(\omega)$ and $p_{n,s}^{*H}(\omega) = \tau mc_{n,s}^H(\omega)$ where $mc_{n,s}^H(\omega)$ is the marginal cost of producing output. In labor markets, wages are equal to the marginal revenue product of the firm's last unit of effective labor hired, or $w_{n,s}^H(\omega) = mrp\ell_{n,s}^H(\omega)$.

In contrast, heterogeneous market power in product and labor markets generates an inefficient equilibrium allocation that depends on distortions in firms' prices and wages relative to those that prevail when markets are perfectly competitive.[37] The distortion in product markets is the standard markup of price over the marginal costs of serving the Home and Foreign markets:

$$\mu_{n,s}^H(\omega) := \frac{p_{n,s}^H(\omega)}{mc_{n,s}^H(\omega)} = \frac{\eta_{n,s}^H(\omega)}{\eta_{n,s}^H(\omega) - 1} \tag{21}$$

and

$$\mu_{n,s}^{*H}(\omega) := \tau^{-1}\frac{p_{n,s}^{*H}(\omega)}{mc_{n,s}^H(\omega)} = \frac{\eta_{n,s}^{*H}(\omega)}{\eta_{n,s}^{*H}(\omega) - 1}. \tag{22}$$

Firms that have larger market shares in their sectoral product markets face more inelastic demand and therefore charge larger markups. The distortion in labor markets is an analogous markdown of wages below the marginal revenue product of labor given by

$$\mu_{n,s}^L(\omega) := \frac{w_{n,s}^H(\omega)}{mrp\ell_{n,s}^H(\omega)} = \frac{\eta_{n,s}^L(\omega)}{\eta_{n,s}^L(\omega) + 1} < 1. \tag{23}$$

A *lower* markdown means that wages are *more* distorted compared to perfect competition. Firms that have larger market shares in their local labor market face more inelastic effective labor supply and therefore offer lower markdowns.

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[37]Section 3.3 describes the effects of these distortions on equilibrium aggregate productivity.

The magnitudes of the markups and markdowns are bounded by functions of the parameters governing product demand and labor supply elasticities. Equations (16) and (17) imply that a firm that sells an infinitesimal amount in a product market charges a markup equal to $\frac{\gamma}{\gamma-1}$ while a monopolist in a sector charges a markup of $\frac{\theta}{\theta-1}$. Similarly, equation (18) implies that firms that employ an infinitesimal amount of labor offer a wage markdown of $\frac{\beta-1}{\beta}$ while a local labor market monopsonist's markdown is $\frac{\alpha-1}{\alpha}$.[38]

Rearranging the first order conditions in equations (19) and (20), firms' prices and wages are functions of their markups and markdowns and are implicitly given by

$$p_{n,s}^H(\omega) = \frac{\mu_{n,s}^H(\omega)}{\mu_{n,s}^L(\omega)} \frac{w_{n,s}^H(\omega)}{\phi_{n,s}^H(\omega)} \tag{24}$$

for the Home market and

$$p_{n,s}^{*H}(\omega) = \tau \frac{\mu_{n,s}^{*H}(\omega)}{\mu_{n,s}^L(\omega)} \frac{w_{n,s}^H(\omega)}{\phi_{n,s}^H(\omega)} \tag{25}$$

for the Foreign market. Both the markup and the markdown inflate firms' prices above what they would charge under perfect competition. The total distortion, which I define as the inverse ratio of the markup to the markdown, depends on a firm's size in both product and labor markets and is increasing in both market shares for a given product market. For domestic sales, this distortion is

$$d_{n,s}^H(\omega) := \frac{\mu_{n,s}^L(\omega)}{\mu_{n,s}^H(\omega)} \equiv \frac{w_{n,s}^H(\omega)/p_{n,s}^H(\omega)}{\phi_{n,s}^H(\omega)} = \frac{1 - \left(\gamma\left(1 - \mathcal{S}_{n,s}^H(\omega)\right) + \mathcal{S}_{n,s}^H(\omega)\right)^{-1}}{1 + \left(\beta\left(1 - \mathcal{S}_{n,s}^L(\omega)\right) + \alpha\mathcal{S}_{n,s}^L(\omega) - 1\right)^{-1}}. \tag{26}$$

The following result describes how firm-level outcomes are related to firm productivities.[39]

Proposition 1. *Consider two Home firms, ω and ω', from local labor market (n, s) that sell to the same product markets. If $\phi_{n,s}^H(\omega) > \phi_{n,s}^H(\omega')$, then $y_{n,s}^H(\omega) > y_{n,s}^H(\omega')$, $w_{n,s}^H(\omega) > w_{n,s}^H(\omega')$, and $\mu_{n,s}^L(\omega) < \mu_{n,s}^L(\omega')$. If the two firms sell in Home, then $p_{n,s}^H(\omega) < p_{n,s}^H(\omega')$ and $\mu_{n,s}^H(\omega) > \mu_{n,s}^H(\omega')$, while if they sell in Foreign, $p_{n,s}^{*H}(\omega) < p_{n,s}^{*H}(\omega')$ and $\mu_{n,s}^{*H}(\omega) > \mu_{n,s}^{*H}(\omega')$.*

This result is intuitive because the only source of heterogeneity across the firms is differences in their productivities.[40] Under the assumption that $\gamma > \theta$ and $\beta > \alpha$, product

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[38]Under an alternative assumption that firms engage in monopolistic competition in product markets and monopsonistic competition in labor markets, $\frac{\gamma}{\gamma-1}$ would be the markup in both Home and Foreign and $\frac{\beta-1}{\beta}$ would be the markdown for all firms. Thisse and Toulemonde (2015) develop a similar closed economy model featuring this market structure and a single sector and location and where firms have identical productivities.

[39]See Appendix A.2 for a proof of this result.

[40]If firms sell to different product markets, this result need not hold because, as decribed in the next subsection, marginal costs of production are increasing.

demand is strictly downward sloping and labor supply is strictly upward sloping. As a result, more productive firms hire more labor and sell more output than their less productive local labor market competitors. This implies that more productive firms face more inelastic labor supply and product demand and therefore offer lower wage markdowns and charge larger price markups.

No explicit analytical solution to firms' price and wage setting problems can be obtained. Equations (24) and (25) contain three unknown firm-level variables: $p_{n,s}^H(\omega)$, $p_{n,s}^{*H}(\omega)$, and $w_{n,s}^H(\omega)$. These two equations and the firm-level labor market clearing condition provide the best response functions of prices and wages for each firm given the prices and wages of the firm's competitors and given aggregate variables. For each sector, denote the total number of employers in Home and Foreign by $\Omega_s^H = \sum_{n=1}^{N^H} \Omega_{n,s}^H$ and $\Omega_s^{*F} = \sum_{n=1}^{N^{*F}} \Omega_{n,s}^{*F}$, respectively. Similarly, let $\hat{\Omega}_s^H = \sum_{n=1}^{N^H} \hat{\Omega}_{n,s}^H + \sum_{n=1}^{N^{*F}} \hat{\Omega}_{n,s}^F$ and $\hat{\Omega}_s^{*F} = \sum_{n=1}^{N^H} \hat{\Omega}_{n,s}^{*H} + \sum_{n=1}^{N^{*F}} \hat{\Omega}_{n,s}^{*F}$ be the number of firms in that sector selling in Home and Foreign, respectively. Since each firm only internalizes the effects of their price and wage choices on other firms in the same industry as that firm, the system of $(\Omega_s^H + \Omega_s^{*F} + \hat{\Omega}_s^H + \hat{\Omega}_s^{*F})$ pricing and labor market clearing conditions can be used to solve for a fixed point in the set of prices and wages of every firm in sector s. As will become clear in the next subsection, this fixed point problem cannot be broken up into an independent problem for each country (except in autarky).

2.7 Market Interdependence

Introducing upward sloping labor supply curves and labor market power makes solving for the general equilibrium of the model more complex but also yields novel testable implications. The added complication arises because firms have increasing marginal costs of production that make their output allocation decisions non-trivial relative to a standard heterogeneous firm trade model. An immediate implication is that product market decisions in Home and Foreign are linked and firms' optimal sales levels cannot be solved for in each country independently. Marginal costs of production are

$$mc_{n,s}^H(\omega) = \frac{\partial \left(w_{n,s}^H(\omega) \ell_{n,s}^H(\omega) \right)}{\partial y_{n,s}^H(\omega)} = \frac{w_{n,s}^H(\omega)}{\phi_{n,s}^H(\omega)} \mu_{n,s}^L(\omega)^{-1}. \tag{27}$$

When the elasticity of labor supply is finite, marginal costs are inflated by the inverse of firms' markdowns.[41] Intuitively, in order to increase production the firm must hire additional labor. When labor supply is upward sloping, the only way to hire more labor is to increase the wage

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[41]This is true under oligopsony competition as well as monopsonistic competition, where, in this model, the elasticity of labor supply would be a constant ($\eta_{n,s}^L(\omega) = \beta - 1$).

offer. This increased wage raises the cost of every unit of output produced by the firm. The output elasticity of marginal costs given the labor supply elasticity in equation (18) is

$$
\begin{aligned}
\frac{\partial \ln mc_{n,s}^{H}(\omega)}{\partial \ln y_{n,s}^{H}(\omega)} &= \eta_{n,s}^{L}(\omega)^{-1}\left(1 - \frac{\eta_{n,s}^{L}(\omega)^{-1}}{\eta_{n,s}^{L}(\omega)^{-1}+1}\frac{\partial \ln \eta_{n,s}^{L}(\omega)}{\partial \ln w_{n,s}^{H}(\omega)}\right) \\
&= \eta_{n,s}^{L}(\omega)^{-1}\left(1 - \frac{\beta(\alpha-\beta)\mathcal{S}_{n,s}^{L}(\omega)(1-\mathcal{S}_{n,s}^{L}(\omega))}{\eta_{n,s}^{L}(\omega)(\eta_{n,s}^{L}(\omega)+1)}\right).
\end{aligned}
$$

Since $\alpha < \beta$, this elasticity is strictly positive.

Marginal costs are increasing for all $y_{n,s}^{H}(\omega) > 0$ even though the production technology is linear. Market power in labor markets therefore provides a non-technological reason for decreasing returns to scale. Furthermore, the prices charged by firms cannot be solved for independently across markets because the marginal cost of production depends on the quantity sold to both markets.

Increasing marginal costs make markets interdependent not only on the intensive margin of sales but also on the extensive margin of which markets to sell to. Adding an endogenous market entry problem considerably increases the complexity of finding a stable equilibrium relative to an environment with perfectly elastic labor supply. Moreover, with strategically interacting firms there can be multiple equilibria, which necessitates an equilibrium selection rule in order to conduct counterfactual analyses. In Appendix C.5, I discuss how the model could be extended to include a market entry problem with fixed labor requirements for selling to each market and describe how equilibrium selection rules used in similar models with perfectly elastic labor supply are inadequate for solving this problem. As previously mentioned, because of this complexity I assume that the markets that each firm sells to are exogenously given.

A reduction in variable trade costs τ has novel effects when firms have labor market power. When τ decreases, demand for each firm's output in its export market increases, as does the marginal revenue of allocating a unit of output to that market. All else equal, firms increase production by exporting more, which raises their marginal costs of production. Since marginal costs increase, marginal revenue in their domestic market must also increase, which implies that firms sell less to their domestic market. Labor market power therefore makes markets separated by trade costs substitutes from the perspective of firms since increasing sales in one market will cause them to decrease sales in other markets.[42] Therefore, there are two firm-level testable implications of the model: product markets are substitutes on the

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[42] As hinted at in the previous paragraph, product markets being substitutes for one another means that algorithms used to solve for optimal market entry even for a single firm, such as the one used in the model of global sourcing in Antràs et al. (2017), cannot be used here.

intensive margin of sales and the elasticity of substitution of sales across markets depends on the extent of a firm's labor market power.

3   Equilibrium

This section closes the model and describes some aggregate properties of the equilibrium. I first outline and define the general equilibrium of the model. Second, I show how firm-level price and wage distortions can be aggregated to labor market-level distortions and describe how variation in firm-level distortions affects the distribution of aggregate earnings. Finally, I demonstrate that endogenous market power in labor markets can reduce aggregate welfare because heterogeneous firm-level distortions lead to an equilibrium that is not allocatively efficient.

3.1   General Equilibrium Definition

In equilibrium, workers maximize utility by choosing the employer that offers them the highest effective wage, firms choose a wage and output allocation across product markets to maximize profits, all labor and product markets clear, and trade is balanced. Workers receive a common per-capita dividend Π from domestic firms' total profits. A Home worker h has an income of $i_{n,s}(h,\omega) = w_{n,s}^{H}(\omega)\varepsilon_{n,s}(h,\omega) + \Pi$ that depends on their chosen employer. Aggregate income is

$$I = (W\lambda_{\Gamma} + \Pi) L^{H}. \tag{28}$$

Since workers spend all their income on the final good, aggregate welfare in Home is equal to total consumption C given in equation (7) and is equivalent to aggregate real income I/P. Trade between Home and Foreign is balanced, which implies

$$\int_{0}^{1} \left(\sum_{n=1}^{N^{*F}} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{F}} p_{n,s}^{F}(\omega)c_{n,s}^{F}(\omega) \right) \mathrm{d}s = \int_{0}^{1} \left(\sum_{n=1}^{N^{H}} \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}} p_{n,s}^{*H}(\omega)c_{n,s}^{*H}(\omega) \right) \mathrm{d}s.$$

The aggregate labor market clearing condition is

$$1 = \sum_{n=1}^{N^{H}} \int_{0}^{1} \mathcal{S}_{n,s}^{L}\mathrm{d}s.$$

Definition 1. A competitive equilibrium consists of the following: a set of firm-level prices and wages, $\{p_{n,s}^{H}(\omega)\}_{\omega=1}^{\hat{\Omega}_{n,s}^{H}}$, $\{p_{n,s}^{*H}(\omega)\}_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}}$, and $\{w_{n,s}^{H}(\omega)\}_{\omega=1}^{\Omega_{n,s}^{H}}$ for Home firms and $\{p_{n,s}^{*F}(\omega)\}_{\omega=1}^{\hat{\Omega}_{n,s}^{*F}}$, $\{p_{n,s}^{F}(\omega)\}_{\omega=1}^{\hat{\Omega}_{n,s}^{F}}$, and $\{w_{n,s}^{*F}(\omega)\}_{\omega=1}^{\Omega_{n,s}^{*F}}$ for Foreign firms in every (n,s)-pair; aggregate prices

$\{P, P^*\}$; sectoral price indices $\{P_s, P_s^*\}$ for every sector; aggregate wage indices and dividends $\{W, W^*, \Pi, \Pi^*\}$; and location-sector pair wage indices $\{W_{n,s}, W_{n,s}^*\}$ for every (n,s)-pair such that all labor and product markets clear, aggregate spending equals aggregate income, trade is balanced, and firms' prices and wages are given by equations (21) to (25).

An iterative two-step procedure can be used to solve for the equilibrium. In the first step, firms take all aggregate variables except the sectoral price indices and the location-sector pair wage indices for their sector as given, and a fixed point is found in the firm-level prices and wages for each firm one sector at a time. These firm-level solutions are used to update the aggregate variables through the market clearing and trade balance conditions. Using these updated variables, the two steps are repeated until a fixed point in the aggregate variables is obtained.

3.2 Market-Level Markdowns

The competitiveness of local labor markets depends on the exogenous set of firms that employ workers there and the price and wage distortions at those firms. This competitiveness can be summarized by an aggregate local labor market markdown, which is the ratio of the local labor market wage index to the marginal revenue product of allocating a unit of effective labor to that market. The market-level marginal revenue product is defined as $MRPL_{n,s} := \frac{\mathrm{d}TR_{n,s}}{\mathrm{d}L_{n,s}}$, where $TR_{n,s}$ is the total revenue earned by employers in location-sector (n,s) and $L_{n,s}$ is a measure of the amount of effective labor employed in that market.[43] Adapting the derivation of sector-level markups in Grassi (2017), I show in Appendix A.3 that the local labor market markdown is

$$\mu_{n,s}^L := \frac{W_{n,s}}{MRPL_{n,s}} = \left(\sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} \frac{\mathcal{S}_{n,s}^L(\omega)}{d_{n,s}^H(\omega)} \frac{c_{n,s}^H(\omega)}{y_{n,s}^H(\omega)} + \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}} \frac{\mathcal{S}_{n,s}^L(\omega)}{d_{n,s}^{*H}(\omega)} \frac{\tau c_{n,s}^{*H}(\omega)}{y_{n,s}^H(\omega)} \right)^{-1}. \quad (29)$$

The local labor market markdown depends on the joint distribution of employment, firm-level markups, and firm-level markdowns. In autarky, it is an employment share-weighted harmonic average of firm-level total distortions $d_{n,s}^H(\omega)$. When there is trade between Home and Foreign, the corresponding firm-level distortions depend on firms' allocations of output to each market. When more labor is allocated to firms with high markups and low markdowns, the local labor market markdown decreases and the market is less competitive. All else being equal, when $\alpha < \beta$ markets that are dominated by large employers are less competitive than markets where employment is more evenly spread across employers.

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[43] $L_{n,s} := W_{n,s}^{-1} \sum_{\omega=1}^{\Omega_{n,s}^H} w_{n,s}^H(\omega)\ell_{n,s}^H(\omega) = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \ell_{n,s}^H(\omega)^{\frac{\beta}{\beta-1}} \right)^{\frac{\beta-1}{\beta}} = \left(\mathcal{S}_{n,s}^L \right)^{\frac{\alpha-1}{\alpha}} \lambda_\Gamma L^H.$

Intuitively, high concentration in labor markets can translate into worse outcomes for workers. When local labor markets are more concentrated on average, the average market-level markdowns decrease. Therefore, concentration in local labor markets can affect the distribubtion of aggregate earnings across labor income and dividend income. One important determinant of this concentration is the underlying dispersion of firm productivities. When there is more variation in productivities, employment shares become more concentrated in high productivity firms on average across markets. In the counterfactual experiments I conduct in Section 5, I show how dispersion in firm productivities affects the distribution of aggregate earnings.

3.3 Variable Markdowns and Misallocation

Not only do variable markdowns help determine the competitiveness of local labor markets and the labor share of aggregate income, I show that they can also change aggregate productivity relative to a model with constant markdowns because they affect the allocation of labor across firms and across local labor markets. This extends the findings of Dhingra and Morrow (2019) in a setting with perfectly competitive labor markets and monopolistic competition and those of Edmond et al. (2015) with oligopolistic competition to an environment with labor market power. When $\alpha < \beta$, aggregate productivity is reduced because variation in markdowns implies that firms that offer low markdowns employ relatively less labor than they would in a constant markdown environment as compared to firms that offer high markdowns. This result can be demonstrated analytically under the following assumptions.

Assumption 1 (Symmetric Economies). Home and Foreign have symmetric economies when $N^H = N^{*F}$, $L^H = L^{*F}$, and, for every (n, s)-pair, the set of operating firms and markets to which those firms sell are identical. In particular, for each (n, s)-pair $\Omega_{n,s}^H = \Omega_{n,s}^{*F} =: \Omega_{n,s}$, $\hat{\Omega}_{n,s}^H = \hat{\Omega}_{n,s}^{*F}$, $\hat{\Omega}_{n,s}^{*H} = \hat{\Omega}_{n,s}^F$, and $\phi_{n,s}^H(\omega) = \phi_{n,s}^{*F}(\omega)$ for every $\omega = \{1, \ldots, \Omega_{n,s}\}$.

Assumption 2. All firms charge a common markup of price over marginal cost in any market they sell to.

Under Assumption 1, the price index P, consumption level C, and aggregate wage index W are the same in both Home and Foreign. Let aggregate productivity be $\Phi := C/L$, where L is an index of aggregate effective labor.[44] I show in Appendix A.4 that the following result holds.[45]

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[44]L is defined analogously to $L_{n,s}$: $L := W^{-1} \int_0^1 \sum_{n=1}^{N^H} W_{n,s} L_{n,s} \mathrm{d}s = \left(\int_0^1 \sum_{n=1}^{N^H} L_{n,s}^{\frac{\alpha}{\alpha-1}} \mathrm{d}s \right)^{\frac{\alpha-1}{\alpha}} = \lambda_\Gamma L^H$.

[45]In the counterfactuals in Section 5, I show that Assumption 2 is not critical for this result to hold.

Proposition 2. *When Home and Foreign are symmetric as in Assumption 1 and firms charge constant markups as in Assumption 2, aggregate productivity* Φ *is smaller when markdowns are variable and asymmetric than when they are constant as long as* $\alpha < \beta$.

When $\alpha < \beta$, the most productive employers are inefficiently small compared to their less productive local labor market competitors because the markdown they offer is lower than the markdown offered by less productive local competitors. If instead firms offer a constant markdown, this source of inefficiency is no longer present, and in moving to a constant markdown environment more productive firms grow relative to their less productive local competitors, which increases aggregate productivity. If instead $\alpha > \beta$, the reverse situation holds, with the most productive firms employing relatively more labor compared to their less productive local competitors than they would if markdowns were constant.[46]

Because variable markdowns can cause labor to be misallocated in equilibrium, a key question considered in the experiments in Section 5 is the effect of trade on misallocation. When $\alpha < \beta$ and the most productive firms are inefficiently small compared to their less productive local competitors because of variable markdowns, the gains from product market trade liberalization can increase compared to a constant markdown model if it causes the most productive firms to increase in size relative to their less productive local competitors.

4 Calibration and Estimation

In this section, I calibrate the model using Indian plant-level production and employment data and sector-level trade data. The model described in the previous sections contains the following sets of parameters: two product demand elasticity parameters, $\{\theta, \gamma\}$; two labor supply elasticity parameters, $\{\alpha, \beta\}$; the iceberg trade cost τ; labor endowments, $\{L^H, L^{*F}\}$; the number of production locations in each country, $\{N^H, N^{*F}\}$; the set of potential employers in each (n, s)-pair in each country, $\{\Omega_{n,s}^H, \Omega_{n,s}^{*F}\}$; the set of sellers in each (n, s)-pair to each country, $\{\hat{\Omega}_{n,s}^H, \hat{\Omega}_{n,s}^{*H}, \hat{\Omega}_{n,s}^F, \hat{\Omega}_{n,s}^{*F}\}$; and the vectors of firm productivities for each (n, s)-pair in each country. To conduct counterfactual experiments using the model, I need values for these parameters.

I begin by describing the plant-level data from the Indian Annual Survey of Industries (ASI). I document the patterns of concentration across product and local labor markets and show that many local labor markets are highly concentrated and contain employers that are

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[46]However, as I show in Section 5.1, with a fixed set of firms and with variable markups, aggregate productivity can be higher under oligopsony compared to perfect competition in labor markets when $\alpha > \beta$. Despite this, the equilibrium is not allocatively efficient because the allocation of labor does not correspond to the one chosen by the social planner facing the same labor supply curves (see Appendix A.4).

large relative to the size of the labor markets. In contrast, plants tend to be small relative to the size of their sectoral product markets, and these markets are relatively less concentrated.

I then estimate the key product demand and labor supply elasticity parameters using a model-implied relationship between the market shares of plants in their product and local labor markets and the share of labor costs in value added. I use the ASI data supplemented with sector-level trade data to measure the variables needed for this estimation. Using the estimated parameters, I recover the implied plant-level productivities consistent with the model and use them to estimate the distribution of productivities. I also calibrate the average number of plants in each local labor market to the Indian data. Finally, I set the remaining parameters to facilitate counterfactual analyses of the effects of endogenous labor market power.

4.1 Data Description

I use plant-level data from the 2008 and 2009 cross sections of the ASI.[47] The ASI surveys establishments in the registered manufacturing sector.[48] Every registered manufacturing establishment with at least 100 employees is surveyed, and a random sample of smaller plants (with at least 10 employees) is conducted using sampling probabilities that enable the construction of a nationally representative sample of plants.[49] The sample includes both public and private firms. Because observations in the survey are at the plant level and there is no firm identifier, I treat each plant as a separate firm. While this is a limitation, an advantage of using the ASI plant-level data is that each plant is assigned a district identifier for the location of the plant. This enables me to define local labor markets at a relatively disaggregated geographic level.

Plants in the ASI are categorized into sectors according to their primary activity by value using the NIC-2008 industrial classification system developed by the Indian Ministry of Statistics and Progamme Implementation (MOSPI).[50] Survey respondents report, amongst

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[47]The data in each annual survey pertain to the period from April 1 through March 31, so the 2008 survey covers production activity in 2008 and 2009. I refer to each cross section by its starting year for brevity and since the majority of the period is covered in the initial year. When combining this data with trade data, I match on the initial year.

[48]Registration is a legal designation for manufacturers that either employ at least 10 workers and use power or employ at least 20 workers and don't use power.

[49]Firms are allowed to file joint returns for their plants that are in the same sector and same state. The vast majority of observations are of single-plant firms. Of the observations in the final sample used for recovering parameters, 94.56% are single-plant and they make up 84.01% and 78.38% of aggregate domestic sales and employment, respectively.

[50]The data also include product-level sales for each plant. However, because input costs and quantities are only observed at the aggregate plant level and since accounting for multi-product firms requires additional modelling considerations, I assume that the sectors in which firms compete are given by their industry

other variables, their employment, labor costs (including non-wage benefits), materials and energy expenditures, total revenues, and share of revenues earned from exports. I define sectoral product markets at the four-digit NIC-2008 level of aggregation and location-sector pair labor markets as the interaction of these four-digit sectors and Indian districts.

Table 1 documents the size of these product and labor markets relative to the aggregate data in the ASI sample. A total of 125 four-digit sectors are observed in each cross section that can be linked to the import data. The average four-digit sector accounts for less than 1% of aggregate sales by domestic firms and employment. During the period, there were a total of 640 districts in India, 619 of which had plants included in the ASI sampling frame. More than 500 districts in each cross section have plants with usable data observed in them.[51] Each district accounts for just 0.2% of aggregate employment and sales in the ASI on average. Local labor markets, defined as district-sector pairs, are of negligible size on average relative to the aggregate data in the ASI.

Table 1: ASI Sectors, Locations, and Plants

	Sectors	Districts	Dis-Sec	Plants
Mean log Domestic Sales (Rs.)	24.841	22.463	19.232	17.652
Mean Share of Domestic Sales	0.008	0.002	0.000	0.000
Mean Employment	68,220.92	16,305.19	704.84	203.62
Mean Share of Agg. Employment	0.008	0.002	0.000	0.000
Observations (across years)	250	1,049	17,388	55,770

Notes: Sectors are at the four-digit NIC-2008 level. 'Dis-Sec' refers to a district-sector pair, and 'Rs.' stands for rupees. Employment is measured as the average number of total employees working per day. See Appendix B for sample selection criteria.

To determine the total size of Indian sectoral product markets, I supplement the plant-level data with import data from UN Comtrade at the six-digit HS code level. I match this import data, which is in terms of six-digit *products*, to the four-digit Indian *sectors* using a series of crosswalks available from the UN Statistics Division and MOSPI.[52] This matching procedure is described in Appendix B. Sectors that cannot be matched to the import data are primarily manufacturing service industries. In addition, I exclude plants that are categorized as mining or services plants and focus on plants in manufacturing sectors.

Table 2 provides summary statistics on the concentration of activity in Indian product and labor markets. The moments in the first four rows are weighted by the size of the observation (sales in product markets and employment in labor markets). To measure the

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classification.

[51]I describe the sample restrictions in Appendix B.

[52]While the finest level of sectoral disaggregation in the ASI is at the five-digit NIC-2008 sector level, the import data can only be concorded with the ASI data at the four-digit level.

Table 2: Summary Statistics of Market Concentration

	Mean	Std Dev
(s) HHI of domestic sales shares	0.050	0.063
(s) top plant domestic sales shares	0.128	0.117
(n, s) HHI of employment shares	0.240	0.295
(n, s) top plant employment shares	0.298	0.299
(n, s) number of plants	11.779	27.999
Indicator if plant is only employer in (n, s)	0.060	0.237
Plant sectoral sales shares	0.003	0.016
Plant district-sector employment shares	0.162	0.273

Notes: s=four-digit NIC-2008 sector, (n, s)=district-sector pair, and HHI is the Herfindahl-Hirschman Index. Sector observations in the first and second rows are weighted by total sales in the sector. District-sector observations in the third and fourth rows are weighted by total employment in the (n, s)-pair. Domestic sales shares are the plant-level shares of total sectoral sales by domestic plants.

level of concentration in a market, I use the Herfindahl-Hirschman Index (HHI). The HHI of a market is the sum of the squared market shares for all plants in the market. The average four-digit sector has an HHI of plants' shares of domestic sectoral sales of 0.05.[53] Taking the inverse of the HHI, which is a measure of the hypothetical number of equally sized plants active in a market, implies the average number of such hypothetical domestic plants is 20.[54] While these sectors are not very concentrated, the average of the largest plant's share of domestic sales in each sector is nearly 13%, which, given the level of disaggregation of the data, is a substantial share. Looking at Indian district-sector labor markets, the average HHI of weighted employment shares is 0.24, which is much larger than the concentration of activity in product markets. Furthermore, the average of the largest plant's employment share in each district-sector is nearly 30%, which suggests that these local labor markets are on average dominated by the largest plants operating there.[55]

The second set of moments in Table 2 are unweighted. The average local labor market has 11.7 plants operating in it, which is more than double the median number of plants, which is 5.2.[56] Many plants are dominant employers in their local labor market. In the sample, 6% of plants are the only observed employer in their district-sector labor market and 11.2% of

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[53]I exclude imports from these HHI because they cannot be assigned to distinct firms.

[54]In a hypothetical market with X_{hyp} equally sized plants, the HHI is $1/X_{hyp}$. This market has the same level of concentration as an observed market with X_{obs} differently sized plants that has an HHI of $1/X_{hyp}$.

[55]The unweighted averages of these statistics are, unsurprisingly, much larger, so that product and labor markets that are larger are less concentrated than those that are smaller.

[56]Because it is derived using the sampling weights to count the number of plants, the median need not be divisible by 0.5.

plants have a labor market share larger than 50%.[57] The average plant is small relative to the size of its sector, with a sales share of just 0.3%. In contrast, the average plant is large relative to the size of its local labor market, with an employment share of 16.2%. Together, these observations imply that firm sizes in the Indian data are heavily skewed and that many local labor markets are dominated by a small number of large employers.

4.2   Estimated and Fitted Parameters

The key model determinants of the importance of market power are the product demand and labor supply elasticity parameters, the dispersion of firm productivities, and the exogenous number of competitors in each local labor market. Following Gaubert and Itskhoki (2018), I set the across-sector elasticity of substitution, θ, equal to one, which implies the outer nest of preferences in equation (7) is Cobb-Douglas, and then use the model to estimate γ, α, and β.[58] Using the estimated values for the remaining elasticity parameters and data on firms' product and labor market shares, I calculate the model-implied firm productivities and fit them to a log-normal distribution to estimate a dispersion parameter for firm productivities. Finally, I allow the number of competitors in each local labor market to be heterogeneous and target the median number of employers in the ASI data.

When firms have market power in product and labor markets, the share of a firm's revenues that are paid to labor depends on their markups and markdowns. In terms of the model, this labor share of revenues for a Home firm can be written as

$$\frac{w_{n,s}^H(\omega)\ell_{n,s}^H(\omega)}{r_{n,s}(\omega)} = \frac{r_{n,s}^H(\omega)/r_{n,s}(\omega)}{\mu_{n,s}^H(\omega)/\mu_{n,s}^L(\omega)} + \frac{r_{n,s}^{*H}(\omega)/r_{n,s}(\omega)}{\mu_{n,s}^{*H}(\omega)/\mu_{n,s}^L(\omega)}, \tag{30}$$

where $r_{n,s}(\omega)$ is total firm revenues, $r_{n,s}^H(\omega)$ is sales in Home, and $r_{n,s}^{*H}(\omega)$ is sales in Foreign. All else being equal, an increase in either markup or a decrease in the markdown leads to a smaller labor share of revenues.

Parameters γ, α, and β are estimated using equation (30) and data on total labor costs, $\ell c_{n,s}^H(\omega) = w_{n,s}^H(\omega)\ell_{n,s}^H(\omega)$, value added, $va_{n,s}^H(\omega)$, and market shares.[59] Domestic product

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[57]Because the ASI samples a subset of employers with between 10 and 100 employees and does not sample from smaller employers, in reality there may be a smaller percentage of plants that are monopsonists.

[58]I assume $\theta = 1$ because of the level of aggregation in the data, which, as noted in the previous subsection, implies firms have small product market shares on average. In the counterfactuals below, I assume that each sector has an identical Cobb-Douglas weight in workers' preferences.

[59]This estimation procedure is also used to recover elasticity parameters in Edmond et al. (2015) and Kikkawa et al. (2018). To account for material and energy inputs, I use value added instead of sales revenue. These are the same in the model with labor as the only input. Value added is calculated following the guidelines in the ASI documentation as the difference between the total value of output and total input expenditures.

market shares $\mathcal{S}_{n,s}^H(\omega)$ and labor market shares $\mathcal{S}_{n,s}^L(\omega)$ can be calculated for Indian plants using the ASI and import data. Because market shares in export markets are unobserved, I use data for the subsample of plants that do not export and for whom $r_{n,s}^H(\omega) = r_{n,s}(\omega)$.[60] The model implies that the difference between the observed firm-level labor share of value added and the firm-level distortion $d_{n,s}^H(\omega)$ defined in equation (26) is equal to zero for non-exporters. I estimate the elasticity parameters by solving

$$\min_{\gamma,\alpha,\beta} \sum_s \sum_n \sum_\omega \left(\frac{\ell c_{n,s}^H(\omega)}{va_{n,s}^H(\omega)} - d_{n,s}^H(\omega) \right)^2 \tag{31}$$

using non-linear least squares, where I assume that $e_{n,s}^H(\omega) = \frac{\ell c_{n,s}^H(\omega)}{va_{n,s}^H(\omega)} - d_{n,s}^H(\omega)$ represents a mean-zero i.i.d. measurement error.

The parameter estimates and implied average elasticities are given in Table 3. Column (1) shows the parameter estimates under the baseline specification in which $\theta = 1$ and the labor market shares are measured in terms of shares of mandays worked by all employees at each plant. The estimate of γ, the within-sector elasticity of substitution, is 1.999, which implies that $\gamma > \theta$ and therefore firms that are larger sellers within national sectoral product markets face more inelastic product demand and charge higher markups over their marginal costs.[61] The point estimates of the labor supply elasticity parameters are also consistent with the model assumption that $\beta > \alpha$. This implies that workers view jobs from the same local labor market as closer substitutes for one another than jobs from different local labor markets and that larger employers within a local labor market face more inelastic labor supply and offer lower wage markdowns than do smaller employers.

The labor supply elasticity parameters are estimated with low precision. This imprecision originates from the weak correlation observed in the data between plants' shares of employment in their local labor market and their labor shares of value added.[62] Nevertheless, this correlation is negative, which suggests that the assumption that $\beta > \alpha$ is correct. I conduct simulated comparative statics in Section 5 for alternative parameter values to evaluate how the results from the counterfactual experiments are sensitive to these parameters.

Using the parameter estimates, the model implies that the average firm-level labor supply

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[60]Exporting plants account for 9.56% of observations, 14.93% of aggregate domestic sales, and 20.65% of total employment among plants that satisfy the sample selection criteria outlined in Appendix B.

[61]These estimated parameters imply that plants charge very high markups. The average labor share of value added in the estimation sample is 43.64%. Through the lens of the model, this implies that plants have a high amount of market power on average. Because variation in these labor shares of value added is more highly correlated with variation in product market shares than with variation in labor market shares, the estimated γ is quite low.

[62]This correlation is -0.032. In part, this is due to aggregation issues such as defining local labor markets at the district-sector level for plants in every sector.

Table 3: Elasticity Parameter Estimates and Implied Elasticities

Specification:	Mandays Worked		Total Wages	Labor Costs
	(1)	(2)	(3)	(4)
α	4.981	3.437	6.046	5.878
	(3.332)	(2.639)	(3.793)	(3.642)
β	8.222	5.577	11.022	10.625
	(10.218)	(8.432)	(14.108)	(13.350)
γ	1.999	2.142	1.932	1.938
	(0.346)	(0.809)	(0.232)	(0.240)
θ	1	1	1	1
	(-)	(-)	(-)	(-)
Observations	50,460	50,460	50,439	50,498
Mean $\eta_{n,s}^{H}(\omega)$	1.972	2.112	1.908	1.914
Std Dev $\eta_{n,s}^{H}(\omega)$	[0.065]	[0.074]	[0.061]	[0.061]
Mean $\eta_{n,s}^{L}(\omega)$	5.995	4.225	7.923	7.611
Std Dev $\eta_{n,s}^{L}(\omega)$	[1.196]	[0.486]	[1.940]	[1.858]
Observations	55,791	55,791	55,768	55,829

Notes: Standard errors of parameter estimates are reported in parentheses. The first row with observation counts refers to the sample size used for estimating parameters. The second row with observation counts refers to the entire sample including exporters. The mean and standard deviation of the elasticities weight plants by their labor costs.

elasticity weighted by the plant's total labor costs is 5.995 for firms in the ASI sample.[63] This average elasticity is somewhat larger than the estimates from the labor literature, which use alternative empirical strategies. For example, Staiger et al. (2010) estimate a short-run elasticity of about 0.1 in the market for nurses, which is the same as the elasticity estimated in an experimental setting by Dube et al. (2020), while Falch (2010) finds an elasticity of 1.4 in the market for Norwegian teachers. The empirical literature surveyed in Manning (2011) tends to find elasticities that are within the range of 0.5 to 2.

The average elasticities are also larger than those estimated in quantitative work using the Fréchet-Roy labor supply model, though these papers do not estimate firm-level labor supply elasticities. Burstein et al. (2019) find an estimated Fréchet parameter of 1.8, which, in the context of this model, implies an elasticity of 0.8.[64] When they introduce a distinct parameter for different types of labor, the median of the implied elasticities increases to 1.6. Lee (2020) finds a Fréchet parameter that ranges between 1.5 and 2, though these estimates increase when workers' productivities take on a nested structure analogous to my model. Finally, Galle et al. (2018) find estimates of the Fréchet parameter in their context between 2

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[63]This average includes exporters. Weighting by total employment implies an average elasticity of 6.360.

[64]The baseline environment of Burstein et al. (2019) has a single Fréchet parameter.

and 2.3.

Table 3 also contains parameter estimates under alternative specifications, which, broadly speaking, are consistent with the estimates in the baseline specification. In column (2), I define local labor markets at the Indian state level, where states are collections of districts. The labor supply elasticity parameter estimates are lower in this specification, which, in the context of the model, suggests that workers view jobs from within the same district-sector pair as closer substitutes than jobs that are from different district-sector pairs but the same state-sector pair. In columns (3) and (4), I use cost-based measures of labor market shares. Column (3) ignores non-wage payments and defines labor market shares as the share of total wages in a district-sector pair paid by each employer. Column (4) uses total labor costs in the definition of labor market shares.[65] In the counterfactual analysis below, I evaluate how results depend on different parameter values for α and β.

With values for the elasticity parameters and data on plants' market shares in product and labor markets, the model-implied distribution of productivities can be recovered. Denote the share of domestic firms' total Home country sectoral sales earned by firm ω as $\bar{\mathcal{S}}_{n,s}^H(\omega)$.[66] This market share is

$$\bar{\mathcal{S}}_{n,s}^H(\omega) = \frac{d_{n,s}^H(\omega)^{\gamma-1} w_{n,s}^H(\omega)^{1-\gamma} \phi_{n,s}^H(\omega)^{\gamma-1}}{\sum_{n=1}^{N^H} \sum_{\omega=1}^{\Omega_{n,s}} d_{n,s}^H(\omega)^{\gamma-1} w_{n,s}^H(\omega)^{1-\gamma} \phi_{n,s}^H(\omega)^{\gamma-1}}.$$

After multiplying the numerator and denominator of this equation by $W^{\gamma-1}$ and rearranging, firm ω's productivity can be written as

$$\phi_{n,s}^H(\omega) = \left(\frac{\bar{\mathcal{S}}_{n,s}^H(\omega)^{-1} d_{n,s}^H(\omega)^{\gamma-1} \left(\mathcal{S}_{n,s}^L(\omega)^{1/\beta} (\mathcal{S}_{n,s}^L)^{1/\alpha} \right)^{1-\gamma}}{\sum_{n=1}^{N^H} \sum_{\omega=1}^{\Omega_{n,s}} d_{n,s}^H(\omega)^{\gamma-1} \left(\mathcal{S}_{n,s}^L(\omega)^{1/\beta} (\mathcal{S}_{n,s}^L)^{1/\alpha} \right)^{1-\gamma} \phi_{n,s}^H(\omega)^{\gamma-1}} \right)^{\frac{1}{1-\gamma}}.$$

Using an iterative fixed point procedure starting from an arbitrary positive vector of productivities, the model-implied productivities of every plant in the ASI data that sells in a sector in which more than one plant operates can be recovered.[67] I fit this recovered

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[65]There are no non-wage components of labor compensation in the model, but the Fréchet-Roy model of employer choice implies that the labor market share measured in quantities should be equal to the share measured in cost terms. The results show a slight departure from the baseline specification in column (1). Firm-level labor supply elasticities are estimated to be larger using the cost-based measures than using the quantity-based measure.

[66]This market share is related to the firm's national sectoral product market share by $\mathcal{S}_{n,s}^H(\omega) = \bar{\mathcal{S}}_{n,s}^H(\omega)\mathcal{S}_s^H$, where $\mathcal{S}_s^H$ is the share of total sectoral sales in Home earned by Home firms.

[67]This algorithm recovers the within-sector model-implied productivity distributions. It can be extended to recovering differences across sectors in productivities when firms' productivities are the product of an idiosyncratic and sector-specific productivity. This extension uses the procedure outlined above to first recover idiosyncratic productivities and then in a second step uses these productivities to recover the sector-specific productivities from an analogous expression for the share of total domestic sales earned by all domestic firms

Figure 1: Recovered Productivity Distribution Fit
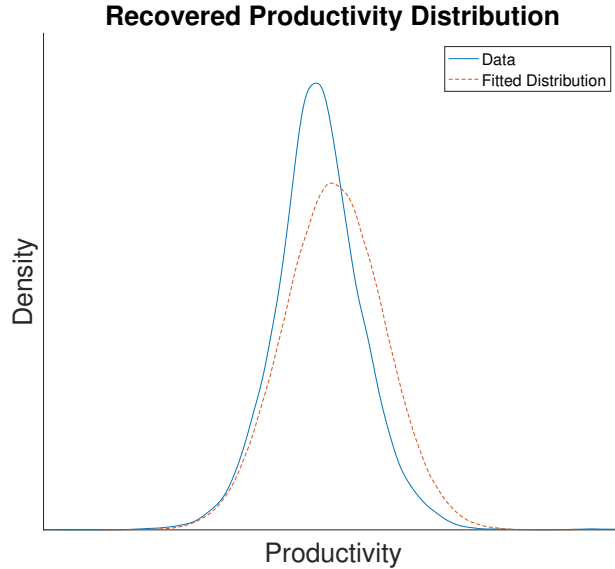
Notes: Figure shows the recovered productivity distribution and
the fitted log-normal distribution.

productivity distribution to a log-normal productivity distribution, which implies that the standard deviation of the log of firm productivities is 2.591. The fit of this distribution relative to the model-implied distribution of productivities recovered from the data is shown in Figure 1. The log-normal distribution underestimates the frequency of very large and very small firms and overstimates the frequency of moderately large firms.[68]

Finally, I allow the number of potential firms operating in each location-sector pair labor market to be randomly determined. In particular, the number of firms is drawn independently from a geometric distribution parameterized to match the median number of plants in Indian district-sector labor markets, which is 5.2 in the ASI data.[69]

4.3 Fixed Parameters

The remaining parameters are chosen to facilitate analysis of the counterfactual experiments described in the next section. I assume that Home and Foreign are symmetric as in Assumption 1 so that all parameters are the same for both countries and each firm in a country has

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in a sector. As I do not leverage differences across sectors for my quantitative experiments, I assume that these sector-specific productivities are all equal to one. See Edmond et al. (2015) for an example of this two-step extension.

[68]This discrepancy is in part due to the sampling frame of the ASI, which samples the largest firms with probability one and samples smaller firms with a smaller probability.

[69]The geometric distribution parameter is 0.125.

an identical counterpart located in an identical local labor market in the other country.

I normalize the labor endowment in each country to be $L^H = L^{*F} = 1$. Due to the computational costs of solving the system of pricing equations, I set the number of locations to 10 and the number of sectors to 20 and discuss how the quantitative results are sensitive to increasing the number of labor and product markets below. Each firm's productivity is drawn independently from a log-normal distribution with standard deviation 2.591.

I focus on intensive margin reallocation effects of trade and leave the extensive margins of firm behavior exogenous. As a baseline, I allow every potentially active firm to employ workers and sell to both countries. I evaluate the implications of allowing only a subset of firms to export in Section 5.3.

5   Quantitative Analysis

Using the parameter values discussed in the previous section, I conduct counterfactual experiments to evaluate how accounting for firms' oligopsony power in labor markets affects equilibrium outcomes and the gains from trade.[70] I first compare outcomes in autarky with and without endogenous labor market power to show how heterogeneous distortions reallocate market shares across employers and affect aggregate welfare and real wages. Next, I compare the effects of opening to trade under different assumptions on firms' labor market power to quantify the extent to which gains from trade depend on these assumptions. I also discuss how trade affects firm's market power in product and labor markets. Finally, I show how the effects of trade depend on the extensive margin of exporting by exogenously varying the set of firms that export in free trade. For each set of counterfactual experiments, I discuss how changes in the model parameters affect the outcomes of interest.

When comparing outcomes under oligopsony competition and perfect competition in labor markets, I assume that the structure underlying workers' employer choices is unchanged so that firms continue to face upward sloping labor supply curves under either model of competition.[71] Under oligopsony, firms offer an endogenous wage markdown, while under perfect competition wages are equal to the marginal revenue product of labor.

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[70]I label these parameter values as the baseline case.

[71]In other words, α and β are finite in both cases. An alternative experiment would be to assume that all firms face perfectly elastic labor supply with $\alpha \to \infty$ and $\beta \to \infty$. Under either assumption, firms do not mark down their wages. However, α influences aggregate labor productivity through the shifter λ_Γ, so increasing α and β to cause firms to face perfectly elastic labor supply curves would change aggregate labor productivity between the two experiments.

Figure 2: Variable Markups and Markdowns
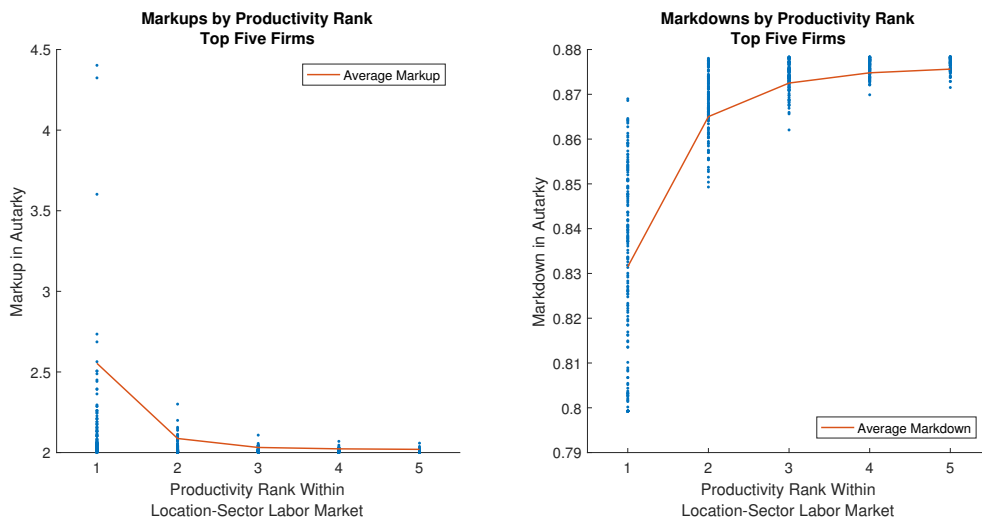
Notes: Figure shows the markups and markdowns of the five most productive firms within each local labor market and the size-weighted average within each rank. Each dot represents a single firm. The left panel shows the domestic markups and the right panel shows the markdowns.

5.1 Oligopsony, Firm-Level Distortions, and Welfare

As discussed in Section 2, when firms have endogenous market power and internalize the effects of their prices and wages on their sectoral product market and local labor market competitors, firm-level outcomes are distorted for two reasons: firms charge variable markups over their marginal costs and offer variable markdowns on their wages. These variable distortions are functions of firms' sizes, which, in this model, depend on firms' productivities and the set of local labor market competitors. Figure 2 demonstrates the result in Proposition 1. It shows, for a typical simulation, the markups and markdowns of the five most productive firms in every local labor market as well as the average within each rank weighted by the size of the firm.[72] In every local labor market, the markup is decreasing and the markdown is increasing in the productivity rank of the firm. Therefore, prices and wages are more distorted for more productive firms than for less productive firms.

Figure 2 also demonstrates that in the calibrated model, variation in the markups and markdowns across firms is largely constrained to the two or three most productive firms in each local labor market. This is consistent with results in Gaubert and Itskhoki (2018). In part, this reflects the large dispersion in plant-level productivities recovered from the Indian data. The weighted average markup of the third most productive firm across location-sector pair labor markets is 2.0316, which is only slightly larger than the CES markup of $\frac{\gamma}{\gamma-1} = 2.0015$. While there is more variation across local labor markets in the markdowns offered by firms,

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[72]The weights for markups are sales while the weights for markdowns are labor costs.

the markdown under monopsonistic competition, $\frac{\beta-1}{\beta} = 0.8784$, is only slightly larger than the weighted average markdown of the third and fourth most productive firms, which are 0.8725 and 0.8748, respectively.

The finding that the most productive firms within a local labor market offer lower wage markdowns compared to less productive firms has two important implications for the effects of oligopsony competition on firm-level outcomes. First, oligopsony power compresses the distribution of wages per effective worker across firms within a local labor market. Second, the most productive firms are too small compared to their local labor market competitors relative to a counterfactual environment in which firms do not exercise labor market power.

Oligopsony competition causes a reduction in between-firm inequality of wages per effective worker relative to perfect competition in labor markets because larger firms offer lower markdowns.[73] Under perfect competition, firms continue to face finitely elastic labor supply curves. Therefore, there is still dispersion of wages per effective worker across firms under perfect competition because heterogeneity in firm productivity implies firms have different labor demand curves and offer different equilibrium wages.[74] Because, under oligopsony competition, the most productive firms offer lower wage markdowns, their wages are closer to what their competitors offer than they would be without variable markdowns. When markdown distortions are eliminated, the most productive firms increase their wages by more than do less productive firms, as shown in Figure 3. This figure shows the ratio of real wages per effective worker with perfect competition relative to oligopsony for the five most productive firms in every local labor market as well as the weighted average across markets within each rank.[75] The most productive firms would also have the largest wage increases when moving from an environment with oligopsony and variable markdowns to one with monopsonistic competition and constant markdowns.

As a corollary to these effects of oligopsony on firm-level wages per effective worker, firms' sizes are distorted within local labor markets. Because the most productive firm in a local labor market charges a higher markup and offers a lower markdown, they have a larger distortion in their output supplied and labor demanded than do less productive firms. The result of removing these distortions, which is displayed in Figure 4 for the five most productive firms in every local labor market along with the cost-weighted average of these ratios, is that the most productive firm in each market always increases in size relative to its

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[73]There is no inequality in wages per *employed* worker because, from equations (5) and (6), these are equal to $\lambda_\Gamma W$ for all firms.

[74]If firms instead face perfectly elastic labor supply curves (e.g., if $\beta \to \infty$), every firm within a local labor market offers the same wage per effective worker.

[75]Weights are labor costs under oligopsony. Within every local labor market, more productive firms increase their wage offer by more than do less productive firms. All firms increase their wage offer when oligopsony competition is eliminated because firms compete more intensely for labor.

Figure 3: Oligopsony and Between-Firm Inequality
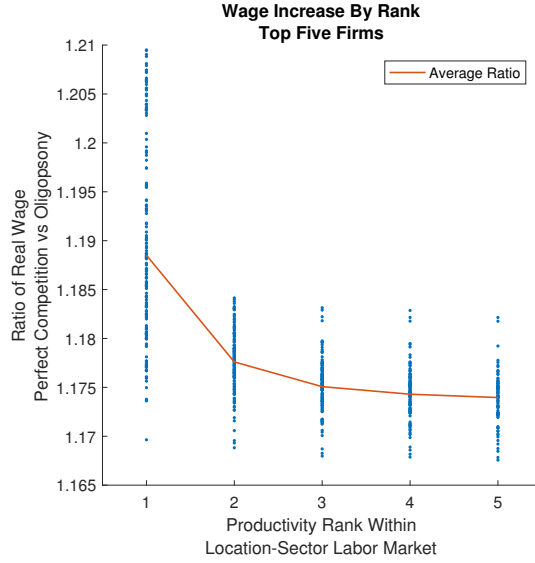
Notes: Figure shows the ratio of real wages under perfect com-
petition and oligopsony for the five most productive firms within
each local labor market and the cost-weighted average within
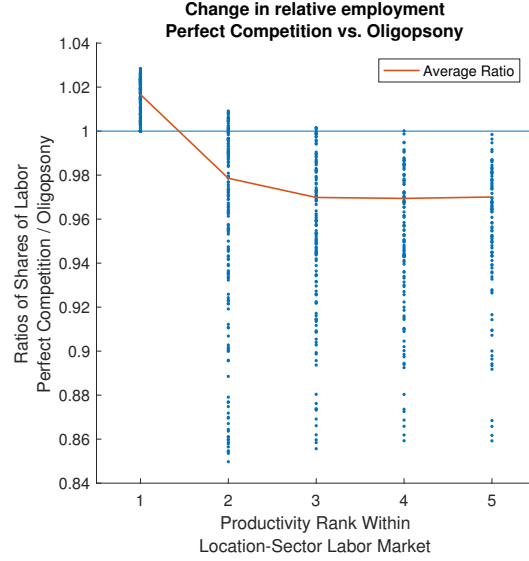each rank. Each dot represents a single firm.

local competitors.

While this is true for the most productive firm in a local labor market, this need not be
the case for less productive firms. Figure 4 shows that almost all firms that are not the most
productive in their local labor market lose labor market share when oligopsony distortions
are eliminated, which is then reallocated to the most productive firms.[76]

Because the most productive firms within a local labor market are too small relative to
the less productive firms under oligopsony competition, aggregate welfare is smaller than it
would be with perfectly competitive labor markets. However, the calibrated model suggests
that these welfare losses are small. Aggregate real income is 0.35% smaller under oligopsony
than under perfect competition.[77] While these welfare losses from oligopsony are small, the
composition of real income is very different in the two models. With oligopsony, aggregate
real wage income is only 84.48% of its level under perfect competition, while aggregate real
dividend income is 11.47% higher with oligopsony. The direction of divergence between the
two models in these results is unsurprising, since with more scope for exercising market power
firms should earn more profits holding the extensive margins of firm activity fixed. In an
alternative setting in which dividend income was distributed unequally to different workers,

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[76]Furthermore, within a local labor market these ratios are strictly decreasing in the productivity rank of
the firm.

[77]This comparison, and all comparisons in this subsection, assumes each country is in autarky. Furthermore,
oligopoly competition in product markets is maintained in all counterfactuals.

Figure 4: Firm Size Distortions Within Labor Markets

Notes: Figure shows the ratio of employment under perfect competition and oligopsony for the five most productive firms within each local labor market and the cost-weighted average within each rank. Each dot represents a single firm.

accounting for endogenous labor market power would introduce additional inequality across workers.

The finding that the welfare effects induced by firms' variable markdowns are small does not depend on the parameter values used for the labor supply elasticities. In Table 4, I show the percentage change of welfare under oligopsony competition in labor markets relative to perfect competition for a range of different labor supply elasticity parameters, all of which imply only small welfare effects.[78] As long as $\alpha \neq \beta$, firms offer variable markdowns and therefore firms' sizes are distorted within local labor markets. Table 4 demonstrates the general pattern that the larger is the gap between α and β, the larger is the welfare change due to oligopsony.[79] When α and β are larger, firms face more elastic labor supply curves and offer larger markdowns to their workers. When both parameters increase proportionally, the welfare effects of variable markdowns become smaller because variation across firms in markdowns decreases, and hence the entries in the top left of Table 4 are in general larger in

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[78]I do not recalibrate the distribution of productivity under these alternative elasticity parameters, so these are comparative static experiments.

[79]When $\alpha > \beta$, large firms offer larger markdowns than small firms and are therefore larger than they would be relative to a constant markdown environment. Using the terminology of Dhingra and Morrow (2019), in this situation private and social incentives can be misaligned depending on the relative magnitudes of the product demand and labor supply elasticity parameters. When α and β are smaller, the relative variation in markdowns across firms is larger and these incentives are more likely to be misaligned.

Table 4: Welfare Effects of Oligopsony and Labor Supply Elasticities

β \ α	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
2.5	0%	0.24%	0.28%	0.27%	0.25%	0.23%	0.21%	0.20%	0.19%
3.5	-0.45%	0%	0.19%	0.28%	0.32%	0.34%	0.35%	0.35%	0.35%
4.5	-0.77%	-0.26%	0%	0.14%	0.22%	0.27%	0.30%	0.32%	0.33%
5.5	-0.97%	-0.45%	-0.17%	0%	0.10%	0.17%	0.22%	0.25%	0.27%
6.5	-1.11%	-0.59%	-0.29%	-0.12%	0%	0.08%	0.13%	0.17%	0.20%
7.5	-1.19%	-0.69%	-0.39%	-0.21%	-0.09%	0%	0.06%	0.11%	0.14%
8.5	-1.25%	-0.77%	-0.47%	-0.28%	-0.16%	-0.07%	0%	0.05%	0.09%
9.5	-1.29%	-0.82%	-0.53%	-0.34%	-0.21%	-0.12%	-0.05%	0%	0.04%
10.5	-1.32%	-0.87%	-0.58%	-0.39%	-0.26%	-0.17%	-0.10%	-0.04%	0%

Notes: Entries show the percentage change of aggregate autarky real income I/P under oligopsony compared to perfect competition in labor markets. Firms compete as oligopolists in all equilibria.

absolute value than those in the bottom right off of the diagonal.[80]

For $\alpha < \beta$, the gap between these two parameters determines the extent to which large employers are able to decrease their wage markdown relative to small employers, so when this gap is larger, large firms' sizes are relatively more distorted and the welfare losses are larger. When $\alpha > \beta$, large firms are larger relative to their local labor market competitors under oligopsony than they would be with perfect competition. For a fixed set of firms and with oligopoly competition in product markets this increases real income under oligopsony compared to perfect competition.[81]

While variations in the labor supply elasticity parameters do not have substantial effects on aggregate welfare losses, they are an important determinant of the composition of real income. Table 5 shows the ratio of aggregate real wage income under oligopsony relative to perfect competition for different labor supply elasticity parameters. When α and β are larger, firms have less market power and extract a smaller portion of the surplus in the employment relationship. They increase their wage offers, which increases the share of labor income in aggregate income.[82]

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[80]To see this, suppose there are two sets of parameters $\{\alpha_1, \beta_1\}$ and $\{\alpha_2, \beta_2\}$ with $\alpha_2 = k\alpha_1$ and $\beta_2 = k\beta_1$ for some $k > 1$. For $\alpha < \beta$ and $i = 1, 2$, the ratio of the largest and smallest possible markdowns are $\frac{\alpha_i(\beta_i-1)}{\beta_i(\alpha_i-1)}$. Taking the ratio for $i = 1$ and dividing it by the ratio for $i = 2$ gives $\frac{\beta_1-1}{k\beta_1-1}\frac{k\alpha_1-1}{\alpha_1-1} > 1$, which implies that the range of markdowns decreases under $\{\alpha_2, \beta_2\}$ relative to $\{\alpha_1, \beta_1\}$. A similar argument holds for $\alpha > \beta$.

[81]When $\alpha > \beta$, the distortions in firm sizes due to oligopsony counteracts the distortions in firm sizes due to oligopoly that cause large sellers to be relatively small compared to a setting with constant markups. The oligopsony equilibrium is not allocatively efficient, however, because the allocation does not correspond to the one that would be chosen by a social planner facing the same labor supply curves.

[82]The increased wage offers are due both to a reduction of markdowns and an increase in the intensity of competition for workers.

Table 5: Oligopsony, Labor Supply Elasticities, and Aggregate Real Wages

β \ α	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
2.5	60.0%	65.4%	69.1%	71.8%	73.9%	75.6%	77.0%	78.2%	79.2%
3.5	66.9%	71.4%	74.5%	76.8%	78.6%	80.0%	81.2%	82.2%	83.1%
4.5	71.1%	75.1%	77.8%	79.8%	81.4%	82.6%	83.7%	84.6%	85.3%
5.5	74.0%	77.6%	80.0%	81.8%	83.2%	84.4%	85.3%	86.1%	86.8%
6.5	76.2%	79.4%	81.7%	83.3%	84.6%	85.7%	86.5%	87.3%	87.9%
7.5	77.9%	80.9%	82.9%	84.5%	85.7%	86.7%	87.5%	88.2%	88.7%
8.5	79.3%	82.1%	84.0%	85.4%	86.6%	87.5%	88.2%	88.9%	89.4%
9.5	80.4%	83.1%	84.9%	86.2%	87.3%	88.2%	88.9%	89.5%	90.0%
10.5	81.4%	83.9%	85.6%	86.9%	87.9%	88.7%	89.4%	90.0%	90.5%

Notes: Entries show the ratio of aggregate autarky real wage W/P under oligopsony relative to perfect competition in labor markets. Firms compete as oligopolists in all equilibria.

Aggregate welfare losses due to endogenous labor market power are also quite insensitive to changes in the other model parameters, as shown in Table 6. When γ increases, goods from the same sector become closer substitutes for one another, which reduces the market power that firms have in product markets. As a result, market shares in product markets shift towards firms that charge lower prices, so the extent of misallocation in the baseline oligopsony equilibrium decreases. However, as γ increases, imperfect competition in labor markets becomes a more important determinant of the composition of real income. Because the most productive firms gain market share in product markets, they also gain market share in labor markets, which allows them to offer lower wage markdowns.

Table 6 also shows the effects of changing the market environment that firms face and the dispersion of firm productivities. When the location dimension of the model is removed and all firms in a sector compete directly with each other within the same labor market, welfare losses due to oligopsony are reduced. Firms have smaller labor market shares, so their wage offers and sizes are less distorted compared to the equilibrium with perfect competition in labor markets. The finding of small welfare losses does not depend on the number of locations in a sector or the number of sectors.[83] The magnitude of the welfare losses depends on the dispersion of firm productivity draws. When the standard deviation of the log-normal distribution from which they are drawn is halved, firms are on average more similar to one another. This reduces the dispersion of market shares in both product and labor markets across firms as well as the dispersion of market power. As a result, welfare losses are smaller. If dispersion of productivities is removed entirely, as is the case in Heiland and Kohler (2018),

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[83]I simulate the model with 20 potential local labor markets in each sector and with 40 sectors (and 10 potential local labor markets per sector). This increases the number of total firms in operation, but has negligible impacts on welfare losses or the composition of real income.

Table 6: Real Income and Distribution under
Oligopsony vs. Perfect Competition

	Income	Wages	Profits
Baseline	-0.35%	-15.52%	11.47%
$\gamma = 5$	-0.31%	-18.31%	24.04%
$\gamma = 10$	-0.17%	-18.70%	31.50%
1 Location	-0.18%	-12.98%	9.66%
20 Locations	-0.34%	-16.20%	12.48%
40 Sectors	-0.27%	-15.31%	11.95%
Std. Dev.= 1.295	-0.08%	-13.82%	12.91%

Notes: Entries show the percentage increase of aggregate
income, wages, and profits under oligopsony relative to
perfect competition.

then every firm has the same labor market share and welfare losses disappear entirely.

5.2   Trade and Oligopsony

Opening to trade exposes firms to increased competition in national product markets. In firms' domestic markets, the entry of firms from the other country causes domestic firms' market shares to decrease. In their export market, firms increase their market share. Looking within local labor markets, the largest firms experience a smaller proportional decrease of their domestic market share and a larger absolute increase of their export market share than do smaller firms.

These differential effects of trade on product market shares for large and for small firms implies that their market power adjusts in different ways. Figure 5 shows the effects of moving from autarky to free trade in both countries on the markups charged by Home firms in their domestic market. Every firm loses market share in their domestic market, which puts downward pressure on their markups. While these market shares decrease by more in proportional terms for less productive firms than for more productive firms from the same local labor market, in absolute terms they decrease by a larger amount for more productive firms. Combined with the fact that markups are bounded from below, this implies that there is a proportionally larger decrease of markups for the more productive firms in a local labor market. The overall competitive effects of trade on domestic markups is reflected in the leftward shift of the distribution of markups in Figure 5. The revenue-weighted harmonic average markup decreases by 6.65% in moving from autarky to free trade.

In contrast with the substantial effects of trade on firms' markups, trade has small effects on firms' markdowns. The corresponding revenue-weighted harmonic average markdown
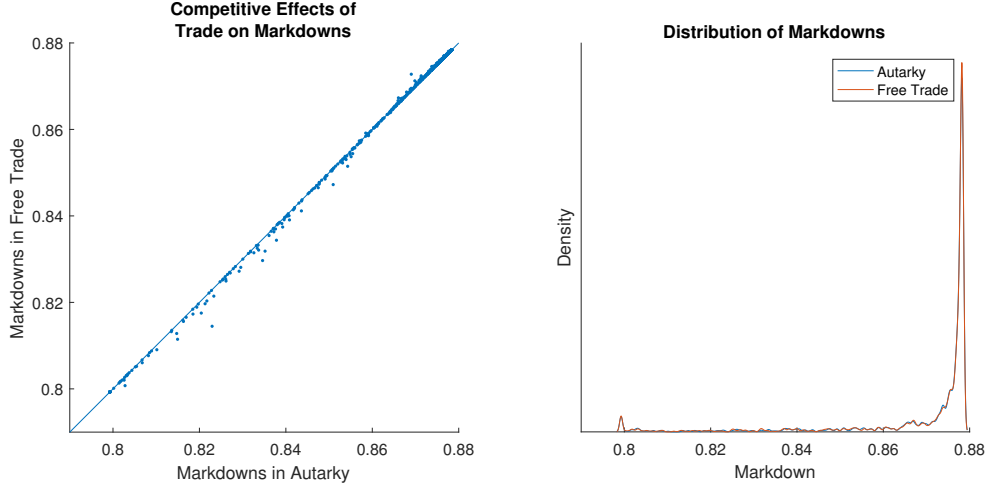
Figure 5: Trade and Markups
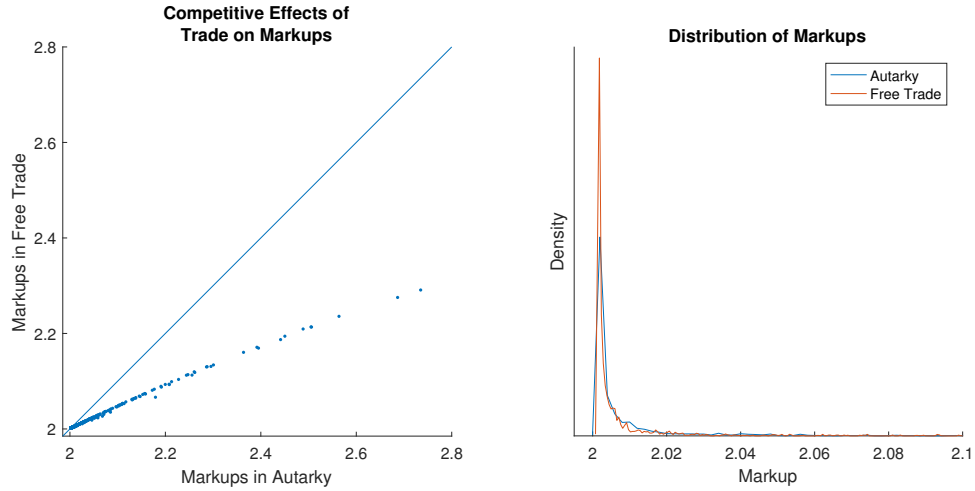
Notes: Figure shows the effect of trade on markups. The left panel plots every Home firm's domestic markup in autarky and free trade. Each dot represents a single firm. The right panel plots the distributions of markups under autarky and free trade.

decreases by only 0.21%, which implies that firms' labor market power increases only slightly on average due to trade. These small effects can be seen at the firm level in Figure 6, where, for most firms, the ratio of their markdown under free trade relative to autarky is approximately one. This figure shows that firms that offer the lowest markdowns in autarky, which are firms that are large employers within their local labor markets, are more likely to decrease their markdown when the two countries open to trade than are firms that offer the highest markdowns in autarky. This reflects a slight reallocation of labor market shares from the least productive to the most productive firms in a local labor market.

The main cause for these reallocations is the change in relative markups across firms within local labor markets. Because the largest firms experience a larger proportional decrease in their domestic markup, relative domestic demand for their variety increases compared to smaller firms in their local labor market. At the same time, these firms increase their export market shares by a larger amount. In combination, these shifts in relative product demand are transmitted into an increase in relative labor demand in the largest employers within a local labor market. Therefore, the largest firms grow relative to the smallest firms.

These reallocations have the potential to affect the distribution of wages across firms both in the aggregate and within local labor markets. Figure 7 shows how firms' wages increase when the countries open to trade. Because competition for workers increases as the most productive firms in a sector expand, trade causes every firm to increase their wage offer. However, because the effects of trade on labor market power are small, the increase in wages has only slight effects on inequality across firms in relative terms. While the distribution of

Figure 6: Trade and Markdowns

Notes: Figure shows the effect of trade on markdowns. The left panel plots every Home firm's markdown in autarky and free trade. Each dot represents a single firm. Larger firms offer lower markdowns compared to smaller firms. The right panel plots the distributions of markdowns under autarky and free trade. The mass point on the left represents employers that are monopsonists in their local labor markets.

wages becomes more dispersed, the ratio of the 90th percentile to 10th percentile wage offer increases by a marginal amount from 2.325 to 2.336.[84]

Looking within local labor markets, Figure 8 shows how real wages change for firms ranked by their productivity within the market. While some of the most productive firms substantially increase their wage offer, there are only slight increases in wage inequality across firms from the same local labor market on average. Furthermore, this increased inequality is only apparent in the wages offered by the most productive firms, as the proportional increase in wages at less productive firms is essentially constant across productivity ranks on average.

Because, as discussed in the previous subsection, the welfare effects of heterogeneous markdowns are small, and since the effects of trade on firms' markdowns are also small, the gains from trade are quite similar whether endogenous labor market power is accounted for or not. In the baseline counterfactuals, the real income gains from trade are just 0.14% higher under oligopsony than under perfect competition in labor markets. These additional gains are due to a trade-induced reduction of misallocation, since the most productive firms in each local labor market face smaller size distortions after opening to trade. However, because these firms increase their labor market share, they increase their labor market power and offer smaller wage markdowns to their workers. Consequently, opening to trade leads to a smaller increase of aggregate real wages and a larger increase of aggregate profits under oligopsony

[84]With perfectly competitive labor markets, the corresponding ratio of 90-10 wage percentiles increases from 2.333 to 2.346. As explained in the previous subsection, oligopsony competition compresses the distribution of wages per effective worker.

Figure 7: Trade and Real Wages

Effects of Trade on Real Wages

Distribution of Real Wages
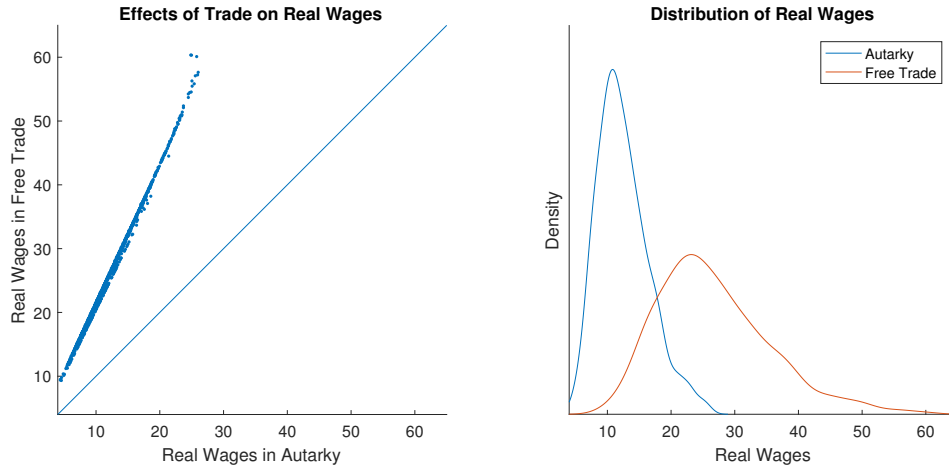
Notes: Figure shows the effect of trade on real wages. The left panel plots every Home firm's real wage in autarky and free trade. Each dot represents a single firm. The right panel plots the distributions of real wages under autarky and free trade.

Figure 8: Trade and Between-Firm Inequality

Wage Increase By Rank
Top Five Firms
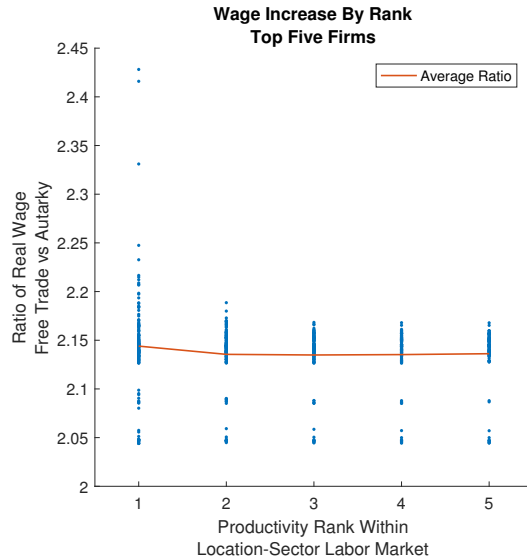
Notes: Figure shows the ratio of real wages under free trade and autarky for the five most productive firms within each local labor market and the cost-weighted average within each rank. Each dot represents a single firm.

Table 7: Gains from Trade and Labor Supply Elasticities: Oligopsony vs. Perfect Competition

β \ α	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
2.5	0%	-0.19%	-0.31%	-0.38%	-0.41%	-0.44%	-0.45%	-0.45%	-0.45%
3.5	0.16%	0%	-0.11%	-0.19%	-0.24%	-0.27%	-0.29%	-0.31%	-0.32%
4.5	0.24%	0.10%	0%	-0.07%	-0.13%	-0.16%	-0.19%	-0.21%	-0.23%
5.5	0.28%	0.17%	0.07%	0%	-0.05%	-0.09%	-0.12%	-0.14%	-0.16%
6.5	0.30%	0.20%	0.12%	0.05%	0%	-0.04%	-0.07%	-0.09%	-0.11%
7.5	0.31%	0.23%	0.15%	0.09%	0.04%	0%	-0.03%	-0.05%	-0.07%
8.5	0.32%	0.24%	0.17%	0.11%	0.07%	0.03%	0%	-0.02%	-0.04%
9.5	0.32%	0.26%	0.19%	0.13%	0.09%	0.05%	0.02%	0%	-0.02%
10.5	0.32%	0.26%	0.20%	0.15%	0.11%	0.07%	0.04%	0.02%	0%

Notes: Entries show the percentage increase of real income I/P gains from trade under oligopsony relative to perfect competition in labor markets. Gains from trade are measured as the ratio of free trade to autarky real income. Firms compete as oligopolists in all equilibria.

than under perfectly competitive labor markets. The baseline real wage gains from trade are -0.36% smaller with oligopsony while the real profit growth is 1.92% higher.

These small effects on aggregate outcomes are robust to different labor supply elasticity parameters. In Table 7, I demonstrate how the additional gains from trade change with variation in these parameters. When labor supply is elastic for all firms (i.e., α and β are large), the welfare effects of oligopsony are small because there is relatively little variation in firms' markdowns. Therefore, employers' relative labor market shares are similar to what they would be under perfect competition, so trade has similar effects on welfare under oligopsony and perfect competition. Similarly, when the gap between the two elasticity parameters is smaller, there is less variation in the markdowns across employers and the extent of misallocation is smaller. However, as the gap between these parameters grows, the dispersion of markdowns increases, which implies the most productive firms' sizes are more distorted.

When $\alpha < \beta$, the most productive firms are relatively small in the oligopsony equilibrium in autarky. Trade reduces the extent of these size distortions by reallocating labor market share towards those firms, so the gains from trade are larger under oligopsony and these additional gains frome trade are increasing in the gap between α and β. In contrast, the most productive firms are relatively large in the oligopsony equilibrium in autarky when $\alpha > \beta$. Trade increases the size distortions caused by oligopsony and the gains from trade decrease. Intuitively, for a fixed set of firms the welfare benefits of increasing the relative size of productive firms is smaller when they are relatively larger to begin with because consumers view goods as imperfect substitutes.

In Table 8, I show the effect that different labor supply elasticity parameters have on the

Table 8: Gains from Trade, Labor Supply Elasticities, and Aggregate Wages: Oligopsony vs. Perfect Competition

α β	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
2.5	0%	0.44%	0.65%	0.75%	0.81%	0.83%	0.84%	0.84%	0.83%
3.5	-0.46%	0%	0.25%	0.40%	0.49%	0.54%	0.58%	0.60%	0.61%
4.5	-0.73%	-0.27%	0%	0.17%	0.27%	0.34%	0.39%	0.42%	0.45%
5.5	-0.90%	-0.45%	-0.18%	0%	0.12%	0.20%	0.25%	0.30%	0.33%
6.5	-1.02%	-0.58%	-0.30%	-0.12%	0%	0.09%	0.15%	0.20%	0.23%
7.5	-1.10%	-0.67%	-0.40%	-0.22%	-0.09%	0%	0.07%	0.12%	0.16%
8.5	-1.16%	-0.75%	-0.48%	-0.29%	-0.16%	-0.07%	0%	0.05%	0.10%
9.5	-1.21%	-0.80%	-0.54%	-0.35%	-0.22%	-0.13%	-0.06%	0%	0.04%
10.5	-1.24%	-0.85%	-0.59%	-0.40%	-0.27%	-0.18%	-0.10%	-0.05%	0%

Notes: Entries show the percentage change of real wage W/P gains from trade under oligopsony relative to perfect competition in labor markets. Real wage gains from trade are measured as the ratio of free trade to autarky real wages. Firms compete as oligopolists in all equilibria.

real wage gains from trade under oligopsony compared to perfect competition. When $\alpha < \beta$, real wage growth is slower under oligopsony than it is under perfect competition because the most productive firms gain additional market power in their labor markets due to the reallocation of market share towards them. When labor supply is elastic, firms' markdowns are close to one, and workers' benefits from the improvement in aggregate productivity are similar under oligopsony and perfect competition. When α is relatively small compared to β, the effect of trade-induced reallocations on the largest firms' markdowns are larger, so the real wage gains from trade are smaller with oligopsony. When $\alpha > \beta$, trade causes the most productive firms to lose market power in their labor markets as they grow in relative size. Consequently, the real wage gains from trade are larger in this case.

Variation in the other model parameters has little effect on the additional gains from trade under oligopsony, as shown in Table 9. In general, the effect of changing model parameters on the gains follows the results presented in Table 6. When the losses due to misallocation are larger, then trade leads to a larger increase in real income.[85] The effects of trade on real wage growth are also very similar with different parameter values compared to the baseline equilibria.

Now consider the effects of taking a step away from the assumption of symmetric countries as an additional trade shock. Suppose that aggregate productivity in Foreign increases such

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[85]The additional gains when $\gamma = 10$ are smaller than when $\gamma = 5$ because the overall gains from trade are substantially smaller in the former case. The relative real wage gains are much more similar in the two cases. In both cases, aggregate dividend growth is much larger under oligopsony because without oligopsony, trade reduces aggregate profits in the symmetric country counterfactual.

Table 9: Gains from Trade: Oligopsony vs.
Perfect Competition

	Income	Wages	Profits
Baseline	0.14%	-0.36%	1.92%
$\gamma = 5$	0.18%	-0.74%	21.36%
$\gamma = 10$	0.10%	-0.86%	57.57%
1 Location	0.03%	-0.40%	1.62%
20 Locations	0.12%	-0.34%	1.73%
40 Sectors	0.09%	-0.33%	1.58%
Std. Dev.= 1.295	0.02%	-0.06%	0.40%

Entries show the percent increase of the gains from trade
and distribution under oligopsony compared to perfect
competition in labor markets.

Table 10: Productivity Shocks and
Oligopsony vs. Perfect Competition

	Income	Wages	Profits
$\check{\Phi}^* = 1.112$	0.003%	-0.010%	0.049%
$\check{\Phi}^* = 2$	0.015%	-0.068%	0.316%

Notes: Entries show the effect of aggregate pro-
ductivity shocks on real income, wages, and profits
under oligopsony compared to perfect competition.

that each firm's total factor productivity is multiplied by the factor $\check{\Phi}^*$. Suppose, following the median estimate in Hsieh and Ossa (2016) of China's productivity growth over 1995 to 2007, that $\check{\Phi}^* = 1.112$. Table 10 shows how this increase in Foreign productivity affects the free trade equilibrium welfare in Home under oligopsony compared to perfect competition in labor markets. An increase in Foreign productivity, like the effects of opening to trade, causes a reallocation in Home product markets away from the least productive firms towards the most productive firms, since the additional competition affects the least productive firms by more. The results in this table show that there are additional gains when comparing oligopsony to perfect competition because these reallocations reduce the losses due to heterogeneous variable markdowns. However, because the labor market power of the most productive firms increases, the benefits of the improved productivity for Home workers' wages is smaller under oligopsony. When $\check{\Phi}^* = 2$, these effects are amplified, though the magnitude of these effects are very small.

5.3 Extensive Margins

As a final counterfactual exercise, I consider the effects of the extensive margin of exporting on the aggregate gains from trade. Instead of allowing every firm to export, suppose that only a fraction of the most productive firms in each sector are able to export in free trade. When only the most productive firms are able to export, there is a larger increase in their labor market share when moving from autarky to free trade than in the baseline counterfactual of the previous subsection. Both exporters and non-exporters face import competition in their domestic product markets that reduces their market share there. However, non-exporters lose additional market share in their local labor markets if there is an exporter there. As a result, the most productive firms gain more labor market power than they would if every firm were allowed to export.

In these experiments, I maintain Assumption 1 so that the set of exporters in each country are identical. I consider the cases where, for each country, 10% and 20% of the most productive firms in each sector export. I also introduce a symmetric fixed skilled labor requirement of exporting paid by exporters in both countries and examine how variation in these market access costs affects outcomes. Denote these labor requirements by f_x for Home firms. As the fixed labor requirement increases, the reallocation of labor towards the exporters when opening to trade increases. However, because this labor used for fixed export costs is not productive, less labor is available to produce output, which reduces aggregate productivity.

Table 11 shows the quantitative effects of allowing only a fraction of the most productive firms to export. Comparing the real income gains under oligopsony to perfect competition in labor markets, real income growth under oligopsony is relatively larger when more firms are able to export. The reason for this is because under oligopsony the additional reallocation in labor markets towards the exporters causes them to offer lower markdowns and become more distorted relative to perfect competition. Because they are more distorted, the relative sizes of these firms are even smaller than what would prevail under perfect competition relative to an equilibrium in which more firms exported. As a result, the additional gains from trade due to oligopsony under the baseline case of the previous section are an upper bound on the additional gains when the sets of producing and exporting firms are exogenous.

Increasing the fixed labor requirement for exporting causes both the real income and real wage gains from trade to be more similar under oligopsony compared to perfect competition. As f_x increases, exporters demand more labor, which forces them to increase their wage offer. Because exporters raise their wage offers, non-exporters also raise their wages due to increased competition for workers. In addition, an increase in the fixed labor requirement of exporting causes a reallocation of employment towards the more productive exporters and

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Table 11: Gains from Trade, Exporting, and
Fixed Labor Requirement

	10% Exporters		20% Exporters	
f_x	Income	Wages	Income	Wages
0.000	0.052%	-0.532%	0.074%	-0.544%
0.001	0.051%	-0.520%	0.072%	-0.498%
0.002	0.050%	-0.510%	0.070%	-0.459%
0.003	0.050%	-0.500%	0.068%	-0.425%
0.004	0.049%	-0.492%	0.067%	-0.394%
0.005	0.048%	-0.486%	0.065%	-0.366%
0.006	0.047%	-0.480%	0.063%	-0.341%
0.007	0.047%	-0.475%	0.062%	-0.317%
0.008	0.046%	-0.472%	0.060%	-0.295%
0.009	0.045%	-0.469%	0.059%	-0.274%
0.010	0.044%	-0.468%	0.057%	-0.255%

Notes: Entries show percent increase of gains from trade under oligopsony compared to perfect competition in labor markets for different exogenous amounts of exporters and different fixed labor requirements, f_x, for exporting. $X\%$ exporters means the $X\%$ most productive firms in each sector are able to export.

away from less productive firms, which reduces the extent of misallocation due to variable markdowns.

6   Conclusion

In this paper, I have developed a novel quantitative model in which heterogeneous firms have endogenous market power in their national sectoral product markets and local labor markets. I show how extending models of workers' idiosyncratic choices that are becoming increasingly used in the trade, labor, and macro literatures provides microfoundations for firms' endogenous labor market power. I apply the model to evaluate how trade affects firms' market power in these markets and how accounting for endogenous labor market power affects the gains from trade and the composition of these gains across workers' wages and firms' profits. This model provides a quantitatively tractable means of incorporating market power of buyers in many input markets beyond labor markets. Moreover, while I study the effects of a foreign trade shock, the model can be used to study other shocks at the sector or local labor market level or to model labor market policies and institutions such as minimum wages and unionization or policies designed to encourage export participation by small firms.

I quantify the importance of endogenous labor market power by estimating the model's

key structural parameters with Indian plant-level data and sectoral import data. Using the relationship between firm-level market power and factor payments, I provide a method for recovering labor supply elasticities that is distinct from approaches used thus far in the literature. This method can be used in other national contexts in both developed and developing countries and outside the manufacturing industry to measure firms' labor market power. The Indian data support the view that firms that are larger sellers in their product markets have more market power than smaller sellers, and firms that are larger employers in their local labor markets have more market power than smaller employers.

I find that in the Indian context, the extent of firms' labor market power is small, which implies that there are only small welfare losses due to the misallocation of resources that is caused by firms' heterogeneous labor market power. Consequently, exposure to trade generates only small additional welfare gains when comparing models with imperfect competition to perfect competition in labor markets. However, the mechanism through which these additional gains are realized is through a reallocation of market shares in local labor markets towards the most productive firms within those markets, which increases the labor market power of those firms. As a result, the distribution of the gains from trade is slightly shifted away from workers' wages towards firms' profits when I account for endogenous labor market power. This redistribution of the gains from trade is amplified when fewer firms can export.

The findings and model in this paper point to numerous interesting directions for future research. For instance, because firms' labor market power depends on the set of local competitors they face, productive firms have an incentive to locate their plants and offices in places where few other productive firms within their sector are operating. This divide and conquer strategy of production location decisions does not factor into the present model because firms' locations are exogenous. Future research can investigate how the location decisions of productive firms affects the market structure of local labor markets and outcomes for both workers and firms. Additionally, extending the model to account for non-labor inputs and costly trade across locations would allow for an evaluation of the tradeoff between firms' proximity to their input suppliers and their ability to offer workers smaller wages in locations and countries with less competitive labor markets.

Another important path for future research is to examine how market and bargaining power on both sides of labor markets is affected by trade and in turn how this affects worker and firm outcomes. Coordination by workers, as in, for example, unions, affects the share of the surplus in employment relationships that is earned by workers. The model in this paper predicts that large employers' labor market power increases due to trade. A natural question to ask is how inequality across workers that participate in unionized versus non-unionized workplaces is influenced by variation in how trade affects competition across employers and

local labor markets. Furthermore, the model can be used to investigate coordination by employers to reduce wages and policy interventions to prevent these practices.

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A   Derivation of Model Results

A.1   Labor Supply Curves

This appendix derives the firm-level labor supply curves in Home shown in Section 2.2. The steps involved follow Lagakos and Waugh (2013) and Hsieh et al. (2019) and the derivation of choice probabilities with multivariate Fréchet distributed productivities in Ramondo and Rodríguez-Clare (2013). Use of the Fréchet distribution in trade models was pioneered by Eaton and Kortum (2002). Workers' match-specific productivities are drawn from

$$
G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\sum_{n=1}^{N^H} \int_0^1 \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \varepsilon_{n,s}(h,\omega)^{-\beta}\right)^{\alpha/\beta} \mathrm{d}s\right).
$$

Let $G_\omega(\boldsymbol{\varepsilon}(h))$ be the derivative of this distribution function with respect to the match-specific productivity at employer ω in location-sector pair (n,s). This derivative is

$$
G_\omega(\boldsymbol{\varepsilon}(h)) = \alpha \varepsilon_{n,s}(h,\omega)^{-\beta-1} \left(\sum_{\omega'=1}^{\Omega_{n,s}^H} \varepsilon_{n,s}(h,\omega')^{-\beta}\right)^{\alpha/\beta-1} G(\boldsymbol{\varepsilon}(h)).
$$

Evaluating this derivative at $\varepsilon_{n',s'}(h,\omega') = \frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)$ for all ω' in every (n',s')-pair gives the probability that employer ω offers the highest nominal income to worker h of any potential employer conditional on worker h having match-specific productivity $\varepsilon_{n,s}(h,\omega)$ with that employer. This probability is given by

$$
\alpha \varepsilon_{n,s}(h,\omega)^{-\alpha-1} G\left(\left\{\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)\right\}\right) w_{n,s}^H(\omega)^{\beta-\alpha} W_{n,s}^{\alpha-\beta}, \tag{32}
$$

where $W_{n,s}$ is defined as in equation (3) and

$$
G\left(\left\{\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)\right\}\right) := \exp\left(-\varepsilon_{n,s}(h,\omega)^{-\alpha} w_{n,s}^H(\omega)^{-\alpha}\left(\sum_{n'=1}^{N^H}\int_0^1 W_{n',s'}^\alpha \mathrm{d}s'\right)\right)
$$

is the distribution function for match-specific productivities evaluated at $\varepsilon_{n',s'}(h,\omega') = \frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)$ for all potential employers.

Notice that $\int_0^\infty \left(\partial G\left(\left\{\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)\right\}\right)/\partial\varepsilon_{n,s}(h,\omega)\right)d\varepsilon_{n,s}(h,\omega) = 1$, and

$$\frac{\partial G\left(\left\{\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)\right\}\right)}{\partial\varepsilon_{n,s}(h,\omega)} = \alpha\varepsilon_{n,s}(h,\omega)^{-\alpha-1}G\left(\left\{\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega)\right\}\right)w_{n,s}^H(\omega)^{-\alpha}W^\alpha,$$

where $W = \left(\sum_{n=1}^{N^H}\int_0^1 W_{n,s}{}^\alpha ds\right)^{1/\alpha}$. Combining these observations, the probability that worker h chooses employer ω, which is the integral of equation (32) over the range of possible match-specific productivities, is given by

$$\left(\frac{w_{n,s}^H(\omega)}{W_{n,s}}\right)^\beta\left(\frac{W_{n,s}}{W}\right)^\alpha. \tag{33}$$

Since this probability is independent of the identity of the worker and all workers share a common distribution from which match-specific productivities are drawn, this is the probability that any worker chooses employer ω as given in the main text by equation (2). Equivalently, because there is a continuum of workers, this probability is equal to the market share of total employment at firm ω.

The average productivity of employer ω's workers depends on the conditional distribution of their productivities. Denote this conditional distribution by $\bar{G}(z;\omega)$, where

$$\bar{G}(z;\omega) = \Pr\left[\varepsilon_{n,s}(h,\omega) < z \;\middle|\; \frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega) > \varepsilon_{n',s'}(h,\omega') \;\forall\omega',n',s'\right]$$

$$= \frac{\Pr\left[\varepsilon_{n,s}(h,\omega) < z \quad \text{and} \quad \frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega) > \varepsilon_{n',s'}(h,\omega') \;\forall\omega',n',s'\right]}{\Pr\left[\frac{w_{n,s}^H(\omega)}{w_{n',s'}^H(\omega')}\varepsilon_{n,s}(h,\omega) > \varepsilon_{n',s'}(h,\omega') \;\forall\omega',n',s'\right]}.$$

The denominator of this equation is just the unconditional choice probability in equation (33). The numerator is the integral of equation (32) over $\varepsilon_{n,s}(h,\omega)$ from zero to z. Therefore, the conditional distribution of ω's workers' productivities is

$$\bar{G}(z;\omega) = \exp\left(-z^{-\alpha}w_{n,s}^H(\omega)^{-\alpha}W^\alpha\right).$$

Using this conditional distribution, the expected productivity of a given worker h at ω is

given by

$$\mathbb{E}[z \mid h \text{ chooses } \omega] = \int_0^\infty \alpha z^{-\alpha} w_{n,s}^H(\omega)^{-\alpha} W^\alpha \exp\left(-z^{-\alpha} w_{n,s}^H(\omega)^{-\alpha} W^\alpha\right) \mathrm{d}z$$

$$= \frac{W}{w_{n,s}^H(\omega)} \int_0^\infty x^{-1/\alpha} \exp(-x) \mathrm{d}x$$

$$= \frac{W}{w_{n,s}^H(\omega)} \Gamma(1 - 1/\alpha), \tag{34}$$

where the second equality uses the change of variables $x = z^{-\alpha} w_{n,s}^H(\omega)^{-\alpha} W^\alpha$, and $\Gamma(1 - 1/\alpha)$ is the gamma function evaluated at $1 - 1/\alpha$.

Because the probability that a worker chooses ω is independent across workers, effective labor supply to the firm is the product of three terms: the probability that the firm is chosen, given by equation (33); the expected productivity of a worker conditional on choosing the firm, given by equation (34); and the number of workers, L^H. This product is given by equation (6) in the main text.

A.2 Proof of Proposition 1

Suppose that the two firms under comparison sell to both markets. The argument below extends to either alternative case with the firms selling to only one of the product markets. For the first statement of the proposition, suppose that $\phi_{n,s}^H(\omega) > \phi_{n,s}^H(\omega')$ but that the statement is untrue. If $y_{n,s}^H(\omega) \leq y_{n,s}^H(\omega')$, then $\ell_{n,s}^H(\omega) \leq \ell_{n,s}^H(\omega')$ since labor is the only input in production. If instead $w_{n,s}^H(\omega) \leq w_{n,s}^H(\omega')$, then $\ell_{n,s}^H(\omega) \leq \ell_{n,s}^H(\omega')$ because, from equation (6), relative effective employment at any two firms from the same local labor market depends only on their relative wage offers. Lastly, if $\mu_{n,s}^L(\omega) \geq \mu_{n,s}^L(\omega')$, then $\mathcal{S}_{n,s}^L(\omega) \leq \mathcal{S}_{n,s}^L(\omega')$ since differences in markdowns depend on differences in employment shares. Therefore, if the statement is false, it must be the case that $\mathcal{S}_{n,s}^L(\omega) \leq \mathcal{S}_{n,s}^L(\omega')$. If ω' hires more workers compared to ω, then it must be true that $w_{n,s}^H(\omega) \leq w_{n,s}^H(\omega')$ and $\mu_{n,s}^L(\omega) \geq \mu_{n,s}^L(\omega')$. Therefore,

$$\frac{w_{n,s}^H(\omega')}{\mu_{n,s}^L(\omega')} \geq \frac{w_{n,s}^H(\omega)}{\mu_{n,s}^L(\omega)}.$$

The ratio of the wage over the markdown is just the marginal effective hiring cost of the firm, which, under profit maximization, implies that marginal revenue products of effective labor in Home must satisfy

$$\frac{p_{n,s}^H(\omega')\phi_{n,s}^H(\omega')}{\mu_{n,s}^H(\omega')} \geq \frac{p_{n,s}^H(\omega)\phi_{n,s}^H(\omega)}{\mu_{n,s}^H(\omega)}.$$

However, this inequality implies that marginal revenue in Home at ω' must be larger than marginal revenue at ω, since

$$\frac{p_{n,s}^{H}(\omega')/\mu_{n,s}^{H}(\omega')}{p_{n,s}^{H}(\omega)/\mu_{n,s}^{H}(\omega)} \geq \frac{\phi_{n,s}^{H}(\omega)}{\phi_{n,s}^{H}(\omega')} > 1$$

by assumption. But if marginal revenue in Home is larger at ω' than at ω, the same must be true for marginal revenue in Foreign. Since marginal revenue is strictly decreasing in the amount sold by firms, this implies that ω' sells a smaller amount to both Home and Foreign. If this is true, however, then ω' must be producing a smaller amount than ω, or $y_{n,s}^{H}(\omega) < y_{n,s}^{H}(\omega')$. Since labor is the only input in production, ω must hire more effective labor, pay higher wages per efficiency unit, and offer a lower markdown. Therefore, the first statement in the proposition must be true.

Now suppose the second statement of the proposition is untrue. If $p_{n,s}^{H}(\omega) \geq p_{n,s}^{H}(\omega')$ and $p_{n,s}^{*H}(\omega) \geq p_{n,s}^{*H}(\omega')$, then, since demand curves are downward sloping, ω' must sell more to both national product markets than does ω. Were this the case, then ω' must hire more workers than ω since they produce a larger amount of output with a smaller total factor productivity. But this has already been shown to be incompatible with the first statement of the proposition, so this cannot be true.

Alternatively, the second statement could be false if the ranking of the two firms' prices are different in each national product market. Suppose that $p_{n,s}^{H}(\omega) < p_{n,s}^{H}(\omega')$ but that $p_{n,s}^{*H}(\omega) \geq p_{n,s}^{*H}(\omega')$. Since relative market shares and hence markups for these two firms depend only on the relative prices, this implies that $(p_{n,s}^{H}(\omega)/\mu_{n,s}^{H}(\omega)) < (p_{n,s}^{H}(\omega')/\mu_{n,s}^{H}(\omega'))$ and $(p_{n,s}^{*H}(\omega)/\mu_{n,s}^{*H}(\omega)) \geq (p_{n,s}^{*H}(\omega')/\mu_{n,s}^{*H}(\omega'))$. However, these two inequalities are not simultaneously compatible with profit maximization, since they imply that for at least one of the firms the marginal revenue of allocating a unit of output to Home is not equal to the marginal revenue of allocating it to Foreign. Therefore, the second statement of the propsition must be true.

The assumption that both firms sell to the same set of product markets is critical for the result to hold. As discussed in Section 2.7, marginal costs of production are increasing. As a result, if ω sells to both markets while ω' only sells to a single market, it is possible that the marginal costs of production for ω are larger than for ω'. While the first statement of the proposition continues to be true, the second statement need not be true because the price charged by ω' in the market to which it sells may be smaller than the price charged by ω in that market. When this is the case, the markup charged by ω' would be larger than the markup charged by ω in the market to which both firms sell.

A.3 Market-Level Distortions

In this appendix, I derive the local labor market-level markdowns in equation (29). Expressing this markdown in terms of the local labor market wage index $W_{n,s}$ requires an index of effective labor $L_{n,s}$ that satisfies

$$W_{n,s}L_{n,s} \equiv \sum_{\omega=1}^{\Omega_{n,s}^H} w_{n,s}^H(\omega)\ell_{n,s}^H(\omega).$$

This implies that $L_{n,s} = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \ell_{n,s}^H(\omega)^{\frac{\beta}{\beta-1}}\right)^{\frac{\beta-1}{\beta}}$. Next, total revenues earned by employers in a local labor market are

$$TR_{n,s} = \sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} p_{n,s}^H(\omega)c_{n,s}^H(\omega) + \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}} p_{n,s}^{*H}(\omega)c_{n,s}^{*H}(\omega)$$

$$= \sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} y_{n,s}^H(\omega)p_{n,s}^H(\omega)\frac{c_{n,s}^H(\omega)}{y_{n,s}^H(\omega)} + \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}} y_{n,s}^H(\omega)p_{n,s}^{*H}(\omega)\frac{c_{n,s}^{*H}(\omega)}{y_{n,s}^H(\omega)}.$$

Rearranging and substituting in equations (13), (24), and (25), these aggregate revenues can be rewritten as

$$TR_{n,s} = W_{n,s}L_{n,s}\left(\sum_{\omega=1}^{\hat{\Omega}_{n,s}^H} \frac{\mathcal{S}_{n,s}^L(\omega)}{d_{n,s}^H(\omega)}\frac{c_{n,s}^H(\omega)}{y_{n,s}^H(\omega)} + \sum_{\omega=1}^{\hat{\Omega}_{n,s}^{*H}} \frac{\mathcal{S}_{n,s}^L(\omega)}{d_{n,s}^{*H}(\omega)}\frac{\tau c_{n,s}^{*H}(\omega)}{y_{n,s}^H(\omega)}\right),$$

which implies that the local labor market marginal revenue product of effective labor is

$$MRPL_{n,s} := \frac{\mathrm{d}TR_{n,s}}{\mathrm{d}L_{n,s}} = \frac{TR_{n,s}}{L_{n,s}}.$$

Finally, dividing the wage index $W_{n,s}$ by $MRPL_{n,s}$ implies equation (29).

A.4 Proof of Proposition 2

To ease notation, suppose that every firm sells to both markets.[86] Aggregate effective labor is[87]

$$
L = \left(\int_0^1 \sum_{n=1}^{N^H} L_{n,s}^{\frac{\alpha}{\alpha-1}} \, \mathrm{d}s \right)^{\frac{\alpha-1}{\alpha}}.
$$

Using the production function in equation (13) and output market clearing constraint in equation (14), aggregate productivity Φ can be expressed as

$$
\Phi := C/L = \left(\int_0^1 \sum_{n=1}^{N^H} \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \left(\frac{c_{n,s}^H(\omega)/C}{\phi_{n,s}^H(\omega)} + \frac{\tau c_{n,s}^{*H}(\omega)/C}{\phi_{n,s}^H(\omega)} \right)^{\frac{\beta}{\beta-1}} \right)^{\frac{\alpha(\beta-1)}{\beta(\alpha-1)}} \mathrm{d}s \right)^{-\frac{\alpha-1}{\alpha}}. \tag{35}
$$

Let D and $D_{n,s}$ denote the aggregate and local labor market total distortions in Home, respectively. Defining the aggregate distortion as $D := \frac{W/P}{\Phi}$ and the market-level distortion as $D_{n,s} := \frac{W_{n,s}/P_s}{\Phi_{n,s}}$, under Assumption 1 aggregate productivity can be rewritten as

$$
\Phi = \left(\int_0^1 \sum_{n=1}^{N^H} \left((\mathcal{S}_{n,s}^L)^{-\frac{\theta}{\alpha}} \left(\frac{D_{n,s}}{D} \right)^{\theta} \Phi_{n,s}^{\theta-1} \right)^{\frac{\alpha}{\alpha-1}} \mathrm{d}s \right)^{\frac{\alpha-1}{\alpha} \frac{1}{\theta-1}}, \tag{36}
$$

where local labor market productivity $\Phi_{n,s}$ is

$$
\Phi_{n,s} = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \mathcal{S}_{n,s}^L(\omega)^{-\frac{\gamma}{\beta}} \phi_{n,s}^H(\omega)^{\gamma-1} \left[\left(\frac{d_{n,s}^H(\omega)}{D_{n,s}} \right)^{\gamma} + \tau^{1-\gamma} \left(\frac{d_{n,s}^{*H}(\omega)}{D_{n,s}} \right)^{\gamma} \right] \right)^{\frac{\beta}{\beta-1} \frac{1}{\gamma-1}}. \tag{37}
$$

In an environment where distortions are constant across firms and markets, $d_{n,s}^H(\omega) = d_{n,s}^{*H}(\omega) = D_{n,s} = D$. In this case, aggregate productivity is

$$
\Phi^{\bar{d}} = \left(\int_0^1 \sum_{n=1}^{N^H} \left((\mathcal{S}_{n,s}^{L,\bar{d}})^{-\frac{\theta}{\alpha}} \left(\Phi_{n,s}^{\bar{d}} \right)^{\theta-1} \right)^{\frac{\alpha}{\alpha-1}} \mathrm{d}s \right)^{\frac{\alpha-1}{\alpha} \frac{1}{\theta-1}}, \tag{38}
$$

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[86]This implies that $\Omega_{n,s}^H = \hat{\Omega}_{n,s}^H = \hat{\Omega}_{n,s}^{*H}$ and $\Omega_{n,s}^{*F} = \hat{\Omega}_{n,s}^{*F} = \hat{\Omega}_{n,s}^F$. Under Assumptions 1 and 2, this proof is easily extended to a setting where some firms sell to only one market as long as the sets of firms selling to each market is exogenous.

[87]This result also holds when aggregate productivity is defined in terms of total labor L^H rather than total effective labor L, since $L = \lambda_\Gamma L^H$.

where

$$\Phi_{n,s}^{\bar{d}} = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \left(\mathcal{S}_{n,s}^{L,\bar{d}}(\omega)^{-\frac{\gamma}{\beta}} \phi_{n,s}^H(\omega)^{\gamma-1} \left[1 + \tau^{1-\gamma} \right] \right)^{\frac{\beta}{\beta-1}} \right)^{\frac{\beta-1}{\beta} \frac{1}{\gamma-1}}, \tag{39}$$

and $\mathcal{S}_{n,s}^{L,\bar{d}}$ and $\mathcal{S}_{n,s}^{L,\bar{d}}(\omega)$ are the local labor market and firm-level shares of labor when distortions are constant, respectively. These are also the first best levels of aggregate and local labor market productivities that a planner would choose if it were subject to the iceberg trade costs and upward sloping labor supply curves. Heterogeneity in distortions causes some firms to be too large and other firms to be too small relative to the planner's allocation. When $\alpha < \beta$, more productive firms are too small relative to their less productive local competitors. If instead $\alpha > \beta$, more productive firms are too large relative to their less productive local competitors. Moving to an environment with constant distortions alleviates this source of allocative inefficiency. However, as can be seen in the experiments in Section 5.1, with a fixed number of firms and with variable markups, aggregate productivity need not be smaller with variable markdowns than with constant markdowns when $\alpha > \beta$.

Because workers have idiosyncratic match-specific productivities, such a move to a constant distortion environment implies a novel tradeoff reflected in the $\mathcal{S}_{n,s}^L(\omega)^{-\frac{\gamma}{\beta}}$ and $\left(\mathcal{S}_{n,s}^L \right)^{-\frac{\theta}{\alpha}}$ terms in the above equations. Focusing on the former, the inclusion of this term in the local labor market productivity implies that a negative effect of increasing the size of an employer is the reduced average match-specific productivity of workers. Intuitively, shifting workers to a given employer can have a negative effect on aggregate productivity because some of those workers would be more productive at a different employer.

That the exponent of this term depends on γ and β highlights how aggregate productivity depends on a balance between love-of-variety in preferences and workers' match-specific productivities. As γ increases, varieties from the same sector become closer substitutes for one another and the local labor market productivity index increases if more labor is allocated to the most productive firm in the market. As β increases, workers' match-specific productivities become more similar on average across employers in a given local labor market, so local labor market productivity increases by shifting workers towards the most productive firms in the market.

B Data Appendix

This appendix describes the sample selection criteria for the ASI data and the crosswalks used to map import data into Indian four-digit sectors.

The ASI samples are from all plants that are listed as registered manufacturers. In the estimation sample, I include all plants that report the variables necessary to construct labor costs, value added, sales shares, and employment and that report zero export revenues. Labor costs are measured as total wages paid to all employees and any non-wage benefits reported. I include wages for all employees because the non-wage benefits cannot be apportioned to different categories of workers (i.e., production workers and managers) in a consistent way across plants. Value added is measured according to guidelines in the ASI documentation. Sales shares are constructed using data on revenues of all firms selling in a four-digit sector and the share of Indian firms in total sectoral sales once imports are calculated. Employment is measured in terms of mandays worked as this is the primary unit used in the ASI for recording the quantity of labor used. As the ASI is designed as a representative survey rather than a census, I use sample weights to compute the total sales of Indian firms in a sector and total employment in a district-sector labor market. I exclude firms from the sample that report negative labor costs or sales or have gross value added that is smaller than their labor costs. Finally, I restrict the sample to plants in manufacturing sectors, i.e., they have four-digit NIC-2008 codes between 1010 and 3300, inclusive. Of the 111,433 observations across the two cross-sectional surveys, $55,770$ have usable data for each variable listed above, meet these restrictions, and have a current status that is not recorded as being deleted from the ASI sampling frame or non-existent. Of those plants, $50,460$ are non-exporters included in the baseline regression specification.

To measure the total size of Indian sectoral product markets, I use import data from UN Comtrade at the six-digit product level and a series of crosswalks to measure the import share within each sector. The import data are available at the six-digit HS 2002 classification level for the year 2008 and at the six-digit HS 2007 classification level for the year 2009. I first map the 2008 data into the HS 2007 classification level using a crosswalk provided by the UN Statistics Division.[88] The HS 2007 product-level data can be mapped into the Central Product Classification 2.0 (CPC2) using another UN provided crosswalk.[89] In this mapping, some HS 2007 codes map into multiple CPC2 codes. To avoid double counting, I assume that the imports using HS 2007 codes are equally split across the corresponding CPC2 codes. With imports measured at the CPC2 level, I use a final crosswalk provided by the UN to map CPC2 codes into International Standard Industrial Classification Revision 4 (ISIC 4) industry-level codes.[90] As with the previous mapping, some CPC2 codes map into multiple ISIC 4 codes. I allocate these imports to the ISIC 4 codes by splitting them evenly

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[88]This crosswalk is available at https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp

[89]This crosswalk can be found at https://unstats.un.org/unsd/classifications/Family/Detail/1073

[90]This crosswalk is available at https://unstats.un.org/unsd/classifications/Family/Detail/27

across the relevant industry-level codes. With import data at the ISIC 4 industry level, the total size of Indian four-digit NIC-2008 sectors can be calculated since, as noted in the ASI documentation, these NIC-2008 codes are identical to the ISIC 4 codes.

C   Model Extensions

C.1   Employer Choice with Non-Pecuniary Benefits

This appendix describes a variant of the model of employer choice developed in Section 2.1 where workers have non-pecuniary taste shocks for working at different employers rather than match-specific productivity shocks. This model extends the framework developed in Thisse and Toulemonde (2015) and Card et al. (2018). Workers are still endowed with a unit of labor that they supply inelastically to their employer. However, the productivity of that labor is the same for every worker at every employer. Employers are differentiated from each other from the perspective of workers by an additional utility term that does not depend on the wage offer of the employer. Suppose that indirect utility of a Home worker h that chooses employer ω in location-sector pair (n, s) is

$$v_{n,s}(h, \omega) = \frac{w_{n,s}^H(\omega) + \Pi}{P} + \varepsilon_{n,s}(h, \omega),$$

where the first term is the real income available to the worker for purchasing consumption goods and the second term is an additive non-pecuniary taste shock.[91] For brevity, denote by $\bar{v}_{n,s}(\omega) = \left(w_{n,s}^H(\omega) + \Pi\right)/P$ the component of indirect utility that is common to all workers at employer ω. Suppose the taste shocks are drawn independently across workers from the following nested type I extreme value distribution

$$G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\sum_{n=1}^{N^H}\left(\int_0^1\left(\sum_{\omega=1}^{\Omega_{n,s}^H}\exp\left(-\frac{\varepsilon_{n,s}(h, \omega)}{\beta}\right)\right)^{\beta/\alpha}\mathrm{d}s\right)^{\alpha}\right).$$

Given the above specification of workers' idiosyncratic preferences, the probability that any given worker h chooses to work for employer ω is given by

$$\check{\mathcal{S}}_{n,s}^L(\omega) = \frac{\exp\left(\bar{v}_{n,s}(\omega)/\beta\right)}{\exp\left(\bar{V}_{n,s}/\beta\right)}\frac{\exp\left(\bar{V}_{n,s}/\alpha\right)}{\exp\left(\bar{V}_n/\alpha\right)}\frac{\exp\left(\bar{V}_n\right)}{\exp\left(\bar{V}\right)},$$

[91] This formulation follows Thisse and Toulemonde (2015). If the taste shock is instead multiplicative, the model is as in Card et al. (2018). In this alternative, the value of the taste shock to the worker depends on their wage level and aggregate profits and price levels.

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where

$$\bar{V}_{n,s} = \beta \ln \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \exp \left(\bar{v}_{n,s}(\omega)/\beta \right) \right)$$

$$\bar{V}_n = \alpha \ln \left(\int_0^1 \exp \left(\bar{V}_{n,s}/\alpha \right) \mathrm{d}s \right)$$

$$\bar{V} = \ln \left(\sum_{n=1}^{N^H} \exp \left(\bar{V}_n \right) \right).$$

One key difference between the model in the main text and this alternative framework is that with the same number of parameters, this alternative model implies that there are asymmetric patterns of worker substitution across (n,s)-pairs because these local labor markets are nested within sectoral labor markets. One cost of the Fréchet distribution assumption in the main text is that it requires an additional parameter to maintain the same nested structure.[92]

While the version of the model with non-pecuniary motives for choosing different employers offers more flexibility in terms of the patterns of worker substitution for the same number of parameters, the cost of such a model is that labor supply elasticities depend on general equilibrium variables. In this model, labor supply is just the product of the probability that a worker chooses employer ω and the national labor endowment, i.e., $\ell_{n,s}^H(\omega) = \check{\mathcal{S}}_{n,s}^L(\omega) L^H$. The resulting labor supply elasticity is given by

$$\eta_{n,s}^L(\omega) = \frac{w_{n,s}^H(\omega)}{P} \left[\frac{1}{\beta} \left(1 - \mathcal{S}_{n,s}^L(\omega) \right) + \frac{1}{\alpha} \mathcal{S}_{n,s}^L(\omega) \right],$$

where $\mathcal{S}_{n,s}^L(\omega) = \left(\exp \left(\bar{v}_{n,s}(\omega)/\beta \right) / \exp \left(\bar{V}_{n,s}/\beta \right) \right)$ is the share of workers that choose location-sector pair (n,s) that work for employer ω.

Labor supply elasticities now have two components that reflect the fact that workers care about both the wage and the non-pecuniary benefit at their employer. The first factor represents workers substitution patterns with regards to firms' wage offers while the second represents substitution patterns with regards to the non-pecuniary benefit. When firms offer higher wages, then, all else being equal, they face more elastic labor supply. However, since an increase in an employers' wage, holding fixed all other firms' wages, implies that their labor market share also increases, the relationship between wages and labor supply elasticities need not be monotonic. When $\alpha > \beta$ in this model, workers view jobs from the same location-sector pair as being closer substitutes than those from different local labor

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[92]The Fréchet version with three nests is presented in Appendix C.3.

markets.[93] In this case, labor supply elasticities are not strictly decreasing in the employers' wage.

Estimating the labor supply elasticity parameters in this alternative framework is more complicated because the elasticities depend on the aggregate price index. Therefore, the elasticity parameters would need to be estimated in the full equilibrium of the model using a simulated method of moments estimation strategy.

A similar problem arises if the specification of indirect utility follows the model in Card et al. (2018). In this case, indirect utility can be written as $v_{n,s}(h,\omega) = \bar{v}_{n,s}(\omega)\varepsilon_{n,s}(h,\omega)$. Assuming that the log of the taste shocks are drawn from the same nested type I extreme value distribution as above, the market share of total employment at employer ω is

$$\check{\mathcal{S}}_{n,s}^{L}(\omega) = \frac{\bar{v}_{n,s}(\omega)^{(1/\beta)}}{\bar{\bar{V}}_{n,s}^{(1/\beta)}} \frac{\bar{\bar{V}}_{n,s}^{(1/\alpha)}}{\bar{\bar{V}}_{n}^{(1/\alpha)}} \frac{\bar{\bar{\bar{V}}}_{n}}{\bar{\bar{\bar{V}}}},$$

where

$$\bar{\bar{V}}_{n,s} = \left(\sum_{\omega=1}^{\Omega_{n,s}^{H}} \bar{v}_{n,s}(\omega)^{(1/\beta)} \right)^{\beta}$$

$$\bar{\bar{\bar{V}}}_{n} = \left(\int_{0}^{1} \bar{\bar{V}}_{n,s}^{1/\alpha} \mathrm{d}s \right)^{\alpha}$$

$$\bar{\bar{\bar{V}}} = \left(\sum_{n=1}^{N^{H}} \bar{\bar{\bar{V}}}_{n} \right).$$

The corresponding labor supply elasticity is

$$\eta_{n,s}^{L}(\omega) = \frac{w_{n,s}^{H}(\omega)}{w_{n,s}^{H}(\omega) + \Pi} \left[\frac{1}{\beta} \left(1 - \mathcal{S}_{n,s}^{L}(\omega) \right) + \frac{1}{\alpha} \mathcal{S}_{n,s}^{L}(\omega) \right],$$

where $\mathcal{S}_{n,s}^{L}(\omega) = \left(\bar{v}_{n,s}(\omega)/\bar{\bar{V}}_{n,s} \right)^{1/\beta}$. In this case, the labor supply elasticity depends on the aggregate per-capita dividend payment. Therefore, the estimation strategy used in the main text to recover the structural parameters cannot be used, as the labor supply elasticity depends on a general equilibrium variable.

---

[93]That is, the structural parameters here are the inverse of the corresponding parameters in the main text.

C.2 Labor Supply with Fixed Effects

Suppose that workers' match-specific productivities are drawn from

$$G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\lambda \sum_{n=1}^{N^H} \lambda_n \int_0^1 \lambda_{n,s} (\sum_{\omega=1}^{\Omega_{n,s}^H} \lambda_{n,s}(\omega)\varepsilon_{n,s}(h,\omega)^{-\beta})^{\alpha/\beta} \mathrm{d}s\right),$$

where λ, λ_n, $\lambda_{n,s}$, and $\lambda_{n,s}(\omega)$ are fixed productivity shifters that adjust the scale of the distribution. This alternative productivity distribution implies (after repeating the steps in Appendix A.1) that the probability that a worker h chooses employer ω is

$$\frac{\lambda_{n,s}(\omega)w_{n,s}^H(\omega)^\beta}{W_{n,s}^\beta} \frac{\lambda_{n,s}W_{n,s}^\alpha}{W_n^\alpha} \frac{\lambda_n W_n^\alpha}{W^\alpha},$$

where

$$W_{n,s} = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} \lambda_{n,s}(\omega)w_{n,s}^H(\omega)^\beta\right)^{1/\beta}$$

$$W_n = \left(\int_0^1 \lambda_{n,s}W_{n,s}^\alpha \mathrm{d}s\right)^{1/\alpha}$$

$$W = \left(\sum_{n=1}^{N^H} \lambda_n W_n^\alpha\right)^{1/\alpha}.$$

The average productivity of ω's workers is now

$$\lambda^{1/\alpha} \frac{W}{w_{n,s}^H(\omega)} \Gamma(1 - 1/\alpha).$$

Labor supply can be written as

$$\ell_{n,s}^H(\omega) = w_{n,s}^H(\omega)^{\beta-1} W_{n,s}^{\alpha-\beta} \Lambda_{n,s}(\omega),$$

where $\Lambda_{n,s}(\omega) = \lambda_{n,s}(\omega)\lambda_{n,s}\lambda_n \lambda^{1/\alpha} W^{1-\alpha}\lambda_\Gamma L^H$ is an endogenous labor supply shifter that is perceived as a constant by employer ω. The formula for a firm's labor supply elasticity given in equation (18) remains unchanged. Adding these fixed effects introduces additional exogenous sources of workers' comparative advantage. Furthermore, if these fixed effects are specific to workers in each country, they enable an investigation of how differences across countries in workers' patterns of comparative advantage affect trade patterns and other outcomes. This type of comparative advantage has been studied in Galle et al. (2018) and Lee (2020) (these papers also allow for the shape parameters of the distribution of worker productivities to

be country-specific). Finally, the particular fixed effects presented in this appendix are an example of how to incorporate additional flexibility into the model. Alternative models with different nesting patterns are also possible.

C.3 Labor Supply with Additional Nests

This appendix describes two extensions to the labor supply model in the main text that allow for an additional nest in order to break the symmetric pattern of worker substitution across location-sector pairs. The first alternative assumes that workers' match-specific productivities are nested as follows: employers within an (n, s)-pair, (n, s)-pairs within sector s, and sectors within location n. Suppose that the distribution of match-specific productivities is

$$G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\sum_{n=1}^{N^H} \left(\int_0^1 (\sum_{\omega=1}^{\Omega_{n,s}^H} \varepsilon_{n,s}(h,\omega)^{-\beta})^{\alpha/\beta} \mathrm{d}s\right)^{\xi/\alpha}\right),$$

where the new parameter, ξ, governs the dispersion of productivity draws across sectors within locations. If $\xi = \alpha$, this distribution collapses to the one in the main text. If $\xi < \alpha$, this distribution implies that workers find jobs within the same location, regardless of their sector, as closer substitutes for one another on average as compared to jobs from different locations.

Following the steps in Appendix A.1, this distributional assumption implies that the probability that worker h chooses employer ω is

$$\left(\frac{w_{n,s}^H(\omega)}{W_{n,s}}\right)^\beta \left(\frac{W_{n,s}}{W_n}\right)^\alpha \left(\frac{W_n}{W}\right)^\xi,$$

where wage indices are given by

$$W_{n,s} = \left(\sum_{\omega=1}^{\Omega_{n,s}^H} w_{n,s}^H(\omega)^\beta\right)^{1/\beta}$$

$$W_n = \left(\int_0^1 W_{n,s}{}^\alpha \mathrm{d}s\right)^{1/\alpha}$$

$$W = \left(\sum_{n=1}^{N^H} W_n{}^\xi\right)^{1/\xi}.$$

The expected productivity of ω's workers is now $\frac{W}{w_{n,s}^H(\omega)}\Gamma(1 - 1/\xi)$, which implies that labor

supply can be written as

$$\ell_{n,s}^H(\omega) = w_{n,s}^H(\omega)^{\beta-1} W_{n,s}{}^{\alpha-\beta} \Lambda_n,$$

where $\Lambda_n = W_n{}^{\xi-\alpha} W^{1-\xi} \Gamma(1 - 1/\xi) L^H$. While the labor supply curve is modified relative to the one used in the main text, the assumption that there is a continuum of sectors implies that the wage elasticity of labor supply remains unchanged and is given by equation (18). The reason for this is that firms, in choosing their wages, correctly take the location-level wage index W_n as a constant and only internalize the effect of their wage on the (n, s)-pair wage index $W_{n,s}$. Introducing the additional nest in this way has no effect on the relationship between market shares and market power, but requires estimation of an additional parameter to compare outcomes under oligopsony and perfect competition in labor markets.

Suppose instead that workers' match-specific productivities are drawn from

$$G(\boldsymbol{\varepsilon}(h)) = \exp\left(-\int_0^1 \left(\sum_{n=1}^{N^H} (\sum_{\omega=1}^{\Omega_{n,s}^H} \varepsilon_{n,s}(h,\omega)^{-\beta})^{\alpha/\beta}\right)^{\xi/\alpha} \mathrm{d}s\right),$$

where ξ now governs the dispersion of productivity draws across locations within a sector. When $\xi < \alpha$, workers view jobs from the same sector as closer substitutes, on average, to each other than jobs from different sectors, regardless of where those jobs are located.

Choice probabilities are now given by

$$\left(\frac{w_{n,s}^H(\omega)}{W_{n,s}}\right)^{\beta} \left(\frac{W_{n,s}}{W_s}\right)^{\alpha} \left(\frac{W_s}{W}\right)^{\xi},$$

where $W_{n,s}$ is unchanged, and

$$W_s = \left(\sum_{n=1}^{N^H} W_{n,s}{}^{\alpha}\right)^{1/\alpha}$$

$$W = \left(\int_0^1 W_s{}^{\xi} \mathrm{d}s\right)^{1/\xi}.$$

Average productivity of ω's workers is $\frac{W}{w_{n,s}^H(\omega)} \Gamma(1 - 1/\xi)$, and the labor supply curve is

$$\ell_{n,s}^H(\omega) = w_{n,s}^H(\omega)^{\beta-1} W_{n,s}{}^{\alpha-\beta} W_s{}^{\xi-\alpha} \Lambda,$$

where $\Lambda = W^{\xi-1} \Gamma(1 - 1/\xi) L^H$. In contrast with the previous alternative nesting structure, this version does change the relationship between firms' size and their market power in labor

markets. Because there is a finite number of locations and a finite number of firms in each sector, firms correctly internalize the effects of their wage choices on the sector-level wage indices W_s. The resulting wage elasticity of labor supply perceived by the firm is

$$(\beta - 1) + (\alpha - \beta)\mathcal{S}^L_{n,s}(\omega) + (\xi - \alpha)\mathcal{S}^L_{n,s}(\omega)\mathcal{S}^L_{n,s},$$

where $\mathcal{S}^L_{n,s} = (W_{n,s}/W_s)^\alpha$ is the share of workers in sector s that work in location-sector pair (n, s). The rate at which the labor supply elasticity decreases with a firm's market share is larger with this alternative nesting structure when $\xi < \alpha$, because firms internalize the effects of their size relative to the entire sector and not just relative to their location-sector pair. Furthermore, firms in larger (n, s)-pairs (within their sector) face more inelastic labor supply.

C.4 Cournot Competition: Differentiated Jobs

In this appendix, I derive price elasticities of product demand and wage elasticities of labor supply under the assumption that firms compete as Cournot oligopolists and oligopsonists. Furthermore, the assumption that workers have idiosyncratic match-specific productivities for working at different firms is maintained so that jobs are imperfect substitutes for one another. In this alternative model, firms assume that their competitors' quantity of output produced and effective labor hired is fixed and that they adjust by changing their prices and wages. As with the Bertrand model in the main text, a firm simultaneously chooses its total output produced and quantity of effective labor hired.

For deriving elasticities under Cournot competition, it is convenient to rewrite the product demand (equations (9) and (10)) and labor supply (equation (6)) curves as inverse demand and supply curves. The Home inverse product demand function facing a Home producer is

$$p^H_{n,s}(\omega) = c^H_{n,s}(\omega)^{-1/\gamma}C_s^{1/\gamma - 1/\theta}\Delta^{1/\theta},$$

while the inverse labor supply curve facing a Home producer is

$$w^H_{n,s}(\omega) = \ell_{n,s}(\omega)^{\frac{1}{\beta-1}}L_{n,s}^{\frac{1}{\alpha-1} - \frac{1}{\beta-1}}\Lambda^{\frac{-1}{\alpha-1}},$$

where $L_{n,s}$ is an index of the total effective employment in location-sector pair (n, s). This effective employment index is

$$L_{n,s} = \left(\sum_{\omega=1}^{\Omega^H_{n,s}} \ell_{n,s}(\omega)^{\frac{\beta}{\beta-1}}\right)^{\frac{\beta-1}{\beta}}.$$

The functional form for this effective employment index emphasizes the structural similarities between the CES preference model and the Fréchet-Roy labor supply model. This can also be seen by comparing the market shares. The Home sectoral product market revenue share of a Home producer is

$$\mathcal{S}_{n,s}^H(\omega) = \left(\frac{p_{n,s}^H(\omega)}{P_s}\right)^{1-\gamma} = \left(\frac{c_{n,s}^H(\omega)}{C_s}\right)^{\frac{\gamma-1}{\gamma}}.$$

The employment market share (both in terms of the share of (n, s)-pair workers that choose employer ω and the employer's share of local effective labor) is

$$\mathcal{S}_{n,s}^L(\omega) = \left(\frac{w_{n,s}^H(\omega)}{W_{n,s}}\right)^{\beta} = \left(\frac{\ell_{n,s}(\omega)}{L_{n,s}}\right)^{\frac{\beta}{\beta-1}}.$$

From the inverse product demand curve, the Home price elasticity of demand under the Cournot assumption is

$$\eta_{n,s}^H(\omega) = \left(\frac{1}{\theta}\mathcal{S}_{n,s}^H(\omega) + \frac{1}{\gamma}\left(1 - \mathcal{S}_{n,s}^H(\omega)\right)\right)^{-1}.$$

The wage elasticity of labor supply when firms compete as Cournot oligopsonists is given by

$$\eta_{n,s}^L(\omega) = \left(\frac{1}{\alpha - 1}\mathcal{S}_{n,s}^L(\omega) + \frac{1}{\beta - 1}\left(1 - \mathcal{S}_{n,s}^L(\omega)\right)\right)^{-1}.$$

As with the wage elasticity of labor supply under Bertrand competition, the Cournot elasticity takes on a functional form that is analogous to the price elasticity of demand. The relationship between firms' market shares and market power depends on the relative magnitude of α and β. If, as in the main text, $\alpha < \beta$, then larger employers face more inelastic labor supply and hence have more market power in their local labor markets.

C.5   Endogenous Market Entry

As discussed in Section 2.7, the production and pricing decisions of a firm that sells in both the Home and Foreign markets are interdependent because firms have increasing marginal costs. This feature of the model complicates market entry decisions both for a given firm and in general equilibrium and implies that equilibrium selection rules used in the literature to endogenize market entry cannot be used without amendment when firms have market power

in labor markets.[94]

Entry decisions in heterogeneous firm trade models typically rely on fixed costs specified in terms of either labor or some good, neither of which firms can affect the price of directly, as the arbiter of which firms are active in each market. In this model, there are two distinct types of assumptions. First, firms could be required to spend a fixed amount of the final good (either their domestic one or market-specific ones) to enter a market. In this case firms' costs of production would not depend on these fixed costs of production.[95] In contrast, in the second case firms could be required to hire a fixed amount of labor or use a fixed amount of their own output to enter a market, which would cause the extensive margin of entry to affect firms' costs through these fixed requirements. Suppose that the latter case holds and Home (Foreign) firms must hire a fixed amount of labor f_d (f_d^*) and f_x^* (f_x) to enter into the domestic and export markets, respectively.

Denote by $\pi_{n,s}^H(\omega, m)$ the total profits of Home firm ω that solve equation (15) when it sells to markets $m \in \{\emptyset, H, F, HF\}$, where $m = \emptyset$ implies the firm sells to neither Home nor Foreign and $m = HF$ implies they sell to both markets. The following definition gives a notion of a stable equilibrium with endogenous market entry decisions for given aggregate variables.

Definition 2. *An equilibrium is stable if for each firm ω the firm, taking as given its set of sector s product market competitiors and (n, s)-pair labor market competitiors and aggregate shifters $\{\Delta, \Delta^*, \Lambda, \Lambda^*\}$, sells to the set of markets m such that $\pi_{n,s}^j(\omega, m) \geq \pi_{n,s}^j(\omega, m')$ for any $m' \neq m$ and $j \in \{H, F\}$.*

Stability of entry decisions is a unilateral concept. Each firm chooses the markets that maximize profits and internalizes the effects of their entry decisions on sectoral price indices P_s and P_s^* and local wage indices $W_{n,s}$ or $W_{n,s}^*$. As is common in many oligopoly environments, there can be many potential stable equilibria for a given set of potentially active firms. For this reason, equilibrium selection rules are used to isolate equilibria that are uniquely

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[94]In the main text, I assume away the problem of determining the sets of firms that sell to each market by assuming they are given exogenously. I make this assumption because of the considerable increase in the complexity of endogenizing these decisions relative to other work using oligopoly models of trade, including Atkeson and Burstein (2008), Eaton et al. (2013), Edmond et al. (2015), and Gaubert and Itskhoki (2018). In an environment where these margins are endogenous, the problem of determining the optimal set of markets to sell to shares many similarities with Antràs et al. (2017). Whereas in that setting the decision to source inputs from a given market is a complement to the decision to source inputs from other markets, here the decision to sell output to a given market is a substitute for the decision to sell output to the other market. Arkolakis and Eckert (2017) offer a generalized analysis of models in which extensive margins are either complements or susbtitutes and show how solving these problems in general equilibrium is a challenging combinatorial problem. They offer an algorithm that finds a solution to the problem in general equilibrium, but the algorithm does not give a unique equilibrium.

[95]In a richer model, an input over which firms have no market power could be used, such as perhaps capital.

determined by certain properties deemed to be desirable.[96]

In an environment with perfectly competitive labor markets, the entry decisions can be solved for each national product market independently. The typical selection rule, following Atkeson and Burstein (2008), is to order firms in a sector by their total factor productivities and consider a sequential entry game that leads to a stable equilibrium in which each firm in the sector from a given country that sells to a national product market is more productive than any firm from that same country and sector that does not sell to that market.[97]

If firms have market power in labor markets, entrants into both markets must be determined simultaneously. When $f_d = 0$ for all Home firms and $f_d^* = 0$ for Foreign firms, as is the case in Atkeson and Burstein (2008), every firm sells in its domestic market and the set of exporters is endogenous. However, refinements to their equilibrium selection rule are required since one needs to determine which country's best firm makes its export entry decision first. For example, suppose that in a given sector there is a single firm in each country and consider the problem facing the Home firm. Because marginal costs are increasing, the profitability of exporting for the Home firm depends on how much it sells domestically.[98] But the amount that the Home firm sells domestically depends on whether or not the Foreign firm sells to the Home market, so the Home firm can be crowded out of exporting when the Foreign firm exports. Therefore, one needs to choose which country's firm makes its export entry decision first. When there are multiple firms in a sector in each country, this choice cannot solely depend on firms' total factor productivity rankings, since differences in the profitability of exporting for two firms from different countries depends on both their exogenous local labor market conditions and differences across countries in the product market environment.[99]

When $f_d > 0$, as in Eaton et al. (2013), Edmond et al. (2015), and Gaubert and Itskhoki (2018), entry decisions are even more complicated. Suppose that there is a single production location in each country so that within a sector each country's firms can be ranked by their productivities. With labor market power, entry into operation (i.e., selling to either market) by a firm increases competition in the labor market, which raises wages for all other firms in

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[96]For example, the property that entry by any given firm into a market is not crowded out by a less efficient firm from the same country selling there.

[97]This sequential entry game is also used in Eaton et al. (2013), Edmond et al. (2015), and Gaubert and Itskhoki (2018).

[98]To emphasize, profitability does not refer to the profits earned from the export market. Instead, profitability refers to the incremental *total* profits from entering the export market, $\pi_{n,s}^H(\omega, HF) - \pi_{n,s}^H(\omega, H)$. Profits earned from the export market must be positive for incremental profits to be positive, but this is not a sufficient condition since entering into exporting reduces profits from the domestic market.

[99]Another wrinkle with labor market power is that in a stable equilibrium it is possible that an exporter has a higher marginal cost than a firm from the same country that does not export even though the exporter has a higher total factor productivity than the non-exporter and even if the two firms being compared produce in the same (n, s)-pair.

that sector and country. Prices of these firms increase in any market to which the firms sell. For firms in the entrant's country that were exporting, this entry into operation can make exporting unprofitable.[100] Therefore, in the context of a sequential entry game one needs to check whether the entry decisions in *both* markets of firms that act earlier in the game are robust to entry of firms later in the game.

Reintroducing multiple production locations within a country adds another layer of complication to determining a stable set of entrants since entrants affect firms from their own (n, s)-pair by more than they affect other competitors within their sector. As mentioned in Section 2.4, exogenous heterogeneity in the set of local labor market competitors means firms within a country cannot be ranked only by their productivities. Furthermore, entry by a second firm that produces in an (n, s)-pair in which there is already a first firm operating can change the ranking of the first firm relative to all other firms from the entrant's country because the competition for labor from the second firm affects its local labor market competitors more closely than other firms. This makes the problem of having to check the entry decisions of previous entrants in a sequential entry game described in the last paragraph more complicated since the ranking of the previous entrants can change.

Given the intricacies in modelling market entry decisions when firms have labor market power, solving for a stable equilibrium is computationally demanding, so I leave this problem for future research.

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[100]If the entrant sells domestically, entry can make exporting unprofitable for firms from the other country, particularly if there are differences in fixed labor requirements for selling to the entrant's country. This is also true in the sequential entry game in Edmond et al. (2015) since there fixed costs of selling domestically are not necessarily the same as fixed costs of exporting. In Eaton et al. (2013) and Gaubert and Itskhoki (2018), firms from either country pay the same fixed cost to sell to a given market, so this problem does not arise.