Labor Market Power*

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Abstract

We develop a quantitative general equilibrium oligopsony model of the U.S. labor market, calibrated to Census data. Parameters governing labor market power are identified using new measures of within-state-firm, across-market differences in the response of employment and wages to state corporate tax changes. After calibrating to match 2014 measures of labor market power, we find that the consumption equivalent welfare gains associated with a Walrasian equilibrium, in which firms do not internalize their market power, range from 2.2 to 6.4 percent. Despite these large gains, labor market power has not contributed to the falling labor share. In our model, the distribution of wage-bill Herfindahls is a sufficient statistic for the aggregate labor share. We document that the employment-weighted wage-bill Herfindahl fell significantly from 1976 to 2014, increasing labor’s share of income by 2.3 percentage points. Lastly, we simulate a minimum wage hike that binds for 10.4 percent of U.S. workers, and show that lower tail income income inequality compresses by 1 log point.

JEL codes: E2, J2, J42

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1 Introduction

How competitive are U.S. labor markets? How has competition in the labor market changed over time? And what are the welfare costs of labor market power? We answer these questions by developing and estimating a general equilibrium model of oligopsony.

We depart from standard models of monopsony (inter alia Burdett and Mortensen (1998), Manning (2003), and Card, Cardoso, Heining, and Kline (2018)) by incorporating Cournot competition into a framework with a finite set of employers (e.g. Atkeson and Burstein (2008)). In our model, firms face upward sloping labor supply curves that depend on their equilibrium relative size in their labor market. In our benchmark oligopsonistic model, there are two sources of market power: (i) firms internalize their upward sloping labor supply curve and (ii) firms are non-atomistic and engage in Cournot competition. As a result a firm’s equilibrium wage is a size-dependent markdown on it’s workers’ marginal revenue product of labor.

Our model has several implications for measurement. Our theory implies that the wage-bill Herfindahl should be used to measure labor market concentration, and employment Herfindahls overstate competition. We also show that the distribution of wage-bill Herfindahls, as opposed to employment Herfindahls, is a sufficient statistic for the labor share.

We apply our measures of labor market concentration to confidential Census data. Throughout we define a labor market by a 3-digit industry within a Commuting Zone (CZ). We restrict attention to tradeable goods industries to mitigate the role of product market power. Using the Longitudinal Business Dynamics (LBD) database, we show that the wage-bill Herfindahl fell from 0.19 to 0.14 between 1976 and 2014. These estimates imply that the effective number of firms in a typical labor market was equivalent to 5.4 equally sized firms per market in 1976, and 7.2 equally sized firms per market in 2014. Are these changes in concentration important for standard macroeconomics aggregates? Our theory provides a closed-form mapping between the distribution of wage-bill Herfindahls and the labor share. We find that declining labor market concentration has increased the labor share by 2.3ppt between 1976 and 2014.

Quantification. To quantify the normative implications of our measures of labor market concentration, we estimate our model and conduct several counterfactuals. Under our assumption on strategic interaction in the market, labor market power is governed by (i) the amount of local labor market competition (number of competitors, and relative productivities), and (ii) the

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1We do note that none of our results are specific to the tradeable sector, and that the wage-bill and employment Herfindahls are monotone decreasing from 1976 to 2014 across all industries (including tradeable and non-tradeable industries).
slope of the labor supply curve and how its variation by firm size.\textsuperscript{2} We take the distribution of firms across labor markets directly from the data, and parameterize the dispersion of firm productivity to match the cross-market distribution of labor market concentration.

We estimate size-dependent labor supply elasticities directly, drawing on insights from Amiti, Itskhoki, and Konings (2016). We show that state corporate tax changes map to changes in labor demand in our framework. We then use within-state-firm, across-market differences in the response of employment and wages to state corporate tax changes (e.g. Giroud and Rauh (2019)) to estimate the size-dependent labor supply elasticities.

To understand how this variation allows us to identify size-dependent labor supply elasticities, consider the following example. Suppose firm $F$ has establishments in market $A$ and market $B$ in the state of Minnesota. In market $A$, the firm is a solo monopsonist. In market $B$, the firm is small enough to be effectively atomistic. Our empirical approach compares the wage and employment response at establishments owned by firm $F$ in market $A$ to the wage and employment response at establishments owned by firm $F$ in market $B$. The differential response identifies the size-dependency of the firms’ labor supply elasticity. Through the model, this allows us to discipline the degree of labor market power.

\textbf{Results.} With the estimated framework, we compute the consumption equivalent welfare gains of departing from the benchmark oligopsonistic equilibrium and study a counterfactual competitive equilibrium. Theoretically, we show that both wages and employment increase in the competitive equilibrium relative to the benchmark oligopsonistic equilibrium. Quantitatively, under an aggregate Frisch elasticity of labor supply of 0.5, households would be willing to give up 4.3 percent of lifetime consumption in order to attain the competitive equilibrium, even though they work 17.7 percent more.\textsuperscript{3} Our results indicate that despite the declining trend in labor market concentration, there are significant level gains from competitive reforms in the labor market.

As an application of the model, we study the effects of a minimum wage increase (\textit{inter alia} Flinn (2006) and Engbom and Moser (2017)). We introduce a minimum wage that binds for 10.4 percent of workers, equivalent to the minimum wage increase in Germany studied by Dustmann, Lindner, and Schoenberg (2019). Compared to their results, we find a similar reallocation of workers across the firm size distribution. The smallest two percent of firms exit

\textsuperscript{2}We assume Cournot competition in our benchmark equilibrium. We obtain very similar results with Bertrand competition, which is an empirically motivated assumption in many search and matching frameworks featuring wage posting (\textit{inter alia} Postel-Vinay and Robin (2002), Cahuc, Postel-Vinay, and Robin (2006), Lise and Robin (2017))

\textsuperscript{3}Under an aggregate Frisch elasticity of labor supply of 0.25, households would be willing to give up 2.2 percent of lifetime consumption in order to attain the competitive equilibrium.
while employment and wages increase at medium sized firms. In the aggregate, employment increases by 1.43 percent and welfare increases by 0.11 percent. The minimum wage has a small impact on wage inequality, driven by compression at the bottom of the distribution. The 50/10 log wage difference declines by about one point, while the 90/50 is unaffected by the policy.

**Validation.** A contribution of this paper is to establish a quantitative framework for studying market power in the labor market. With this in mind we validate model against three sets of non-targeted moments that often enter the discussion of labor market power: (1) unweighted wage-bill and employment Herfindahls, (2) wage-pass through, and (3) the firm size-wage premium.

First, we establish empirically that the market wage-bill weighted average wage-share Herfindahl and the unweighted average wage-share Herfindahl differ substantially in the data. The former—which we target in the model—is 0.14, while the latter is 0.45. Our model successfully replicates this fact, with weighted (unweighted) measures of 0.14 and 0.31. We argue that this negative covariance of market size and concentration is an important feature of the U.S. labor market. What generates this in the data and model? In the data, rural regions in the U.S. have very high wage-bill Herfindahls. In fact, 15 percent of markets have one firm, and so a wage-bill Herfindahl equal to one. However, these single-firm markets comprise only 0.4 percent of aggregate employment and are uninformative of labor market conditions faced by most U.S. households. In the model, employment in these regions is small as monopsonist pay low wages and hire few workers.

Second, we replicate the reduced form pass-through experiments in Kline, Petkova, Williams, and Zidar (2018) in the benchmark oligopsonistic equilibrium. We document a pass-through rate from value added per worker to wages of 45.8 percent. For every one dollar increase in value added per worker, the wage-bill per worker increases by 45.8 cents. Kline, Petkova, Williams, and Zidar (2018) report a pass-through rate of 31.7 percent, which, by construction, is directly comparable to our point estimate.

Third, we replicate the computations for the size-wage premium in Bloom, Guvenen, Smith, Song, and von Wachter (2018). We document a size-wage premium in the model of 0.14. Firms that are 10 percent larger pay 1.4 percent higher wages. Bloom, Guvenen, Smith, Song, and von Wachter (2018) report size-wage premiums in the Social Security Administration database that range from 0.11 in 1980 to 0.03 in 2013. Since the size wage premium in the model is closely linked to the average labor supply elasticity of the firm, we view this exercise as cross-validating both our empirical tax-shock experiments and their implications for model parameters.
Layout. This paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 provides summary statistics on the labor market concentration in the U.S. in 1976 and 2014. Section 4 lays out our model. Section 5 characterizes (i) the market level Nash equilibrium, and (ii) the economy-wide General equilibrium. In Section 6 we establish our empirical results regarding market-share dependent labor supply elasticities and use these along with concentration data to parameterize the model. Section 7 provides our key validation exercises testing the model against non-targeted moments. Section 8 presents our main quantitative welfare results. Section 9 studies the implications of declining labor market concentration for labor’s share of income. Section 10 applies the model to study the effect of a minimum wage, and Section 11 concludes.

2 Literature

Recent studies have focused on the role of market power in the product market. A number of papers have focussed on empirical measures of national sales concentration (e.g. Gutiérrez and Philippon (2016), Autor, Dorn, Katz, Patterson, and Van Reenen (2017)). While other studies have measured markups directly (De Loecker and Eeckhout, 2017). Notably, concurrent and innovative work by Rossi-Hansberg, Sarte, and Trachter (2018) document declining regional sales and employment concentration, despite rising national concentration, which is consistent with the findings in our paper.

Our main empirical contributions are to (1) measure size-dependent labor supply elasticities using state corporate tax shocks in the LBD (2) provide better measures of labor market concentration for the U.S. by computing regional wage-bill shares (as opposed to employment shares) in the U.S. Our measurement of size-dependent labor supply elasticities combines the corporate tax identification approach of Giroud and Rauh (2019) with recent advances in measuring pass-through rates from the trade literature (e.g Amiti, Itskhoki, and Konings (2014) and Amiti, Itskhoki, and Konings (2016)). By measuring the size-dependent pass-through rates of corporate tax shocks to wages and employment, we are able to provide the first estimates of size-dependent labor supply elasticities. By doing so, we contribute to a large literature which has, to date, measured labor supply elasticities of individual firms in specific contexts. This literature finds widely varying labor supply elasticities, which, when viewed alone, seem to be implausible measures of aggregate labor supply elasticities.4 Showing that firm-specific labor

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4As Manning (2011) writes when discussing the widely cited natural experiment estimates of Staiger, Spetz, and Phibbs (2010a) and others: “Looking at these studies, one clearly comes away with the impression not that it is hard to find evidence of monopsony power but that the estimates are so enormous to be an embarrassment even for those who believe this is the right approach to labour markets.”
supply elasticities vary systematically with the firm’s share of wage payments in a labor market reconciles the range of high and low labor supply elasticities found in the literature.

Recently, several studies have documented cross-sectional and time-series patterns of U.S. Herfindahls in employment Herfindahls (e.g. Benmelech, Bergman, and Kim (2018), Rinz (2018), and Hershbein et al. (2018)) and vacancies (e.g. Azar, Marinescu, Steinbaum, and Taska (2018) and Azar, Marinescu, and Steinbaum (2017)). Notably, concurrent work by Rinz (2018) documents declining regional employment Herfindahls, despite rising national employment concentration. Our contribution to this literature are (i) to measure and discuss the discrepancies between wage-bill Herfindahls and employment Herfindahls in the cross-section and over time, (ii) map these measures of concentration to labor market power through a structural model, and (iii) measure the welfare losses associated with labor market power. Moreover, we document and explain significant differences between weighted and unweighted wage-bill Herfindahl distributions which indicates that much of the concentration observed in U.S. data comes from very small rural regions of the U.S.

Our main quantitative contribution is to build a general equilibrium model of oligopsony and measure the welfare costs of current levels of U.S. labor market power. We depart from benchmark models of monopsony described in Burdett and Mortensen (1998), Manning (2003), and Card, Cardoso, Heining, and Kline (2018) by modeling a finite set of employers who engage in Cournot competition. Our framework adapts the general tools developed in Atkeson and Burstein (2008) to the labor market, extended to general equilibrium. We further depart from Atkeson and Burstein (2008) by integrating decreasing returns and capital into the framework. We show that these additional ingredients are crucial to simultaneously match the distribution of labor market concentration and labor’s share of income.

By modeling a finite set of employers, our model can be used to understand the wage and welfare effects of mergers, firm exit, and other shocks to local labor market competition. Moreover, our model has important implications for measurement. We show that the wage-bill Herfindahl, as opposed to the employment Herfindahl, is a sufficient statistic—when intermediated through other estimated parameters of the model—for labor market competition and the labor share. Moreover, the employment Herfindahl overstates labor market competition by ignoring the positive covariance between wages and employer size.

Our model features strategic complementarity between oligopsonists. Strategic complementarity is not new to the monopsony literature. The earliest models used to motivate monopsony power are based on the spatial economies of Hotelling (1990) and Salop (1979). Boal and Ransom (1997) and Bhaskar, Manning, and To (2002) provide an excellent summary of strategic complementarity in spatial models of the labor market. Relative to earlier stylized models, we
develop a quantitative general equilibrium model. Our framework incorporates firm heterogeneity, decreasing returns to scale, and general equilibrium across multiple markets, making it rich enough to be estimated on U.S. Census data and with a structure that allows us to provide estimates of counterfactual welfare losses from monopsony power.


In this section, we describe labor market concentration in 1976 and 2014 using the Longitudinal Business Database (LBD). In order to compute concentration, we must define the relevant market. We define a market to be a 3-digit NAICS industry within a Commuting Zone (CZ). Examples of adjacent 3-digit NAICS codes include subsector 323 which is ‘Printing and Related Support Activities,’ subsector 324 ‘Petroleum and Coal Products Manufacturing,’ and subsector 325 ‘Chemical Manufacturing.’ Examples of commuting zones include the collection of counties surrounding downtown Minneapolis and Chicago.\(^5\) Using our definition of a market, Printing and Related Support activities in the Minneapolis commuting zone and Chemical Manufacturing activities in the Minneapolis commuting zone are different employment markets.

To remove product market power from the analysis, we further restrict our sample to tradeable industries as identified in Delgado, Bryden, and Zyontz (2014).\(^6\) The LBD provides plant-level employment and pay annually. Our analysis aggregates plants owned by the same firm (the same firmid) within a market. Therefore an observation in our dataset is a firm-market-year (firmid by Commuting Zone by 3-digit NAICs by Year). For each observation, we compute total employment, total pay, and total pay per worker (henceforth the wage). We use the consistent 2007 NAICS codes provided by Fort and Klimek (2016) throughout the entire paper. Appendix B provides more details on the sample restrictions.

Table 1 summarizes our sample from the LBD. Panel A describes characteristics of the firm-market-year observations in our sample. The average nominal payroll was $470,900 in 1976 and $1,839,000 in 2014. Within a market, the average firm employed 37 workers in 1976 and 28 workers in 2014. The nominal payroll per worker was $12,696 in 1976 and $65,773 in 1976.

Panel B aggregates to the market level (Commuting Zone by 3-digit NAICs by Year). We consider two measures of labor market concentration: (1) the wage-bill Herfindahl, and (2) the employment Herfindahl. Let \(i\) denote the firmid and \(j\) denote the market. Let \(w_{ij}\) denote the firm’s pay per-worker in market \(j\), and let \(n_{ij}\) denote the firm’s employment in market \(j\). Equation (1) defines the wage bill Herfindahl, which is the sum of the squared wage-bill shares.

\(^5\)We provide more examples in Tables 14 and 15 in Appendix B.

\(^6\)These include the 11, 21, 31, 32, 33, and 55 2-digit NAICS industries.
As we will discuss in the model section, this is the relevant measure of market concentration according to our theory.

\[ HHI_{jn}^{wn} \equiv \sum_{i \in j} (s_{ij}^{wn})^2, \quad s_{ij}^{wn} = \frac{w_{ij}n_{ij}}{\sum_i w_{ij}n_{ij}} \]  

(1)

Equation (2) defines the employment Herfindahl. As we discuss in the model section, this measure ignores the covariance of wages and employment and consistently overstates competition.

\[ HHI_{jn}^{n} \equiv \sum_{i \in j} (s_{ij}^{n})^2, \quad s_{ij}^{n} = \frac{n_{ij}}{\sum_i n_{ij}} \]  

(2)

The unweighted wage-bill Herfindahl is equal to .45 and remains unchanged between 1976 and 2014. Likewise, the employment Herfindahl remains relatively stable, falling marginally from .43 to .42 between 1976 and 2014. The next two rows of Panel B compute the wage-bill Herfindahl and employment Herfindahl weighted by the employment share of the market. The weighted wage-bill Herfindahl is .19 in 1976 and falls significantly to .14 in 2014. Likewise, the weighted employment Herfindahl is .18 in 1976 and falls significantly to .12 in 2014.

Why is there such a large discrepancy between the weighted and unweighted Herfindahls? Approximately 14.6% of markets in 1976 and 14.7% of markets in 2014 had only 1 employer, and thus these markets had wage-bill and employment Herfindahls of 1. These outlier markets accounted for .63% and .36% of national employment in the tradeable sector in 1976 and 2014, respectively. When we compute Herfindahls weighted by employment, these sparsely populated markets are effectively ignored, and the Herfindahls decline three-fold.

Lastly, Panel C of Table 1 shows that the correlation between the number of firms in a market and the Herfindahl are negatively correlated, as expected. Let \( M_j \) denote the number of firms in a market. We compute each firm’s relative wage in the market (\( w_{rel} = \frac{w_{ij}M_j}{\sum_i w_{ij}} \)). We find that relative wage dispersion is negatively correlated with market concentration; meaning that there is more relative wage dispersion in markets with a greater number of firms. The next row shows that the employment and wage-bill Herfindahls are highly correlated, despite their level differences. Lastly, in both 1976 and 2014, high Herfindahls are correlated with small markets. This negative correlation is important for understanding why the weighted and unweighted Herfindahls are so different (Panel B).

Panel A of Figure 1 graphically illustrates the change in the weighted Herfindahl indexes. To facilitate interpretation of these Herfindahls, we plot the inverse wage-bill Herfindahl (\( \frac{1}{HHI_{jn}^{wn}} \)) and the inverse employment Herfindahl (\( \frac{1}{HHI_{jn}^{n}} \)) in Panel B of Figure 1. The Inverse Herfindahl can be interpreted as the effective number of equally sized firms competing in the market. Using
the inverse wage-bill Herfindahl, the effective number of firms in tradeable U.S. labor markets increased from 5.37 in 1976 to 7.17 in 2014. Labor market concentration has fallen according to both measures, and the effective number of firms per market has risen. In the raw data, we also see a large rise in the number of firms per market.

To map these measures of labor market concentration to welfare, we turn to our theoretic framework. The theoretic framework is also useful for informing measurement. We document that wage-bill Herfindahls are sufficient statistics for the economy’s labor share, and we explicitly measure the bias associated with measuring competition via employment Herfindahls.

Table 1: Summary Statistics, Longitudinal Employer Database 1976 and 2014

<table>
<thead>
<tr>
<th>(A) Firm-market-level averages</th>
<th>1976</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total firm pay (000s)</td>
<td>470.90</td>
<td>1839.00</td>
</tr>
<tr>
<td>Total firm employment</td>
<td>37.09</td>
<td>27.96</td>
</tr>
<tr>
<td>Pay per employee</td>
<td>$12,696</td>
<td>$65,773</td>
</tr>
<tr>
<td>Firm-level observations</td>
<td>660,000</td>
<td>810,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(B) Market-level averages</th>
<th>1976</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage-bill Herfindahl (Unweighted)</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Employment Herfindahl (Unweighted)</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>Wage-bill Herfindahl (Weighted by market’s share of total employment)</td>
<td>0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>Employment Herfindahl (Weighted by market’s share of total employment)</td>
<td>0.18</td>
<td>0.12</td>
</tr>
<tr>
<td>Firms per market</td>
<td>42.56</td>
<td>51.60</td>
</tr>
<tr>
<td>Percent of markets with 1 firm</td>
<td>14.6%</td>
<td>14.7%</td>
</tr>
<tr>
<td>National employment share of markets with 1 firm</td>
<td>0.63%</td>
<td>0.36%</td>
</tr>
<tr>
<td>Market-level observations</td>
<td>15,000</td>
<td>16,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(C) Market-level correlations</th>
<th>1976</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation of Wage-bill Herfindahl and number of firms</td>
<td>-0.22</td>
<td>-0.21</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Std. Dev. Of Relative Wages</td>
<td>-0.49</td>
<td>-0.51</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Employment Herfindahl</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Market Employment</td>
<td>-0.20</td>
<td>-0.21</td>
</tr>
<tr>
<td>Market-level observations</td>
<td>15,000</td>
<td>16,000</td>
</tr>
</tbody>
</table>

Notes: Tradeable NAICS2 codes (11,21,31,32,33,55). Market defined to be NAICS3 within Commuting Zone. Observations rounded to nearest thousand and numbers rounded to 4 significant digits according to Census disclosure rules. Firm-market-level refers to a ‘firmid by Commuting Zone by 3-digit NAICs by Year’ observation. Market-level refers to a ‘Commuting Zone by 3-digit NAICS by Year’ aggregation of observations.
4 Model

4.1 Environment

Agents. The economy consists of a representative household and a continuum of firms. Firms are heterogeneous in two dimensions. First, firms inhabit a continuum of different local labor markets indexed by $j \in [0, 1]$, with finitely many firms in each market $M_j$. Within each market $j$, firms are indexed by $i \in \{1, 2, ..., M_j\}$. Second, firms are heterogeneous in their productivity $z_{ijt} \in (0, \infty)$. Productivities are drawn from a distribution $F(z)$ which is location invariant, hence locations differ ex-ante only in $M_j$.

Goods and technology. The goods that the continuum of firms produce are perfect substitutes, and hence trade in a competitive economy-wide market. This good, which can be used for consumption or investment, is the numeraire. The technology for production takes as inputs capital $k_{ijt}$ and labor $n_{ijt}$. Let $\overline{Z}$ be the common component of productivity across firms.\(^7\) A firm then produces $y_{ijt}$ according to the production function:

$$y_{ijt} = z_{ijt} \overline{Z} \left( k_{ijt}^{1-\alpha} n_{ijt}^\alpha \right)^\gamma, \quad \alpha \in (0, 1), \quad \gamma > 0.$$  

\(^7\)As we discuss in Section 6, we will use $\overline{Z}$ to scale the equilibrium economy in order to match the average wage in the data.
The capital stock is owned by the representative household, and rented to firms in a competitive market at price $R_t$. To model imperfect labor market competition, we draw on tools developed in the trade literature (e.g. Atkeson and Burstein (2008)), which we describe below in more detail.

4.2 Household

Preferences and problem. A representative household chooses the amount of labor to supply to each firm, $n_{ijt}$, how much capital to carry into next period, $K_{t+1}$, and how much of the final good to consume $C_t$ in order to maximize their net present value of utility. Given an initial capital stock $K_0$, the household’s problem is given by

$$U_0 = \max \left\{ \sum_{t=0}^{\infty} \beta^t u \left( C_t - \frac{1}{\phi} \frac{N_t^{1+1/\phi}}{1+1/\phi} \right) : \beta \in (0,1) , \ \phi > 0 \right\},$$

where the aggregate disutility of labor supply is given by,

$$N_t = \left[ \int_0^1 \left[ \int_0^{\theta+1} N_{jt}^{\eta} \ dj \right]^{\theta \eta \phi + 1} \right]^{\phi \eta} , \ \theta > 0$$

$$N_{jt} = \left[ n_{1jt}^{\eta} + \cdots + n_{Mjt}^{\eta} \right]^{\eta \phi + 1} , \ \eta > \theta$$

and maximization is subject to the household’s budget constraint

$$C_t + \left[ K_{t+1} - (1-\delta)K_t \right] = \int_0^1 \left[ w_{1jt}n_{1jt} + \cdots + w_{Mjt}n_{Mjt} \right] dj + R_tK_t + \Pi_t,$$

$$C_t = \int_0^1 \left[ c_{1jt} + \cdots + c_{Mjt} \right] dj.$$

The return on capital, net of depreciation, is $R_t$. Firm profits, $\Pi_t$, are rebated lump sum to the household. The function $u$ is twice continuously differentiable with $u' > 0, u'' < 0$ and satisfies the Inada conditions. Consumption goods produced by firms are perfect substitutes.

Notation. Our convention is to use a bold-face font to denote indexes. Indexes are not directly observable in the raw data but can be constructed from observables. For example, the disutility of labor supply is given by $N_t$, and does not correspond to any aggregates reported by the Bureau of Labor Statistics. However, $N_t$ can be constructed from data on observed firm-level
employment, \( \{n_{ijt}\} \) from the universe of firms. If we compute an aggregate such as labor \( N_t \), this is computed as the sum \( N_t = \sum_{ij} n_{ijt} \).

**Elasticities.** The elasticities of substitution at the firm and market levels, \( \eta > 0 \) and \( \theta > 0 \), jointly play a role in the labor market power of firms. Both across and within markets, the lower the degree of substitutability, the greater the market power of firms. Below we discuss a microfoundation of the representative agent problem—presented in full in Appendix A—that delivers an exact interpretation of these parameters as governing the relative net costs to individuals of relocating within versus across markets. Where net costs incorporate positive amenities and negative commuting costs.

Across-market substitutability \( \theta \) stands in for mobility costs across markets, which are often estimated to be significant (e.g. Kennan and Walker (2011)). As substitutability across markets nears zero (\( \theta \to 0 \)), the representative household chooses an equal division of workers across markets such that \( N_{jt} = N_{j't} \), \( \forall j, j' \in [0,1] \), in order to minimize aggregate labor disutility \( N_t \). This limiting case results in the largest degree of monopsony power for firms, since the allocation of employment is perfectly inelastic market by market, and does not respond to market wages. As substitutability approaches infinity, the representative household chooses to send all workers to the market with the highest wage index, eroding the market power of firms outside that market.

Within-market substitutability \( \eta \) stands in for across firm mobility costs such as the job search process (e.g. Burdett and Mortensen (1998)), some degree of non-genericity of accumulated human capital (e.g. Becker (1962)), or heterogeneity in worker-firm specific amenities or commuting costs. As substitutability within a market approaches zero (\( \eta \to 0 \)), the representative household chooses an equal division of workers across firms such that \( n_{ijt} = n_{i'jt} \), \( \forall i, i' \in \{1, 2, ..., M_j\} \), in order to minimize the within-market disutility of labor supply \( N_{jt} \). This generates the largest degree of monopsony power for firms. As substitutability approaches infinity, the representative household chooses to send all workers allocated to the market to the firm that pays the highest wage. The local labor market is then perfectly competitive and all active firms would set equal wages.

**Labor supply.** Given the distribution of wages \( \{w_{ijt}\} \), we take the household’s first order conditions for labor, \( \{n_{ijt}\} \). Combining these first order conditions yields the following system
of upward sloping labor supply curves, where these labor supply curves are firm specific:

\[
n_{ijt} = \bar{\phi} \left( \frac{w_{ijt}}{W_{jt}} \right)^{\eta} \left( \frac{W_{jt}}{W_t} \right)^{\theta} W_t^{\theta} \), \text{ for all } i, j
\] (3)

We define the market wage index \( W_{jt} \) and the aggregate wage index \( W_t \) as follows. \( W_t \) and \( W_{jt} \) are the numbers that satisfy

\[
W_{jt} N_{jt} := \sum_{i \in j} w_{ijt} n_{ijt} \), \quad W_t N_t := \int_0^1 W_{jt} N_{jt} \, dj.
\]

These definitions imply that

\[
W_{jt} = \left[ \sum_{i \in j} w_{ijt}^{1 + \eta} \right]^{\frac{1}{1 + \eta}} \), \quad W_t = \left[ \int_0^1 W_{jt}^{1 + \theta} \, dj \right]^{\frac{1}{1 + \theta}}. \quad (4)
\]

Holding the market and aggregate wage indexes constant, equation (3) implies that labor supply to a firm increases when that firm offers a higher wage. In the remainder of the paper, we will focus on the inverse labor supply function:

\[
w_{ijt} = \phi^{-\frac{1}{\phi}} \left( n_{ijt} \right)^{\frac{1}{\eta}} \left( \frac{N_{jt}}{N_t} \right)^{\frac{1}{\theta}} N_t^{\frac{1}{\theta}}
\]

(5)

We lay out the remaining first order conditions for consumption and capital in Appendix C.

**Micro-foundation.** In Appendix A we micro-found our preference specification. In the model presented, labor supply curves to firms are derived under a representative agent with nested-CES preferences. The exact same supply system described by equations (3) and (4) can be obtained in an environment with heterogeneous workers making independent decisions.

The environment is as follows. Each worker decides which firm to work for and how many units of labor to supply. In making this decision, each worker minimizes the total disutility of attaining some level of income. Total disutility is the logarithm of hours supplied and features an additive worker specific disutility of supplying labor to each firm. The worker specific disutility of supplying labor to each firm is drawn from a correlated Gumbel in which \( \eta \) governs the within-market correlation of the draws and \( \theta \) governs the cross-market correlation of draws. Similar formulations of individual decisions have been used to model firm labor supply in competitive markets by Card, Cardoso, Heining, and Kline (2018) and Borovickova and
Shimer (2017). Our contribution is to adapt existing results in the discrete choice literature to demonstrate equivalence with our ‘nested-CES’ representative household specification, and to set up the problem in oligopsonistic markets. We also establish that the same supply system obtains in the steady-state of a dynamic discrete-choice setting where workers separate from their firm with some probability \( \lambda \) each period and firms compete for the separated workers in a dynamic oligopoly.

Beyond unifying alternative approaches, this micro-foundation is useful in that it delivers an intuitive interpretation of \( \eta \) and \( \theta \). Let \( \xi_{ij} \) be a worker’s realization of the random disutility of supplying labor to firm \( ij \). In the discrete choice setting, increasing \( \theta \) decreases the overall variance of \( \xi_{ij} \) in the economy. If \( \theta \) is high, a worker has a high likelihood that their lowest draws of non-wage utility \( \zeta_{ij} \) are close together, increasing the competition on wages between firms. Increasing \( \eta \) increases the covariance of \( \xi_{ij} \) within markets. If \( \eta \approx \theta \), then the smallest realizations of a worker’s disutilities are more likely to be bunched within a particular \( j \), so the worker compares wages within \( j \). If \( \eta \approx \theta \), then the smallest realizations of a worker’s disutilities are more likely to be spread across sectors, so the worker compares wages across \( j \)’s. In the former case, a productive firm in sector \( j \) is shielded from competing with the continuum of firms outside of its market. This provides a direct mapping of the model back to the originally proposed sources of monopsony power by Robinson (1933).

An important feature of the model is that workers are not confined to particular markets. This micro-foundation makes clear that workers are able to move across markets. The limitation that markets do impose, however, is on the boundary of the strategic behavior of firms. Within markets firms are strategic, but with respect to firms in other markets, firms are price takers. We now describe the behavior of the firm.

### 4.3 Firms

Firms draw idiosyncratic productivities \( z_{ijt} \) from a distribution \( F(z) \). Within a market, we assume that \( M_j \) firms engage in either Cournot or Bertrand competition. Firms take the aggregate wage index \( W_t \) and the aggregate labor supply \( N_t \) as given. In order to maximize profits,

---

8 We adapt arguments from the product market case considered by Verboven (1996). In that paper the author establishes the equivalence of nested-logit and nested-CES, extending the results of Anderson, De Palma, and Thisse (1987) who established an equivalence between single sector CES and single sector logit.

9 To quote in full: “We have seen in what circumstances the supply of a factor to an industry may be less than perfectly elastic. The supply of labor to an individual firm might be limited ... there may be a certain number of workers in the immediate neighborhood and to attract workers from further afield it may be necessary to pay a way equal to what they can earn at home plus their fares to and fro; or there may be workers attached to the firm by preference or custom... Or ignorance may prevent workers from moving from one firm to another.” In our micro-foundation of the CES supply structure the \( \xi_{ij} \) terms could reasonably be interpreted in any of these ways.
firms choose how much capital to rent, \( k_{ijt} \), and either the number of workers to hire \( n_{ijt} \) (i.e. Cournot competition) or wages \( w_{ijt} \) (i.e. Bertrand competition). Our baseline calibration assumes Cournot competition and Appendix C explores Bertrand competition. Therefore, profits are given by,

\[ \pi_{ijt} = \max_{n_{ijt}, k_{ijt}} Z \left( k_{ijt}^{1-\alpha} n_{ijt}^\alpha \right)^\gamma - R_t k_{ijt} - w_{ijt} n_{ijt} \text{, subject to (5)}. \]

We optimize over capital and rewrite the profit choice over \( n_{ijt} \). To facilitate derivations, we define three new parameters:

\[ \tilde{\alpha} := \frac{\alpha \gamma}{1 - (1 - \alpha) \gamma} \text{, } \tilde{z}_{ijt} := \left[ 1 - (1 - \alpha) \right] \left( \frac{(1 - \alpha) \gamma}{R_t} \right) \left( \frac{1}{\tilde{z}_{ijt}} \right)^{\frac{1}{1 - (1 - \alpha) \gamma}}, \text{ } \tilde{z} := \frac{1}{Z^{1 - (1 - \alpha) \gamma}} \]

With this notation, the firm’s optimization problem can be rewritten as follows:

\[ \pi_{ijt} = \max_{n_{ijt}} \tilde{z}_{ijt} \tilde{z} n_{ijt}^{\tilde{\alpha} - 1} - w_{ijt} n_{ijt} \text{, subject to (5).} \quad (6) \]

We define the marginal revenue product of labor to be \( MRPL_{ijt} = \tilde{\alpha} \tilde{z}_{ijt} \tilde{z} n_{ijt}^{\tilde{\alpha} - 1} \). The first order conditions of this problem yield the solution that the wage is a markdown \( (\mu_{ijt}) \) below the marginal revenue product of labor:

\[ w_{ijt} = \mu_{ijt} MRPL_{ijt} \text{, } \mu_{ijt} \in (0, 1). \]

Figure 2 describes firm level optimality. Decreasing returns to scale in production yields a downward sloping marginal revenue product of labor. Upward sloping labor supply generates an upward sloping marginal cost curve that lies above labor supply. Adding an additional unit of labor costs more than just the wage, since the firm must increase the wage paid to all workers. Therefore, choosing \( n_{ijt} \) such that marginal revenue equals marginal cost necessarily yields a markdown of wages relative to the marginal revenue product.

In equilibrium, this markdown is determined by the equilibrium elasticity of the firms’ inverse labor supply curve \((1/\epsilon_{ijt})\). From the inverse labor supply curve (5), this is straightforward to compute. Given competitor’s labor demands,

\[ \frac{1}{\epsilon_{ijt}} := \frac{d \log w_{ijt}}{d \log n_{ijt}} = \frac{1}{\eta} + \left( \frac{1}{\theta} - \frac{1}{\eta} \right) \frac{d \log N_{jt}}{d \log n_{ijt}} \text{, } s_{ijn} = \frac{w_{ijt} n_{ijt}}{\sum_{k \in j} w_{kjt} n_{kjt}} \]
In the nested-CES case the Nash equilibrium inverse labor supply elasticity is therefore linear in the sectoral wage bill share of the firm, $s_{ijt}^{wn}$. The results is that markdowns are given by

$$
\mu_{ijt} = \frac{\epsilon_{ijt}}{\epsilon_{ijt} + 1}, \quad \epsilon_{ijt} = \left[ \frac{1}{\eta} (1 - s_{ijt}^{wn}) + \frac{1}{\theta} s_{ijt}^{wn} \right]^{-1}
$$

Appendix C includes the derivations of these expressions.

Returning to Figure 2, panel A describes the equilibrium outcomes for a low productivity firm. Relative to the high productivity firm in panel B, the low productivity firm has a lower $MRPL_{ij}$. In equilibrium it has both lower wages, $w_{ij}^*$, and lower employment, $n_{ij}^*$, so its equilibrium share of wage payments, $s_{ij}^{wn^*}$, is smaller. With a smaller share of the labor market, its inverse elasticity of labor supply is larger. This flatter inverse supply curve yields a narrower markdown at its optimal labor demand, $n_{ij}^*$.

### 4.4 Equilibrium

We will focus on a steady state equilibrium and drop time subscripts from this point forward. The economy-wide vector of wage-bill shares, $s^{wn} = \{s_j^{wn}\}$ where $s_j^{wn} = (s_{ij}^{wn}, \ldots, s_{Mij}^{wn})$, is the only object that needs to be determined in a steady state equilibrium. A steady state equilibrium is a vector of wage-bill shares which yield wages and employment consistent with the vector of wage-bill shares. The steady state equilibrium interest rate is determined by the discount factor.

**Definition** A steady state equilibrium is a vector of wage-bill shares $s^{wn}$ and an interest rate $r$, that are
consistent with firm optimization, and that clear the labor market, capital market, and final good market.

5 Characterization

We discuss the properties of the equilibrium in two steps. First, we describe the role of labor market power in determining employment and wages at the sectoral level. Second, we describe the role of labor market power in determining employment and wages at the aggregate level.

5.1 Sectoral equilibrium

In this section, we explore several properties of the model. Lemma 5.1 summarizes the relationship between wage-bill shares, labor supply elasticities, and markdowns. If \( \mu_i < \mu_j \) our convention will be to describe \( \mu_i \) as having a greater mark-down.

**Lemma 5.1.** Firms with greater market shares face lower labor supply elasticities, \( \frac{\partial \epsilon_{ij}}{\partial s_{ij}} < 0 \) and impose greater mark-downs, \( \frac{\partial \mu_{ij}}{\partial s_{ij}} < 0 \).

**Size dependence of labor supply elasticities.** Under the maintained assumption that \( \eta > \theta \), large firms face lower labor supply elasticities (lower \( \epsilon_{ij}(s'_{ij}) < \epsilon_{ij}(s_{ij}) \) so long as \( s'_{ij} > s_{ij} \)). This negative correlation between the firm’s size (measured using the wage-bill share) and its labor supply elasticity will be used to infer \( \eta \) and \( \theta \) in Section 6. Single firm monopsonists face a labor supply elasticity of \( \theta \), whereas infinitesimally small firms face a labor supply elasticity of \( \eta \).

To further explore Lemma 5.1, Figures 3 and 4 plot examples of the equilibrium shares, markdowns, wages, and employment as we progressively add more productive employers to the market. We begin with a single low-productivity firm (10th percentile of the productivity distribution), then we add a mid-productivity firm (50th percentile of the productivity distribution), and then we add a high-productivity firm (90th percentile of the productivity distribution). Figure 3 studies the case of oligopsonistic competition (\( \eta > \theta \)). The red dot labeled ‘1 firm’ corresponds to the market equilibrium when there is only a single low-productivity employer. Panel (A) shows that the wage bill share is 1, panel (B) shows that the markdown on the marginal product of labor is approximately 73% since they face the lower labor supply elasticity of \( \theta \) (see Lemma C.2), panel (C) shows that the marginal revenue productivity of the firm is close to zero, and panel (D) shows that the corresponding employment of the firm is close to zero. The blue dotted line label ‘2 firms’ corresponds to the market equilibrium when we add a mid-productivity firm to this market. This is a duopsony. The low-productivity firm’s wage bill share plummets to roughly 2%, whereas the firm with mid-productivity effectively takes over...
the market. The low-productivity firm’s markdown declines to 50%, as they now face a higher labor supply elasticity that is closer to $\eta$ than $\theta$. Panel (C) and (D) show that the wage increases and employment declines at the original low-productivity firm. Lastly, the green dotted line labeled ‘3 firms’ corresponds to the market equilibrium when a high-productivity firm is added to the market. The markdown at the low- and mid-productivity firms declines significantly. The largest firm has the greatest markdown (panel (B)), but pays more (panel (C)) and employs more workers (panel (D)).

Figure 4 repeats this exercise under the assumption of monopsonistic competition ($\eta = \theta$). The equilibrium labor supply elasticity becomes a constant, $\bar{\epsilon} = \eta$, and the equilibrium markdown is also a constant, $\bar{\mu} = \eta / (\eta + 1)$). Thus, there are no strategic complementarities. Panel (A) shows that lower productivity firms’ wage bill shares still fall as more productive competition is added. However, the markdown is constant as illustrated in panel (B). Panels (C) and (D) show that the wages of the lower productivity firms are non-responsive to additional competition; as a result, employment declines at the lower productivity firms as more productive firms are added.
In this section, we characterize the general equilibrium labor share, aggregated across all markets. We define the wage-bill Herfindahl index as follows:

$$HHI_{jn} \equiv \sum_{i \in j} (s_{ijn})^2$$ (7)

Define the inverse wage-bill Herfindahl index as $IH_{jn} = \frac{1}{HHI_{jn}}$. Let the wage-share of a market be defined by $s_{jn} = \frac{\sum_i w_{ijn} n_{ij}}{\sum_i w_{ijn} d_{ij}}$. Define the wage-share weighted wage-bill Herfindahl as follows:

$$\tilde{IHI}_{jn} = \left[ \int_0^1 s_{jn} (IH_{jn})^{-1} dj \right]^{-1}$$

Under Cournot competition, the labor share is determined by a harmonic wage-share weighted mean of the inverse wage-bill Herfindahl index:

$$LS = \frac{\tilde{\alpha} \tilde{IHI}_{jn}}{\left( \frac{\eta+1}{\eta} \right) \tilde{IHI}_{jn} + \left( \frac{\theta+1}{\theta} - \frac{\eta+1}{\eta} \right)}$$ (8)
Under the assumption of stable preferences, this expression implies that wage-bill Herfindahl dynamics are a sufficient statistic for labor share dynamics.

Lemma 5.2.

(i) Under oligopsonistic competition \((\eta > \theta)\) the labor share is an increasing function of the wage-bill weighted inverse Herfindahl index, \(\frac{\partial LS}{\partial \tilde{IHI}_{wn}} > 0\). Under monopsonistic competition \((\eta = \theta)\), the labor share is independent of the wage-bill weighted inverse Herfindahl index.

(ii) Suppose \(\text{cov}(w_{ij}, n_{ij}) > 0\), then the wage-bill Herfindahl is strictly larger than the employment Herfindahl, \(HHI_{wn}^j \equiv \sum_{i \in j} (s_{wn}^i)^2 > HHI_n^j \equiv \sum_{i \in j} (s_{n}^i)^2\).

Lemma 5.2 has important implications for measurement. Part (i) of Lemma 5.2 implies that labor’s share of income is determined by the wage-bill Herfindahl, as defined in equation 7. Our theory rationalizes why the wage-bill Herfindahl can be used as a proxy for both local and national labor shares. Our model-implied measure of labor market concentration differs from most existing studies. For example, recent work by Benmelech, Bergman, and Kim (2018) and Rinz (2018) use employment Herfindahls. Independent of our model framework, employment Herfindahls overstate competition since they ignore the positive relationship between wages and employment, i.e. the positive size-wage premium. For the same reason that sales concentration is used instead of quantity concentration to describe product market competitiveness, wage-bill Herfindahls capture relevant information about labor market competitiveness contained in the covariance of wages with employment. Part (ii) of Lemma 5.2 states this formally. So long as there is a size-wage premium, which is a robust feature of most economies (e.g. Brown and Medoff (1989), Lallemand, Plasman, and Rycx (2007), Bloom, Guvenen, Smith, Song, and von Wachter (2018)), Lemma 5.2 shows that using an employment Herfindahl overstates competition.

6 Calibration

We calibrate the model in two steps. The first step uses size-dependent labor supply elasticities to infer the degree of within-market (\(\eta\)) and cross-market (\(\theta\)) labor substitutability. We estimate these parameters outside of general equilibrium. We then calibrate the remaining parameters to target relevant moments included in Table 1.

As discussed in Section 5, the model predicts that the labor supply elasticity faced by firms varies by their market share. If this variation were known in the data, one could use it to precisely pin down the elasticities of substitution of labor within and across sectors. Existing
work estimating labor supply elasticities to firms has focused either on specific markets with their own idiosyncrasies (e.g. Webber (2016), Staiger, Spetz, and Phibbs (2010b)), or in well identified responses to very small variations in wages (Arindrajit Dube, 2019; Dube, Cengiz, Lindner, and Zipperer, 2019). A contribution of this paper is to estimate the size-labor supply elasticity relationship through a novel natural experiment.

To obtain $\eta$ and $\theta$ we measure average labor supply elasticities faced by firms of varying market shares. To estimate the labor supply elasticities faced by firms, we use state level corporate tax shocks (Giroud and Rauh (2019)). Corporate tax shocks affect firms’ demand for workers because accounting profits and economic profits differ. The mapping of our model to the data will not require us to take a stance on the transmission mechanism from corporate taxes to productivity, but in Appendix F we show how corporate tax rates map to productivity shocks in our framework. As in Section 3, we define a market to be a 3-digit NAICS industry within a commuting zone.\(^{10}\)

We rely on state-level corporate tax variation to isolate changes in labor demand, and so we restrict our analysis to C-Corporation (C-Corp) firms in the Longitudinal Business Database (LBD) from 2002 to 2014. As discussed in Section 3, in order to remove product market power from the analysis, we restrict our sample to tradeable industries as identified in Delgado, Bryden, and Zyontz (2014) and listed in Appendix B. We aggregate plants owned by the same firm (the same \textit{firmid}) within a market, and therefore an observation in this analysis is a firm-market-year (\textit{firmid} by Commuting Zone by 3-digit NAICs by Year). For each firm-market-year observation, we compute the wage as total pay per worker.

Our identification strategy is to compare how plants owned by firms in different markets within the same state respond to corporate taxes. To isolate this variation, we use firm by state fixed effects and we further restrict our sample to firms operating in at least two markets. Let $i$ denote the firm identifier (\textit{firmid}), let $j$ denote industry (3-digit NAICS), let $k$ denote commuting zone, and let $t$ denote the year. Let $y_{ijkt}$ denote the outcome of interest at the firm-market-year level (\textit{firmid} by Commuting Zone by 3-digit NAICS by Year), such as employment, total pay, or the wage. Let $\alpha_{is(k)}$ denote firm by state fixed effects.\(^{11}\) Let $\delta_j$, $\psi_k$, and $\mu_t$ respectively denote industry, commuting zone, and year fixed effects. Let $\tau_{s(k)t}$ denote state-level taxes and let $s_{wn}^{ijkt}$ denote the wage-bill share of an individual firm in industry $j$ and commuting zone $k$ in year $t$.

We estimate specifications of the following form:

$$\log n_{ijkt} = \alpha_{is(k)} + \delta_j + \phi_k + \mu_t + \beta \tau_{s(k)t} + \psi s_{wn}^{ijkt} + \gamma \left( \tau_{s(k)t} \times s_{wn}^{ijkt} \right) + \epsilon_{ijkt}$$  \hspace{1cm} \text{(9)}

\(^{10}\)See Appendix B for more details

\(^{11}\)In this exercise only, we exclude commuting zones that straddle multiple states since there are conceptual issues with how to define the market.
### Table 2: Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate Tax Rate in Percent ($\tau_{s(k)t}$)</td>
<td>7.14</td>
<td>3.19</td>
</tr>
<tr>
<td>Change in Corporate Tax Rate</td>
<td>0.05</td>
<td>0.78</td>
</tr>
<tr>
<td>Total Pay At Firm (Thousands)</td>
<td>2148</td>
<td>19010</td>
</tr>
<tr>
<td>Total Employment At Firm</td>
<td>37.99</td>
<td>215.2</td>
</tr>
<tr>
<td>Log Wage</td>
<td>3.58</td>
<td>0.73</td>
</tr>
<tr>
<td>Wage Bill Share ($s_{ijkt}^{wn}$)</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>HHI - Wage Bill</td>
<td>0.10</td>
<td>0.16</td>
</tr>
<tr>
<td>HHI - Employment</td>
<td>0.09</td>
<td>0.15</td>
</tr>
<tr>
<td>Employment Share</td>
<td>0.03</td>
<td>0.11</td>
</tr>
<tr>
<td>Number of Firms per Market</td>
<td>1345</td>
<td>2813</td>
</tr>
<tr>
<td>Log Number of Firms per Market</td>
<td>5.56</td>
<td>2.01</td>
</tr>
<tr>
<td>Log Total Employment (log $n_{ijkt}$)</td>
<td>2.39</td>
<td>1.32</td>
</tr>
<tr>
<td>Log Wage (log $w_{ijkt}$)</td>
<td>3.58</td>
<td>0.71</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>4,425,000</td>
</tr>
</tbody>
</table>

**Notes:** Tradeable C-Corps from 2002 to 2014.

#### 6.1 Summary Statistics: C-Corps

Table 2 includes summary statistics for the sample at the firm-market-year level. There are 4.5 million observations. The average corporate tax rate in our dataset is 7.14%. The average worker earns $56,541 (=2,148,000/37.99). The average firm has 38 employees and 3% of the wage-bill share of the market. The standard deviation is equal to .12, indicating that most markets have wage bill shares well below .2. In their typical market, the wage-bill Herfindahl indicates that they face competition equivalent to roughly 10.0 equal sized firms (=1/.10). As the theory predicts, the employment Herfindahl overstates competition and indicates that they face competition equivalent to roughly 11.1 equal sized firms (=1/.09). In a typical market, the average employment share of a firm is 3%. The number of firms in a market is highly skewed; while the average is 1345, the average of the log of the number of firms per market implies only 260 (=exp(5.56)) firms per market.

#### 6.2 Empirical Analysis: Size-Dependent Labor Supply Elasticities

Table 3 estimates equation (9), progressively adding covariates and fixed effects. Column (1) regresses firm-market-year employment on corporate taxes $\tau_{s(k)t}$ including on year and commuting zone fixed effects. The coefficient on $\tau_{s(k)t}$ is an elasticity since $\tau_{s(k)t}$ is a percent. The
coefficient on $\tau_{s(k)t}$ indicates that a 1 percent increase in corporate taxes results in a 0.18% reduction in employment measured at the firm-market-year level. Column (2) adds fixed effects for industry and firm by states. Column (3) includes an interaction between a firm’s market wage-bill share $s_{ijkl}$ and the corporate tax rate $\tau_{s(k)t}$. Column (4) includes the interaction terms as well as the firm-state and industry fixed effects. The coefficient on the wage-bill share is positive and significant, indicating that larger firms have greater employment. The positive and significant interaction between the tax rate and share indicate that the pass-through rate of taxes to employment is weaker for firms with larger market shares. To interpret the interaction terms, it is useful to think about specific values of the wage-bill share and tax rates. The mean wage-bill share is 0.03 and one standard deviation is 0.11. By rule-of-thumb, roughly 68% of our observations have market wage-bill shares less than 0.14. The elasticity of employment with respect to the corporate tax rate is $-0.18\%$ for a firm with a wage bill share of 0.03 and $-0.14\%$ for a firm with a wage bill share of 0.14, roughly 20% smaller.

Columns (5) through (8) of Table 3 use the wage as the dependent variable. We focus our attention on column (8) which includes firm-state and industry fixed effects. In this column, the elasticity of wages with respect to the corporate tax rate is $-0.32\%$ for a firm with a wage bill share of 0.03 and $-0.15\%$ for a firm with a wage bill share of 0.14, roughly 50% smaller.

Table 4 repeats the analysis using employment and wages measured one year after the corporate tax rate. We estimate equation (9) using year $t+1$ employment, log $n_{ijkl+1}$, as the dependent variable. In column (1), the coefficient on $\tau_{s(k)t}$ indicates that a 1 percent increase in corporate taxes in year $t$ results in a 0.16% reduction in employment in year $t+1$ measured at the firm-market-year level. Column (2) adds fixed effects for industry and firm-by-state. Column (3) includes an interaction between a firm’s market wage-bill share $s_{ijkl}$ and the corporate tax rate $\tau_{s(k)t}$. Column (4) is our benchmark employment specification, and it includes the interaction terms as well as the firm by state and industry fixed effects. The elasticity of employment with respect to the corporate tax rate is $-0.27\%$ ($= -0.00321 + 0.0172 \times 0.03$) for a firm with a wage bill share of 0.03 and $-0.08\%$ for a firm with a wage bill share of 0.14, roughly 70% smaller.

Columns (5) through (8) of Table 4 use the year $t+1$ wage as the dependent variable. We focus our attention on column (8), which is our benchmark wage specification. In this column, the elasticity of wages with respect to the corporate tax rate is $-0.08\%$ for a firm with a wage bill share of 0.03 and $-0.04\%$ for a firm with a wage bill share of 0.14, roughly half as large.

The employment and wage responses to corporate tax shocks allow us to estimate the labor supply elasticities faced by firms of varying size. Let $\beta^w$ and $\gamma^w$ denote the coefficients on taxes and the interaction term from column (4) in Table 4. Let $\beta^n$ and $\gamma^n$ denote the coefficients
Table 3: Regression of contemporaneous market level employment and wages on state-level corporate taxes, stratified by market wage-bill share.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(1) log $n_{ijkt}$</th>
<th>(2) log $n_{ijkt}$</th>
<th>(3) log $n_{ijkt}$</th>
<th>(4) log $n_{ijkt}$</th>
<th>(5) log $w_{ijkt}$</th>
<th>(6) log $w_{ijkt}$</th>
<th>(7) log $w_{ijkt}$</th>
<th>(8) log $w_{ijkt}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau_s(k)t$</td>
<td>-0.00180*** (0.000618)</td>
<td>-0.00177*** (0.000644)</td>
<td>-0.00226*** (0.000757)</td>
<td>-0.00201*** (0.000584)</td>
<td>-0.000181*** (0.000782)</td>
<td>-0.000187*** (0.000588)</td>
<td>-0.000198*** (0.000588)</td>
<td>-0.000175*** (0.000588)</td>
</tr>
<tr>
<td>$s_{wn}$</td>
<td>3.263*** (0.0801)</td>
<td>2.085*** (0.0467)</td>
<td>0.081*** (0.000495)</td>
<td>0.0158*** (0.000495)</td>
<td>0.0168*** (0.000495)</td>
<td>0.0168*** (0.000495)</td>
<td>0.0168*** (0.000495)</td>
<td>0.0168*** (0.000495)</td>
</tr>
<tr>
<td>$s_{wn} \times \tau_s(k)t$</td>
<td>0.081*** (0.0112)</td>
<td>0.0158*** (0.000495)</td>
<td>0.0168*** (0.000495)</td>
<td>0.00310*** (0.000749)</td>
<td>0.00310*** (0.000749)</td>
<td>0.00310*** (0.000749)</td>
<td>0.00310*** (0.000749)</td>
<td>0.00310*** (0.000749)</td>
</tr>
</tbody>
</table>

Year FE | Y | Y | Y | Y | Y | Y | Y | Y
Commuting Zone FE | Y | Y | Y | Y | Y | Y | Y | Y
Industry FE | N | Y | N | Y | N | Y | N | N
Firm \times State FE | N | Y | N | Y | N | Y | N | Y

P-Value Summed Coefs | 0.0718 | 0.0434 | 0.0283 | 0.00675
R-squared | 0.036 | 0.872 | 0.132 | 0.879 | 0.112 | 0.819 | 0.122 | 0.82
Round N | 4,425,000 | 4,425,000 | 4,425,000 | 4,425,000 | 4,425,000 | 4,425,000 | 4,425,000 | 4,425,000

Notes: *** p<0.01, ** p<0.05, * p<0.1 Standard errors clustered at State \times year level. Tradeable C-Corps from 2002 to 2014.

on taxes and the interaction term from column (8) in Table 4. Our main specification can be differentiated to obtain share dependent elasticities of wages and employment with respect to corporate taxes:

\[
\frac{\partial \log w_{ijkt}}{\partial \tau_s(k)t} = \beta^w + \gamma^w s_{ijkt} \quad , \quad \frac{\partial \log n_{ijkt}}{\partial \tau_s(k)t} = \beta^n + \gamma^n s_{ijkt}
\]  

Taking the ratio of the expressions in (10) yields the labor supply elasticity as a function of a firm’s market share. Let the market-share-dependent labor supply elasticity be denoted $\varepsilon(s_{ijkt})$:

\[
\varepsilon(s_{ijkt}) = \frac{\partial \log n_{ijkt}}{\partial \log w_{ijkt}} = \frac{\partial \log n_{ijkt} / \partial \tau_s(k)t}{\partial \log w_{ijkt} / \partial \tau_s(k)t} = \frac{\beta^n + \gamma^n s_{ijkt}}{\beta^w + \gamma^w s_{ijkt}}
\]  

Figure 5 plots the labor supply elasticity $\varepsilon(s_{ijkt})$ using our estimated coefficients. We will focus on the year $t+1$ estimates for reasons explained below. The smallest firms face a labor supply elasticity of 3.5, whereas extremely large firms with a market share of 14% or more face a labor supply elasticity of 2. The bulk of variation in our data lies between wage bill shares of approximately zero and 0.14 (one standard deviation above the mean). These labor supply elasticities imply markdowns on marginal revenue products of labor of roughly 23% at small firms and roughly 33% at large firms. Our year $t+1$ estimates imply lower elasticities of labor supply.
Table 4: Regression of next year’s market level employment and wages on state-level corporate taxes, stratified by market wage-bill share.

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1 Standard errors clustered at State × year level. Tradeable C-Corps from 2002 to 2014.

The year $t + 1$ estimates yield higher labor supply elasticities than the year $t$ estimates. As discussed in Boal and Ransom (1997), there are strong theoretic reasons to believe that short-run elasticities are smaller than long-run elasticities due to various forms of path-dependence (Boal and Ransom (1997) consider a reduced form case were the wage is a function of labor today and labor yesterday). Boal and Ransom (1997) argue that many researchers use short-run elasticities which may overstate the degree of monopsony power. Therefore our benchmark specifications are column (4) and column (8) of Table 4, which we will refer to as the long run elasticities.

6.3 Calibration of Labor Market Substitutability ($\eta$ and $\theta$)

We estimate the within-market substitutability $\eta$ and the across-market substitutability $\theta$ to match the relationship between labor supply elasticity and firm size. Through the lens of our theory, the labor supply elasticity is given by:

$$\varepsilon_{ij} = \left[ s_{ij} \frac{1}{\theta} + (1 - s_{ij}) \frac{1}{\eta} \right]^{-1}$$

(12)

For any $s_{ijkl}$, our regression model (equation (11)) implies the tuple $\{\varepsilon(s_{ijkl}), s_{ijkl}\}$. These empirical tuples of labor supply elasticities and wage-bill shares map to $\{\varepsilon_{ij}, s_{ij}\}$ in equation (12). This empirical relationship between wage-bill shares and labor supply elasticities (equation (11)) in conjunction with the model-implied relationship between wage-bill shares and labor supply

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
<td>$\tau_{ik}$</td>
</tr>
<tr>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
<td>$s_{ijkl}$</td>
</tr>
<tr>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
<td>$s_{ijkl} \times s_{ijkl}$</td>
</tr>
<tr>
<td>Year FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Commuting Zone FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Industry FE</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Firm × State FE</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>P-Value</td>
<td>Summed Coeff</td>
<td>0.0711</td>
<td>0.0427</td>
<td>0.0273</td>
<td>0.00752</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>4,425,000</td>
<td>4,425,000</td>
<td>4,425,000</td>
<td>4,425,000</td>
<td>4,425,000</td>
<td>4,425,000</td>
<td>4,425,000</td>
</tr>
</tbody>
</table>

Table 4: Regression of next year’s market level employment and wages on state-level corporate taxes, stratified by market wage-bill share.

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1 Standard errors clustered at State × year level. Tradeable C-Corps from 2002 to 2014.

The year $t + 1$ estimates yield higher labor supply elasticities than the year $t$ estimates. As discussed in Boal and Ransom (1997), there are strong theoretic reasons to believe that short-run elasticities are smaller than long-run elasticities due to various forms of path-dependence (Boal and Ransom (1997) consider a reduced form case were the wage is a function of labor today and labor yesterday). Boal and Ransom (1997) argue that many researchers use short-run elasticities which may overstate the degree of monopsony power. Therefore our benchmark specifications are column (4) and column (8) of Table 4, which we will refer to as the long run elasticities.

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$$\varepsilon_{ij} = \left[ s_{ij} \frac{1}{\theta} + (1 - s_{ij}) \frac{1}{\eta} \right]^{-1}$$

(12)

For any $s_{ijkl}$, our regression model (equation (11)) implies the tuple $\{\varepsilon(s_{ijkl}), s_{ijkl}\}$. These empirical tuples of labor supply elasticities and wage-bill shares map to $\{\varepsilon_{ij}, s_{ij}\}$ in equation (12). This empirical relationship between wage-bill shares and labor supply elasticities (equation (11)) in conjunction with the model-implied relationship between wage-bill shares and labor supply
elasticiest (equation (12)) allow us to identify the within-market and across-market degrees of substitution. In fact, only two labor supply elasticity and wage-bill share tuples are necessary for identification. For instance, the implied labor elasticity at the mean market share observed in the data, \{\varepsilon(\bar{s}_{ijkt}), \bar{s}_{ijkt}\}, and the implied labor elasticity one standard deviation above the mean, \{\varepsilon(\bar{s}_{ijkt} + \sigma(s_{ijkt})), \bar{s}_{ijkt} + \sigma(s_{ijkt})\}, provide two equations (i.e. (12) evaluated at each tuple) and two unknowns \{\eta, \theta\}.

In Table 5 we provide our preferred point estimates. We use non-linear least squares to estimate \eta and \theta using the observed tuples \{\varepsilon(s_{ijkt}), s_{ijkt}\}. Figure 5 plots the model-fitted values of labor supply elasticities versus the data. Overall, the model does well at matching the declining labor supply elasticity by firm market share; however, the model implies a convex labor supply elasticity schedule, whereas the data is concave.

6.4 Calibration of other parameters

We assume that the distribution of productivity, \tilde{z}_{ijt}, is log-normal with mean 1 and standard deviation \sigma_2. The mean of the distribution is irrelevant since we will scale the distribution
Table 5: Non-linear regression estimates of substitutability based on equation (12)

<table>
<thead>
<tr>
<th></th>
<th>(1) Year t</th>
<th>(2) Year t+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within market substitutability, $\eta$</td>
<td>2.09</td>
<td>3.74</td>
</tr>
<tr>
<td>Across market substitutability, $\theta$</td>
<td>0.31</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Notes: We use an evenly spaced grid of labor shares on $[s, \bar{s}] = [0.0025, 0.14]$ (within 1 standard deviation of the mean wage-bill share), in conjunction with equation (11) to generate 56 tuples of labor supply elasticities and wage-bill shares, $\{\epsilon(s_{ijkl}), s_{ijkl}\}$ (one for every grid point). We then use these predicted values as data for $\{\epsilon_i, s_i\}$ to provide non-linear regression estimates of $\eta$ and $\theta$ using equation (12). Column (1) uses estimates from Columns (4) and (8) in Table 3 and Column (2) uses estimates from Columns (4) and (8) in Table 4.

Table 6: Distribution of firms across markets, $M_j \sim G(M_j)$

<table>
<thead>
<tr>
<th>Distribution of number of firms $M_j$</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data (LBD, 2014)</td>
<td>51.6</td>
<td>264.9</td>
<td>29.9</td>
</tr>
<tr>
<td>Model</td>
<td>51.6</td>
<td>264.9</td>
<td>28.7</td>
</tr>
</tbody>
</table>

by $\bar{z}$ in order to match average firm size (measured in terms of employees). We fit the 2014 distribution of firms across markets, $M_j \sim G(M_j)$, to be a mixture of Pareto distributions. Table 6 summarizes the model’s fit of firms per market relative to the data. Appendix G provides additional details. Lastly, in the simulations, we assume there are 5,000 markets, and we verify that our results are not sensitive to this choice.

We set $\eta = 3.74$ and $\theta = .76$ based on our long-run ‘Year t+1’ estimates in Table 5. The ‘Year t+1’ values for $\eta$ and $\theta$ generate a lesser degree of labor market power than the short-run ‘Year t’ estimates. We set the discount rate to 4% per annum, implying $\beta = .9615$. We set the depreciation rate to 10% per annum, $\delta = .1$. We set the Frisch elasticity $\varphi = .5$, which lies in the range of estimates obtained in micro-data analyses (e.g. Keane and Rogerson (2012)).

The remaining parameters $\{\tilde{\varphi}, \bar{z}, \tilde{\alpha}, \sigma_z\}$ are calibrated to match the following moments: (1) average earnings per worker, (2) average firm size, (3) the labor share, and (4) the employment-weighted wage-bill Herfindahl.

To determine the scale of the economy, we exploit the closed-form mapping of our model’s parameters, $\{\tilde{\varphi}, \bar{z}\}$, to average firm size and average earnings per worker. Setting $\tilde{\varphi} = 6.32$ and $\bar{z} = 30460$ generates the 2014 average firm size of 27.96 employees and 2014 average earn-

---

12The CBO uses estimates between .27 and .53. See Reichling and Whalen (2012) for more discussion.
13We provide the closed-form mapping in Appendix E.1.
ings per worker of $65,773 (see Table 1).

We calibrate $\tilde{\alpha} = .961$ to deliver a labor share of 57% in 2014 (Giandrea and Sprague (2017)). In order to recover aggregates as well as the labor share, we assume a capital share of 18% in 2014 (Barkai (2016)).

14 We calibrate $\sigma_z = .309$ to deliver an employment-weighted wage-bill Herfindahl of 0.14 (see Table 1).

Table 7 summarizes the parameters, and Table 8 compares the model targets to the data.

Table 7: Summary of Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assigned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\eta$</td>
<td>Within sector elasticity</td>
<td>3.74</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Across sector elasticity</td>
<td>0.76</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Frisch Elasticity</td>
<td>0.5</td>
</tr>
<tr>
<td>Estimated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tilde{\alpha}$</td>
<td>DRS parameter</td>
<td>0.962</td>
</tr>
<tr>
<td>$\tilde{\zeta}$</td>
<td>Log Normal Standard Deviation</td>
<td>0.309</td>
</tr>
<tr>
<td>$\bar{z}$</td>
<td>Productivity shifter</td>
<td>30460</td>
</tr>
<tr>
<td>$\bar{\phi}$</td>
<td>Aggregate labor disutility shifter</td>
<td>6.320</td>
</tr>
</tbody>
</table>

Table 8: Estimated parameters

<table>
<thead>
<tr>
<th>Var.</th>
<th>Description</th>
<th>Value</th>
<th>Targeted Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tilde{\alpha}$</td>
<td>DRS parameter</td>
<td>0.962</td>
<td>Labor share</td>
<td>0.57</td>
<td>0.57</td>
</tr>
<tr>
<td>$\tilde{\zeta}$</td>
<td>Log Normal Standard Deviation</td>
<td>0.309</td>
<td>$E(HHI_{j}^{\text{emp}}) - Emp.weighted$</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>$\bar{z}$</td>
<td>Productivity shifter</td>
<td>30460</td>
<td>Avg. wage per worker</td>
<td>$65,773$</td>
<td>$65,773$</td>
</tr>
<tr>
<td>$\bar{\phi}$</td>
<td>Aggregate labor disutility shifter</td>
<td>6.320</td>
<td>Avg firm size</td>
<td>27.96</td>
<td>27.96</td>
</tr>
</tbody>
</table>

7 Validation

We complete a number of over-identifying tests of the model. First, we verify that the model produces rates of pass-through from productivity to wages, including recent estimates by Kline, Petkova, Williams, and Zidar (2018) and Card, Cardoso, Heining, and Kline (2018). Second, despite calibrating the model to employment weighted measures of concentration across markets,

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14 We must also take a stance on the capital share in our economy in order to go from the ‘hatted’ equilibrium described in Appendix D to the equilibrium with capital.
we verify that the model matches the unweighted distribution of these measures. Third, we compare the model’s size-wage premium to recent estimates by Bloom, Guvenen, Smith, Song, and von Wachter (2018).

7.1 Pass-through

We compare model and data estimates of the pass-through rate from productivity to worker wages. Since productivity is not easily observed in many datasets, most empirical studies focus on the pass-through rate of sales per worker or value added per worker to wages, where wages are measured either as labor compensation per worker or as an hourly wage. While there are many papers which conduct such pass-through regressions, Kline, Petkova, Williams, and Zidar (2018) is one of the few papers that provides enough summary statistics necessary to replicate their natural experiment in our model. They focus on relatively large firms (median size of 25 employees) that successfully obtain a high-value patent. Their estimates imply that the receipt of a high-value patent increases various measures of productivity, such as value added per worker or surplus (labor compensation plus EBITDA) per worker, by approximately 20%.

In order to compare our estimates to Kline, Petkova, Williams, and Zidar (2018), we randomly sample firms of the same size, and then we simulate an increase in productivity ($\tilde{z}_{ij}$) that translates to an increase of output per worker ($y_{ij}/n_{ij}$) of approximately 20%. Let primes denote the new steady state variables among the firms that were randomly selected from our calibrated steady state. We regress the wage change in levels ($\Delta w_{ij} = w'_{ij} - w_{ij}$) on the output per worker change in levels ($\Delta y_{ij}/n_{ij} = y'_{ij}/n'_{ij} - y_{ij}/n_{ij}$) and a constant.

Table 9 reports our estimates of wage pass-through in the model. We find a pass-through rate of 45.8%, meaning that for every 1 dollar increase in output per worker, wages increase by 45.8 cents. Kline, Petkova, Williams, and Zidar (2018) find a pass-through rate of 31.7% using U.S. data, which, by design, is directly comparable to our model estimate. Using Portuguese data, other recent work by Card, Cardoso, Heining, and Kline (2018) uses lagged sales per worker as an instrument for value added per worker. While we cannot replicate their regressions directly, they find a pass-through rate of 32.7%. Since we did not target pass-through in our estimation, we view our model’s ability to generate a pass-through rate that is quite close to recent empirical estimates as a success of our theory.
Table 9: Wage pass-through, model versus data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass-through coefficient</td>
<td>0.458</td>
<td>0.317</td>
<td>0.327</td>
</tr>
<tr>
<td>Dependent Variable</td>
<td>$w_{ij}$</td>
<td>Labor compensation per worker</td>
<td>Hourly wage</td>
</tr>
<tr>
<td>Independent Variable</td>
<td>$y_{ij}/n_{ij}$</td>
<td>Labor compensation plus earnings (EBITDA) per worker</td>
<td>Value added per worker (IV with avg. sales per worker)</td>
</tr>
</tbody>
</table>

Notes: Model point estimate generated by randomly sampling 1% of firms in the benchmark oligopsonistic economy with size greater than 10 employees (corresponding to median size of 25.9 in the sample vs 25.2 in Kline et al (2018)), increasing productivity by 30% (corresponding to a 26% increase in $y_{ij}/n_{ij}$ versus ≈ 20% in Kline et al (2018)), and repeating this exercise 100 times. Average point estimate over 100 repetitions is reported.

7.2 Across market concentration distribution

Table 10 compares the model generated wage-bill Herfindahls, weighted and unweighted, relative to the data. In the data, concentration is strongly negatively correlated with employment. Markets with one firm tend to employ few workers, hence the unweighted distribution of market concentration skews to the right: the weighted (unweighted) average HHI is 0.14 (0.45). Panel A of Table 10 illustrates that the model generates an unweighted wage-bill Herfindahl of .31. This is roughly 100% greater than the employment weighted wage-bill Herfindahl, which was one of our calibration targets. The model generates the right standard deviation of the Herfindahl distribution, but too much skewness. Panel B shows that the model understates the standard deviation of the weighted Herfindahl distribution, but approximately matches the skewness.

The reason that the model is able to produce such a large discrepancy between the weighted and unweighted wage-bill Herfindahls is because the model generates a very strong negative correlation between market concentration and market size. The model correlation between market size and market concentration is -.73, whereas in the data the correlation is -.21. Smaller markets with one firm are highly concentrated and thus offer greater markdowns on the marginal product of labor as discussed in Section 5. Without competition, these firms act as solo monopsonists, restricting quantity (lower employment) and raising markdowns (lowering wages).

The model is also able to replicate the negative correlation of the wage-bill Herfindahl and the number of firms per market, as well as the negative correlation between the wage-bill Herfindahl and the variance of relative wages within a market. Lastly, the wage-bill and employment Herfindahls are perfectly correlated in both the model and the data, despite their
significant level differences.

Table 10: Labor market concentration and cross-market correlations, model versus data

<table>
<thead>
<tr>
<th>Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Unweighted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage-bill Herfindahl (unweighted)</td>
<td>0.31</td>
<td>0.45</td>
</tr>
<tr>
<td>Std. Dev. of Wage-bill Herfindahl (unweighted)</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>Skewness of Wage-bill Herfindahl (unweighted)</td>
<td>1.20</td>
<td>0.48</td>
</tr>
<tr>
<td><strong>B. Weighted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage-bill Herfindahl (weighted by market’s share of total employment)</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Std. Dev. of Wage-bill Herfindahl (weighted by market’s share of total employment)</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>Skewness of Wage-bill Herfindahl (weighted by market’s share of total employment)</td>
<td>2.89</td>
<td>2.28</td>
</tr>
<tr>
<td><strong>C. Correlations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and number of firms</td>
<td>-0.50</td>
<td>-0.21</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Std. Dev. Of Relative Wages</td>
<td>-0.47</td>
<td>-0.51</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Employment Herfindahl</td>
<td>1.00</td>
<td>0.98</td>
</tr>
<tr>
<td>Correlation of Wage-bill Herfindahl and Market Employment</td>
<td>-0.73</td>
<td>-0.21</td>
</tr>
</tbody>
</table>

Notes: Benchmark oligopsonistic equilibrium. See data notes in Section 3.

### 7.3 Size-Wage Premium

Larger, more productive firms have greater markdowns, but they also pay more. This mechanism produces a size-wage premium in the model. In this section, we show that our model produces a size-wage premium that is in line with existing estimates (e.g. Brown and Medoff (1989), Lallemand, Plasman, and Rycx (2007), Bloom, Guvenen, Smith, Song, and von Wachter (2018)). Using the Social Security Administration records, Bloom, Guvenen, Smith, Song, and von Wachter (2018) find a size-wage elasticity that begins at .11 in 1980 and declines to .03 by 2013. Using the steady state distribution of firms, we estimate the size-wage premium by regressing the model’s log wages on log firm size (measured in terms of employees):

$$
\log(w_{ij}) = \beta_0 + \beta_1 \log(n_{ij}) + \epsilon_j
$$

Table 11 reports the model’s size-wage premium. The model’s elasticity of wages with respect to firm size ($\beta_1$) is .14. This point estimate implies that a firm which is 10% larger pays a 1.4% greater wage. Our size-wage premium is larger than those reported by Bloom, Guvenen, Smith, Song, and von Wachter (2018), but falls within the range observed in other datasets (e.g. Brown and Medoff (1989), Lallemand, Plasman, and Rycx (2007)). We view the model’s ability
to generate a size-wage premium that is quite close to the range observed in other datasets as another success of the theory.

Table 11: Size-wage premium, model versus data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of wage WRT size</td>
<td>0.14</td>
<td>0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>Dependent Variable</td>
<td>$\log(w_{ij})$</td>
<td>Log annual earnings</td>
<td>Log annual earnings</td>
</tr>
<tr>
<td>Independent Variable</td>
<td>$\log(n_{ij})$</td>
<td>Log firm employees</td>
<td>Log firm employees</td>
</tr>
</tbody>
</table>

Notes: ‘Elasticity of wage WRT size’ corresponds to $\beta_1$ in equation (13). $\beta_1$ computed using the benchmark oligopsonistic equilibrium. See data notes in Section 3.

8 Welfare Consequences of Labor Market Power

We use our calibrated model to measure the welfare losses from labor market power. We proceed by discussing the sources of labor market power in our model economy, defining a competitive equilibrium, and then computing the consumption equivalent welfare gain of moving from our oligopsonistic equilibrium to the competitive equilibrium.

Our assumptions for worker preferences generate upward sloping labor supply curves. In our benchmark oligopsonistic model, there are two sources of market power: (i) firms internalize that they face an upward sloping labor supply curve and (ii) firms are non-atomistic and engage in Cournot competition for workers. Existing models such as Burdett and Mortensen (1998) have firms that internalize their upward sloping labor supply curves, but firms behave atomistically.

To measure the welfare losses from both sources of market power, we compare our benchmark oligopsonistic equilibrium to the competitive equilibrium. The competitive equilibrium still features upward sloping labor supply curves, but firms do not internalize that labor supply curves are upward sloping. The competitive economy still features the same number of firms (and thus there are no changes in the number of ‘varieties’ of firms, i.e. no ‘love of variety’ effects), but firms behave atomistically. Thus, there are no strategic complementarities.

We formally define the competitive equilibrium as follows:

**Definition** A **competitive (Walrasian) equilibrium** is an allocation of employment $n_{ij}$ and wages $w_{ij}$ such that:
- Taking \( w_{ij} \) as given, \( n_{ij} \) solves each firm’s optimization problem

\[
n_{ij} = \arg \max_{n_{ij}} \bar{z}_{ij} \bar{z}_{ij}^{\alpha} n_{ij}^{\bar{\alpha}} - w_{ij} n_{ij}
\]

- Taking \( w_{ij} \) as given, \( n_{ij} \) is the household’s optimal labor supply to firm \( ij \):

\[
n_{ijt} = \bar{\phi} \left( \frac{w_{ijt}}{W_{jt}} \right)^{\eta} \left( \frac{W_{jt}}{W_{t}} \right)^{\theta} W_{it}^{\varphi}
\]

Figure 6 graphically depicts the oligopsonistic equilibrium (\( \{ w_{ij}, n_{ij} \} \)) and the competitive equilibrium (\( \{ w_{ij}^*, n_{ij}^* \} \)). With an upward sloping labor supply curve, as depicted, the monopsonist always hires less labor and pays lower wages than what would prevail under competitive markets.

![Figure 6: Competitive vs. Oligopsonistic equilibrium](image)

Notes: In a competitive equilibrium the firm perceives that its marginal cost \( MC_{ij}^* \) is simply equal to its wage, which it takes as given. The resulting employment is \( n_{ij}^* \). In an oligopsonistic equilibrium the firm understands that its marginal cost \( MC_{ij} \) is increasing in its employment. The resulting employment is \( n_{ij} \).

To compute the welfare losses from oligopsony, we introduce some additional notation. Let \( \{ C_m, N_m \} \) denote consumption and disutility of labor in the benchmark oligopsonistic equilibrium. Let \( \{ C_c, N_c \} \) denote consumption and disutility of labor in the competitive equilibrium. We express the welfare losses as a consumption equivalent. Households are willing to give up \( 100 \times (\lambda - 1) \) percent of their consumption in the benchmark oligopsonistic economy in order
to move to the competitive economy, where $\lambda$ is given by the following expression:

$$
\lambda = \left[ C_c - \frac{1}{\phi^H} \frac{N_c^{1+\frac{1}{\phi}}} {1 + \frac{1}{\phi}} + \frac{1}{\phi^M} \frac{N_m^{1+\frac{1}{\phi}}} {1 + \frac{1}{\phi}} \right] / C_m
$$

(14)

Table 12 reports the welfare gain in our benchmark calibration, which assumes a Frisch elasticity of $\phi = .5$. We also compute the welfare gain under alternate values of the Frisch elasticity, $\phi = .2$ and $\phi = .8$. We find that in our benchmark calibration, agents would be willing give up 4.3% of lifetime consumption in order to leave the oligopsonistic equilibrium and enter the competitive equilibrium. This is true despite the fact that time spent working increases by 17%. For lower values of the Frisch elasticity, additional time spent working is more costly in terms of utils, and thus the welfare gain of moving from the oligopsonistic to competitive equilibrium is only 2.2%. Additionally, Table 12 shows that larger Frisch elasticities ($\phi = .8$) generate larger welfare gains.

Table 12: Welfare gains from competition

<table>
<thead>
<tr>
<th>(1) Frisch Elasticity</th>
<th>(2) Consumption Equivalent Welfare Gain (Percent)</th>
<th>(3) Relative Employment Index $N$ (Competitive over Monopsony)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>2.2</td>
<td>1.068</td>
</tr>
<tr>
<td>0.5</td>
<td>4.3</td>
<td>1.177</td>
</tr>
<tr>
<td>0.8</td>
<td>6.4</td>
<td>1.294</td>
</tr>
</tbody>
</table>

Notes: Consumption equivalent welfare gain corresponds to $100 \times (\lambda - 1)$ where $\lambda$ is given by (14). Consumption equivalent welfare gain corresponds to moving from benchmark oligopsony to competitive equilibrium.

9 Labor share and labor market power: 1976 to 2014

In this section, we use the aggregation results in Section 5 to estimate the impact of falling labor market concentration on labor’s share of income. In particular, we use the closed-form expression for labor’s share of income given by equation (8) to link the dynamics of labor’s share of income to our measures of wage-bill Herfindahls in Table 1.

The weighted wage-bill Herfindahl fell from .19 in 1976 to .14 in 2014, which implies that the inverse weighted wage-bill Herfindahl increased from 5.37 to 7.17.\textsuperscript{15} Under the assumption

\textsuperscript{15}Table 1 rounds to 2 digits, but the unrounded weighted wage-bill Herfindahls are .1862 in 1976 and .1394 in 2014.
of stable preference parameters ($\eta = 3.74$, $\theta = .76$) and technology ($\bar{\alpha} = .962$) as calibrated in Table 7 (see Section 6), equation (8) implies that declining wage-bill Herfindahls between 1976 and 2014 have contributed to an increase in the labor share of 2.3%.

Therefore, changes in labor market concentration are unlikely to have contributed to the declining labor share in the United States (e.g. Karabarbounis and Neiman (2013)).

10 Minimum wages

As an application of the model, we study minimum wages. The effect of a minimum wage on wages and employment has been a major motivation for developing monopsonistic models (e.g. Boal and Ransom (1997), Manning (2003)). The main prediction in monopsonistic models is that if some firms are paying below their marginal revenue products, a higher minimum wage may lead these firms to compress their markdowns, increasing wages, and at the same time increasing employment as they move along their labor supply curves. Our model shares this prediction, which we examine.

More recent evidence on the affect of minimum wages has described the impacts across the distribution of firms. In particular, Dustmann, Lindner, and Schoenberg (2019) find that in response to a national minimum wage increase in Germany, (i) small firms exit, (ii) employment reallocates to larger firms, and (iii) the largest employment and wage affects are among medium sized firms.

In Table 13, we simulate the same minimum wage increase studied by Dustmann, Lindner, and Schoenberg (2019). They report that 10.4% of workers earned less than the new minimum wage in Germany. To map this natural experiment to our model framework, we solve for the equivalent minimum wage ($w_{min}$) that would bind for 10.4% of workers in our benchmark oligopsonistic equilibrium. In Table 13, we impose this minimum wage ($w_{min}$) which is equal to 67% of the median wage (in the German experiment, the minimum wage is equal to 48% of the median wage), and we compare outcomes across steady states. We do not allow for entry, but we find that 2% of firms in our benchmark oligopsonistic equilibrium could no longer profitably operate in the presence of the minimum wage. Dustmann, Lindner, and Schoenberg (2019) find that approximately 10% of firms exit.\textsuperscript{16} Average firm size increases by 3% in the model versus 10% in the data. The source of the size gain is a reallocation of workers from smaller firms to larger firms more productive firms that attain a greater share of the market. We find a 45% reduction in the number of small firms with less than 2 employees, and a marginal

\textsuperscript{16}The ‘data’ column was taken from preliminary slides, and are in some instances inferred from graphs, and are thus subject to change.
rise in the number of firms with greater than 50 employees. We see a reduction in the share of employment at small firms of 3% in both the model and data. In terms of inequality, the $p_{50} - p_{10}$ wage ratio is largely unaffected by the minimum wage hike, declining only one log point from .41 to 0.40. Likewise, the $p_{90} - p_{50}$ wage ratio is unaffected by the minimum wage. As our theory predicts, the minimum wage increases total employment $\sum_{ij} n_{ij} d_{j}$ by 1.43 percent, and increases aggregate consumption by .56%. Lastly, we find that households would be willing to give up 0.11 percent of lifetime consumption in order to have this minimum wage imposed.

11 Conclusion

In this paper, we develop a model of labor market oligopsony. We use the framework to (1) inform measurement of labor market concentration, (2) map labor market concentration to labor market power, and (3) measure the welfare losses of labor market power. In our framework, we show that the relevant measure of labor market concentration is the wage-bill Herfindahl, employment Herfindahls overstate competition, and the distribution of wage-bill Herfindahls is a sufficient statistic for the labor share.

We apply our measures of labor market concentration to tradeable sector firms in the Longitudinal Business Dynamics (LBD) database. We show that the wage-bill Herfindahl fell from .19 to .14 between 1976 and 2014, indicating a significant decrease in labor market concentration. Using our theory’s closed-form mapping between the labor share and wage-bill Herfindahls, we show that declining labor market concentration has increased the labor share by 2.3% be-

To assess the normative implications of our measures of labor market concentration, we estimate our model and conduct several counterfactuals. We use within-state-firm, across-market differences in the response of employment and wages to state corporate tax changes (e.g. Giroud and Rauh (2019)) to estimate the size-dependent labor supply elasticities. The size-dependent labor supply elasticities allow us to discipline the degree of labor market power in our model. To test how sensible our estimates are, we show that the model successfully replicates three non-targeted moments: the large discrepancy between weighted and unweighted wage-bill Herfindahls, the pass-through rate of value added per worker to wages, and the size-wage premium.

We then use our model to measure the consumption equivalent welfare gain of leaving the benchmark oligopsonistic equilibrium and entering the competitive equilibrium. We find that households would be willing to give up 4.2% of lifetime consumption in order to leave the oligopsonistic equilibrium and enter the competitive equilibrium.

Finally, as an application of the model, we study the effects of a minimum wage increase that binds for 10.4% of U.S. workers. We show that it would have little impact on wage inequality when measured by the p50-p10 or p90-p50 ratio. In particular, the p50-p10 ratio would decline by 1 log point, and the p90-p50 ratio remains unaffected by the policy.
References


—— (2016): “International shocks and domestic prices: how large are strategic complementarities?,”
Discussion paper, National Bureau of Economic Research.

Economics Letters, 24(2), 139–140.


This Appendix is organized as follows. Section A provides our micro-foundation for nested-CES preferences used in the main text and references in Section 4. Section B contains details about the data and sample selection criteria. Section C contains derivations of the household labor supply curves, optimal firm markdowns, and other formulas referenced in the main text. Section D contains additional details regarding the computation of the model.

A Micro-foundation of nested CES labor supply system

In this section we provide a micro-foundation for the nested CES preferences used in the main text. The arguments used here adapt those in Verboven (1996). We begin with the case of monopsonistic competition to develop ideas and then move to the case of oligopsonistic labor markets studied in the text. We then show that the same supply system occurs in a setting where workers solve a dynamic discrete choice problem and firms compete in a dynamic oligopoly.

A.1 Static discrete choice framework

Agents. There is a unit measure of ex-ante identical individuals indexed by $l \in [0,1]$. There is a large but finite set of $J$ sectors in the economy, with finitely many firms $i \in \{1, \ldots, M_j\}$ in each sector.

Preferences. Each individual has random preferences for working at each firm $ij$. Their disutility of labor supply is convex in hours worked $h_l$. Worker $l$’s disutility of working $h_{lij}$ hours at firm $ij$ are:

$$v_{lij} = e^{-\mu \epsilon_{lij}} h_{lij}, \quad \log v_{lij} = \log h_{lij} - \mu \epsilon_{ij},$$

where the random utility term $\epsilon_{lij}$ from a multi-variate Gumbel distribution:

$$F(\epsilon_{i1}, \ldots, \epsilon_{NJ}) = \exp \left[ - \sum_{ij} e^{-(1+\eta)\epsilon_{ij}} \right].$$

The term $\epsilon_{lij}$ is a worker-firm specific term which reduces labor disutility and hence could capture (i) an inverse measure of commuting costs, or (ii) a positive amenity.
**Decisions.** Each individual must earn $y_l \sim F(y)$, where earnings $y_l = w_{ij}h_{lij}$. After drawing their vector $\{\epsilon_{lij}\}$, each worker solves

$$\min_{ij} \{\log h_{ij} - \epsilon_{lij}\} \equiv \max_{ij} \{\log w_{ij} - \log y_l + \epsilon_{lij}\}.$$ 

This problem delivers the following probability that worker $l$ chooses to work at firm $ij$, which is independent of $y_l$:

$$\text{Prob}_l (w_{ij}, w_{-ij}) = \frac{w_{ij}^{1+\eta}}{\sum_{ij} w_{ij}^{1+\eta}}.$$ (15)

**Aggregation.** Total labor supply to firm $ij$, is then found by integrating these probabilities, multiplied by the hours supplied by each worker $l$:

$$n_{ij} = \int_0^1 \text{Prob}_l (w_{ij}, w_{-ij}) h_{lij} dF(y_l), \quad h_{lij} = y_l / w_{ij}$$

$$n_{ij} = \frac{w_{ij}^{\eta}}{\sum_{ij} w_{ij}^{1+\eta}} \int_0^1 y_{lj} dF(y_l)$$

(16)

Aggregating this expression we obtain the obvious result that $\sum_{ij} w_{ij}n_{ij} = Y$. Now define the following indexes:

$$W := \left[ \sum_{ij} w_{ij}^{1+\eta} \right]^{1/(1+\eta)}, \quad N := \left[ \sum_{ij} n_{ij}^{\eta+1} \right]^{\eta/(\eta+1)}.$$ 

Along with (16), these indexes imply that $WN = Y$. Using these definitions along with $WN = Y$ in (16) yields the CES supply curve:

$$n_{ij} = \left( \frac{w_{ij}}{W} \right)^\eta N.$$ 

We therefore have the result that the supply curves that face firms in this model of individual discrete choice are equivalent to those that face the firms when a representative household solves the following income maximization problem:

$$\max_{\{n_{ij}\}} \sum_{ij} w_{ij}n_{ij} \quad \text{s.t.} \quad \left[ \sum_{ij} n_{ij}^{\eta+1} \right]^{\eta/(\eta+1)} = N.$$
Since at the solution, the objective function is equal to \( WN \), then the envelope condition delivers a natural interpretation of \( W \) as the equilibrium payment to total labor input in the economy for one additional unit of aggregate labor disutility. That is, the following equalities hold:

\[
\frac{\partial}{\partial N} \sum_{ij} w_{ij} n_{ij}^*(w_{ij}, w_{-ij}) = \lambda = W = \frac{\partial}{\partial N} WN.
\]

**Nested logit and nested CES.** Consider changing the distribution of preference shocks as follows:

\[
F(\varepsilon_{i1}, ..., \varepsilon_{NJ}) = \exp \left[ - \sum_{j=1}^{J} \left( \sum_{i=1}^{M_j} e^{-\eta_{ij}} \right)^{\frac{1+\theta}{\eta}} \right].
\]

We recover the distribution (15) above if \( \eta = \theta \). Otherwise, if \( \eta > \theta \) the problem is convex and the conditional covariance of within sector preference draws differ from the economy wide variance of preference draws. We discuss this more below.

In this setting, choice probabilities can be expressed as the product of the conditional choice probability of supplying labor to firm \( i \) conditional on supplying labor to market \( j \), and the probability of supplying labor to market \( j \):

\[
Prob_l\left(w_{ij}, w_{-ij}\right) = \frac{w_{ij}^{1+\eta}}{\sum_{i=1}^{M_j} w_{ij}^{1+\eta}} \times \left[ \sum_{i=1}^{M_j} w_{ij}^{1+\eta} \right]^{\frac{1+\theta}{\eta}} \left[ \sum_{k=1}^{M_j} w_{kl}^{1+\eta} \right]^{\frac{1+\theta}{\eta}} / \left[ \sum_{l=1}^{J} \sum_{k=1}^{M_j} w_{kl}^{1+\eta} \right]^{\frac{1+\theta}{\eta}}.
\]

Following the same steps as above, we can aggregate these choice probabilities and hours decisions to obtain firm level labor supply:

\[
n_{ij} = \frac{w_{ij}^{\eta}}{\sum_{i=1}^{M_j} w_{ij}^{1+\eta}} \left[ \sum_{i=1}^{M_j} w_{ij}^{1+\eta} \right]^{\frac{1+\theta}{\eta}} \left[ \sum_{k=1}^{M_j} w_{kl}^{1+\eta} \right]^{\frac{1+\theta}{\eta}} Y. \tag{17}
\]
We can now define the following indexes:

\[
\mathbf{w}_j = \left[ \sum_{i=1}^{M_j} w_{ij}^{1+\eta} \right]^{\frac{1}{1+\eta}}, \quad \mathbf{n}_j = \left[ \sum_{i=1}^{M_j} n_{ij}^{\frac{\eta}{\eta+\theta}} \right]^{\frac{\eta}{\eta+\theta}},
\]

\[
\mathbf{W} = \left[ \sum_{j=1}^J \mathbf{w}_j^{1+\theta} \right]^{\frac{1}{1+\theta}}, \quad \mathbf{N} = \left[ \sum_{i=1}^{M_j} n_{ij}^{\frac{\theta}{\eta+\theta}} \right]^{\frac{\theta}{\eta+\theta}}.
\]

Using these definitions and similar results to the above we can show that \( w_j n_j = \sum_{i=1}^{M_j} w_{ij} n_{ij} \), and \( Y = \mathbf{W} \mathbf{N} = \sum_{j=1}^J \mathbf{w}_j \mathbf{n}_j \).

Consider the thought experiment of adding more markets \( J \) (which is necessary to identically map these formulas to our model). While the min of an infinite number of draws from a Gumbel distribution is not defined (it asymptotes to \(-\infty\)), the distribution of choices across markets is defined at each point in the limit as we add more markets \( J \) (Malmberg (2013)). As a result, the distribution of choices will have a well defined limit, and with the correct scaling as we add more markets (we can scale the disutilities at each step and not affect the market choice), as described in (Malmberg (2013)), the limiting wage indexes will be defined as above. We can then express (17) as:

\[
n_{ij} = \left( \frac{w_{ij}}{w_j} \right)^\eta \left( \frac{\mathbf{w}_j}{\mathbf{W}} \right)^\theta \mathbf{N},
\]

which completes the CES supply system defined in the text.

**Comment.** The above has established that it is straightforward to derive the supply system in the model through a discrete choice framework. This is particularly appealing given recent modeling of labor supply using familiar discrete choice frameworks first in models of economic geography and more recently in labor (Borovickova and Shimer (2017), Card, Cardoso, Heining, and Kline (2018), Lamadon, Mogstad, and Setzler (2018)). Since firms take this supply system as given, we can then work with the nested CES supply functions as if they were derived from the preferences and decisions of a representative household. This vastly simplifies welfare computations and allows for the integration of the model into more familiar macroeconomic environments.

A second advantage of this micro-foundation is that it provides a natural interpretation of the somewhat nebulous elasticities of substitution in the CES specification: \( \eta \) and \( \theta \). Returning
to the Gumbel distribution we observe the following

$$ F(\epsilon_{i1}, ..., \epsilon_{NJ}) = \exp \left[ - \sum_{j=1}^{J} \left( \sum_{i=1}^{M_j} e^{-(1+\eta) \epsilon_{ij}} \right)^{\frac{1+\theta}{1+\eta}} \right] $$

A higher value of $\eta$ increases the correlation of draws within a market (McFadden, 1978). Within a market if $\eta$ is high, then an individual’s preference draws are likely to be clustered. With little difference in non-pecuniary idiosyncratic preferences for working at different firms, wages dominate in an individual’s labor supply decision and wage posting in the market is closer to the competitive outcome. A higher value of $\theta$ decreases the overall variance of draws across all firms (i.e. it increases the correlation across any two randomly chosen sub-vectors of an individual’s draws). An individual is therefore more likely to find that their lowest levels of idiosyncratic disutility are in two different markets, increasing across market wage competition.

In the case that $\eta = \theta$, the model collapses to the standard logit model. In this case the following obtains. Take an individual’s $\epsilon_{ij}$ for some firm. The conditional probability distribution of some other draw $\epsilon_{i'j'}$ is the same whether firm $i'$ is in the same market ($j' = j$) or some other market ($j' \neq j$). Individuals are as likely to find somewhere local that incurs the same level of labor disability as finding somewhere in another market. In this setting economy-wide monopsonistic competition obtains. When an individual is more likely to find their other low disutility draws in the same market, then firms within that market have local market power. This is precisely the case that obtains when $\eta > \theta$.

**A.2 Dynamic discrete choice framework**

We show that the above discrete choice framework can be adapted to an environment where some individuals draw new vectors $\epsilon_i$ each period and reoptimize their labor supply. Firms therefore compete in a dynamic oligopoly. Restricting attention to the stationary solution to the model where firms keep employment and wages constant—as in the tradition of Burdett and Mortensen (1998)—we show that the allocation of employment and wages once again coincide with the solution to the problem in the main text. To simplify notation we consider the problem for a market with $M$ firms $i \in \{1, \ldots, M\}$ which may be generalized to the model in the text.

**Environment.** Every period a random fraction $\lambda$ of workers each draw a new vector $\epsilon_i$. Let $n_i$ be employment at firm $i$. Let $\bar{w}_i$ be the average wage of workers at firm $i$, such that the total wage bill in the firm is $\bar{w}_i n_i$. Let the equilibrium labor supply function $h(w_i, w_{-i})$ determine the
amount of hires a firm makes if it posts a wage $w_i$ when its competitors wages in the market are given by the vector $w_{-i}$.

**Value function.** Let $V(n_i, \bar{w}_i)$ be the firm’s present discounted value of profits, where the firm has discount rate $\beta = 1$. Then $V(n_i, \bar{w}_i)$ satisfies:

$$
V(n_i, \bar{w}_i) = (Pz_i - \bar{w}_i)(1 - \lambda)n_i + \max_{w'_i} \left\{ (Pz_i - w'_i) h(w'_i, w'_{-i}) + V(n'_i, \bar{w}'_i) \right\} \quad (18)
$$

$$
n'(n_i, w'_i, w'_{-i}) = (1 - \lambda)n_i + h(w'_i, w'_{-i}), \quad (19)
$$

$$
\bar{w}'(n_i, \bar{w}_i, w'_i, w'_{-i}) = \frac{(1 - \lambda) \bar{w}_i n_i + h(w'_i, w'_{-i}) w'_i}{(1 - \lambda)n_i + h(w'_i, w'_{-i})}. \quad (20)
$$

The firm operates a constant returns to scale production function. Of the firm’s $n_i$ workers, a fraction $(1 - \lambda)$ do not draw new preferences. The total profit associated with these workers is then average revenue $(Pz_i)$ minus average cost $(\bar{w}_i)$. The firm chooses a new wage $w'_i$ to post in the market. In equilibrium, given its competitor’s wages $w'_{-i}$, it hires $h(w_i, w_{-i})$ workers. The total profit associated with these workers is again average revenue $(Pz_i)$ minus average cost $(w'_i)$. The second and third equations account for the evolution of the firm’s state variables.

**Optimality.** Given its competitor’s prices, the first order condition with respect to $w'_i$ is:

$$(Pz_i - w'_i) h_1(w'_i, w'_{-i}) - h(w'_i, w'_{-i}) + V_n(n'_i, \bar{w}'_i) n'_w(n_i, w'_i, w'_{-i}) + V_{\bar{w}}(n'_i, \bar{w}'_i) \bar{w}_w(n_i, \bar{w}_i, w'_i, w'_{-i}) = 0$$

The relevant envelope conditions are

$$
V_n(n_i, \bar{w}_i) = (Pz_i - \bar{w}_i)(1 - \lambda) + V_n(n'_i, \bar{w}'_i) n'_n(n_i, w'_i, w'_{-i}) + V_{\bar{w}}(n'_i, \bar{w}'_i) \bar{w}'_n(n_i, \bar{w}_i, w'_i, w'_{-i})
$$

$$
V_{\bar{w}}(n_i, \bar{w}_i) = - (1 - \lambda)n_i + V_{\bar{w}}(n'_i, \bar{w}'_i) \bar{w}'_n(n_i, \bar{w}_i, w'_i, w'_{-i})
$$

In a stationary equilibrium $\bar{w}_i = w'_i$, and $n'_i = n_i$. One can compute the partial derivatives involved in these expressions, and evaluate the conditions under stationarity to obtain

$$(Pz_i - w_i) h_1(w_i, w_{-i}) = h(w_i, w_{-i}) .$$

Rearranging this expression:

$$w_i = \frac{\varepsilon_i(w_i, w_{-i})}{\varepsilon_i(w_i, w_{-i}) + 1} Pz_i, \quad \varepsilon_i(w_i, w_{-i}) := \frac{h_1(w_i, w_{-i}) w_i}{h(w_i, w_{-i})}$$
The solution to the dynamic oligopsony problem for a given supply system is identical to the solution of the static problem. In this setting, the supply system is obviously that which is obtained from the individual discrete choice problem in the previous section.

**Comments.** This setting establishes that the model considered in the main text can also be conceived as a setting where individuals periodically receive some preference shock that causes them to relocate, and firms engage in a dynamic oligopoly given these worker decisions. When $\eta > \theta$ the shock causes a worker to consider all firms in one market very carefully to the exclusion of other markets when they are making their relocation decision. When $\eta = \theta$ the individual considers all firms in all markets equally.

**B Data**

This section provides additional details regarding the data sources used in the paper, sample restrictions, and construction of a number of variables.

**B.1 Census Longitudinal Business Database (LBD)**

The LBD is built on the Business Register (BR), Economic Census and surveys. The BR began in 1972 and is a database of all U.S. business establishments. The business register is also called the Standard Statistical Establishment List (SSEL). The SSEL contains records for all industries except private households and illegal or underground activities. Most government owner entities are not in the SSEL. The SSEL includes single and multi unit establishments. The longitudinal links are constructed using the SSEL. The database is annual.

**B.2 Sample restrictions**

For both the summary statistics and corporate tax analysis, we isolate all plants (lbdnums) with non missing firmids, with strictly positive pay, strictly positive employment, non-missing county codes for the continental US (we exclude Alaska, Hawaii, and Puerto Rico). We then isolate all lbdnums with non-missing 2 digit NAICS codes equal to 11,21,31,32,33, or 55. We use the consistent 2007 NAICS codes provided by Fort and Klimek (2016) throughout the paper. These are the top tradeable 2-digit NAICS codes as defined by Delgado, Bryden, and Zyontz (2014). We winsorize the relative wage at the 1% level to remove outliers. Each plant has a
unique firmid which corresponds to the owner of the plant.\textsuperscript{17} Throughout the paper, we define a firm to be the sum of all establishments in a commuting zone with a common firmid and NAICS3 classification.

**Summary Statistics Sample:** Our summary statistics include all observations that satisfy the above criteria in 1976 and 2014.

**Corporate Tax Sample:** The corporate tax analysis includes all observations that satisfy the above criteria between 2002 and 2014. We further restrict the sample to firmid-market-year observations which have a ‘Corporation’ legal form of organization. The legal form of organization changes discontinuously in 2001 and earlier years, and thus we restrict our analysis to post-2002 observations. We must further restrict our attention to corporations that operate in at least two markets, since we use variation across markets, within a state, in order to isolate the impact of the corporate tax shocks on employment and wages.

**Sample NAICS Codes and Commuting Zones:** Table 14 describes the NAICS 3 codes in our sample. Table 15 provides examples of commuting zones and the counties that are associated with those commuting zones.

<table>
<thead>
<tr>
<th>NAICS3</th>
<th>Description</th>
<th>NAICS3</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>Crop Production</td>
<td>322</td>
<td>Paper Manufacturing</td>
</tr>
<tr>
<td>112</td>
<td>Animal Production and Aquaculture</td>
<td>323</td>
<td>Printing and Related Support Activities</td>
</tr>
<tr>
<td>113</td>
<td>Forestry and Logging</td>
<td>324</td>
<td>Petroleum and Coal Products Manufacturing</td>
</tr>
<tr>
<td>114</td>
<td>Fishing, Hunting and Trapping</td>
<td>325</td>
<td>Chemical Manufacturing</td>
</tr>
<tr>
<td>115</td>
<td>Support Activities for Agriculture and Forestry</td>
<td>326</td>
<td>Plastics and Rubber Products Manufacturing</td>
</tr>
<tr>
<td>211</td>
<td>Oil and Gas Extraction</td>
<td>327</td>
<td>Nonmetallic Mineral Product Manufacturing</td>
</tr>
<tr>
<td>212</td>
<td>Mining (except Oil and Gas)</td>
<td>331</td>
<td>Primary Metal Manufacturing</td>
</tr>
<tr>
<td>213</td>
<td>Support Activities for Mining</td>
<td>332</td>
<td>Fabricated Metal Product Manufacturing</td>
</tr>
<tr>
<td>311</td>
<td>Food Manufacturing</td>
<td>333</td>
<td>Machinery Manufacturing</td>
</tr>
<tr>
<td>312</td>
<td>Beverage and Tobacco Product Manufacturing</td>
<td>334</td>
<td>Computer and Electronic Product Manufacturing</td>
</tr>
<tr>
<td>313</td>
<td>Textile Mills</td>
<td>335</td>
<td>Electrical Equipment, Appliance, and Component Manufacturing</td>
</tr>
<tr>
<td>314</td>
<td>Textile Product Mills</td>
<td>336</td>
<td>Transportation Equipment Manufacturing</td>
</tr>
<tr>
<td>315</td>
<td>Apparel Manufacturing</td>
<td>337</td>
<td>Furniture and Related Product Manufacturing</td>
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<tr>
<td>316</td>
<td>Leather and Allied Product Manufacturing</td>
<td>339</td>
<td>Miscellaneous Manufacturing</td>
</tr>
<tr>
<td>321</td>
<td>Wood Product Manufacturing</td>
<td>551</td>
<td>Management of Companies and Enterprises</td>
</tr>
</tbody>
</table>

\textsuperscript{17}Each firm only has one firmid. The firmid is different from the EIN. The firmid aggregates EINS to build a consistent firm identifier in the cross-section and over time.
Table 15: Commuting Zone Examples

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>58</td>
<td>Cook County</td>
<td>Chicago-Naperville-Joliet, IL Metropolitan Division</td>
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B.3 Construction of variables and moments

C Mathematical derivations

This section details derivation of mathematical formulae appearing in the main text. It covers: (i) the household problem, (ii) sectoral equilibria of the firm problem, (iii) the labor share, (iv) wage pass-through results.

C.1 Household problem derivations

We solve for demand of the final good by taking the first order condition of the household problem with respect to $C_t$:

$$u' \left( C_t - \frac{1}{\bar{\psi}} \frac{N_t}{1 + \frac{1}{\bar{\psi}}} \right) = \Lambda_t$$

The Euler equation for households yields:

$$R_t = \frac{\Lambda_{t-1}}{\Lambda_t} [r_t + \delta]$$

Where the discount rate is given by $r_t$:

$$r_t = \frac{1}{\bar{\beta}} - 1$$
To determine labor supply, we proceed with a three-step budgeting problem. Consider the first stage. Suppose the household must earn $S_t$ by choosing labor supply across markets:

$$N_t = \min_{\{n_{jt}\}} \left[ \int_0^1 n_{jt}^\eta \, dj \right]^{\frac{\eta}{\eta + 1}} \quad \text{s.t.} \quad \int_0^1 w_{jt}n_{jt}dj \geq S_t$$

The FOC \((n_{jt})\) is\(^{18}\)

$$N_t^{-\frac{1}{\eta}} n_{jt}^{\frac{1}{\eta}} = \lambda w_{jt}$$

$$N_t^{-\frac{1}{\eta}} n_{jt}^{\frac{\eta + 1}{\eta}} = \lambda w_{jt}n_{jt}$$

$$N_t^{-\frac{1}{\eta}} \left[ \int_0^1 n_{jt}^{\frac{\eta + 1}{\eta}} \, dj \right] = \lambda \int_0^1 w_{jt}n_{jt}dj$$

$$N_t^{-\frac{1}{\eta}} N_t^{\frac{\eta + 1}{\eta}} = \lambda \int_0^1 w_{jt}n_{jt}dj$$

$$N_t = \lambda \int_0^1 w_{jt}n_{jt}dj$$

then define \(W_t\) by the number that satisfies \(W_tN_t = \int_0^1 w_{jt}n_{jt}dj\), which implies that \(\lambda = W_t^{-1}\).

Using the wage index in the first-order condition, we obtain:

$$N_t^{-\frac{1}{\eta}} n_{jt}^{\frac{1}{\eta}} = \lambda w_{jt}$$

$$N_t^{-\frac{1}{\eta}} n_{jt}^{\frac{\eta}{\eta}} = W_t^{-1} w_{jt}$$

$$n_{jt} = \left( \frac{w_{jt}}{W_t} \right)^{\frac{\eta}{\eta}} N_t \quad (21)$$

\(^{18}\)Where we have used \(\left[ \int_0^1 n_{jt}^{\frac{\eta + 1}{\eta}} \, dj \right]^{\frac{\eta}{\eta + 1}} = \left[ \int_0^1 n_{jt}^{\frac{\eta + 1}{\eta}} \, dj \right]^{-\frac{1}{\eta + 1}} = N_t^{-\frac{1}{\eta}}\)
We then recover the wage index by multiplying (21) by \( w_{ijt} \) and integrating across markets:

\[
\begin{align*}
\mathbf{w}_{jt}' \mathbf{n}_{jt} &= \mathbf{w}_{jt}' \mathbf{W}_{t}^{-\eta} \mathbf{N}_t \\
\int_0^1 \mathbf{w}_{jt}' \mathbf{n}_{jt} dj &= \int_0^1 \mathbf{w}_{jt}'^{1+\eta} dj \mathbf{W}_{t}^{-\eta} \mathbf{N}_t \\
\mathbf{W}_{t} \mathbf{N}_t &= \int_0^1 \mathbf{w}_{jt}'^{1+\eta} dj \mathbf{W}_{t}^{-\eta} \mathbf{N}_t \\
\mathbf{W}_{t}^{1+\eta} &= \int_0^1 \mathbf{w}_{jt}'^{1+\eta} dj \\
\mathbf{W}_{t} &= \left[ \int_0^1 \mathbf{w}_{jt}'^{1+\eta} dj \right]^{\frac{1}{1+\eta}}
\end{align*}
\]

Moving to the second stage, suppose that a household must raise resources \( S_t \) within a market and chooses labor supply to each firm within that market:

\[
\mathbf{n}_{jt} = \min_{\{\mathbf{n}_{ijt}\}} \left( \sum_{i=1}^{M} \frac{\eta+1}{\eta+\eta+1} \right)^{\frac{\eta+1}{\eta+1}} \text{ s.t. } \sum_{i=1}^{M} \mathbf{w}_{ijt} \mathbf{n}_{ijt} \geq S_t
\]

Let \( \mathbf{w}_{jt} \) be the number such that \( \mathbf{w}_{jt} \mathbf{n}_{jt} = \sum_{i} \mathbf{w}_{ijt} \mathbf{n}_{ijt} \). Taking first order conditions and proceeding similarly to the first stage we obtain the following:

\[
\begin{align*}
\mathbf{n}_{ijt} &= \left( \frac{\mathbf{w}_{ijt}}{\mathbf{w}_{jt}} \right)^{\frac{\theta}{\eta}} \mathbf{n}_{jt} \\
\mathbf{w}_{jt} &= \left[ \int_0^1 \mathbf{w}_{ijt}'^{1+\eta} dj \right]^{\frac{1}{1+\eta}}
\end{align*}
\]

Moving to the third stage, we recast the original problem and take first order conditions for \( \mathbf{N}_t \):

\[
U = \max_{\{\mathbf{N}_t, C_t, K_t\}} \sum_{t=0}^{\infty} \beta^t u \left( C_t - \frac{1}{\phi^\frac{1}{\psi}} \frac{\mathbf{N}_t^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}} \right)
\]

subject to the household’s budget constraint which is given by,

\[
C_t + \left[ K_{t+1} - (1 - \delta) K_t \right] = \mathbf{N}_t \mathbf{W}_t + R_t K_t + \Pi_t.
\]
This yields the following expression for the aggregate labor supply index:

\[ N_t = \bar{\phi} W_t^\eta \quad (23) \]

Substituting (21) and (23) into equation (22), we derive the labor supply curve in the main text:

\[
\begin{align*}
n_{ijt} &= \left( \frac{w_{ijt}}{w_{jt}} \right)^\eta \left( \frac{w_{jt}}{W_t} \right)^\theta (W_t)^\phi \\
w_{jt} &= \left[ \int_{0}^{1} w_{ijt}^{1+\eta} dj \right]^{\frac{1}{1+\eta}} \\
W_t &= \left[ \int_{0}^{1} w_{jt}^{1+\theta} dj \right]^{\frac{1}{1+\theta}}
\end{align*}
\]

To obtain the inverse labor supply curve, we use the first order conditions for labor supply within the market:

\[
n_{ijt} = \left( \frac{w_{ijt}}{w_{jt}} \right)^\eta n_{jt}
\]

Inverting this equation yields,

\[
w_{ijt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{1/\eta} w_{jt} \quad (24)
\]

Labor supply across markets is given by the following expression:

\[
n_{jt} = \left( \frac{w_{jt}}{W_t} \right)^\theta N_t
\]

Inverting this equation yields,

\[
w_{jt} = \left( \frac{n_{jt}}{N_t} \right)^{1/\theta} W_t \quad (25)
\]

Combining (25), (24) and (23) yields the expression in the text.
C.2 Derivation of firm problem under Cournot competition

Let \( y_{ijt} = z_{ijt} Z \left( k_{ijt}^{1-\alpha} n_{ijt}^\alpha \right)^\gamma \). The firm problem with capital and decreasing returns to scale is given by,

\[
\max_{k_{ijt}, n_{ijt}} z_{ijt} Z \left( k_{ijt}^{1-\alpha} n_{ijt}^\alpha \right)^\gamma - R_t k_{ijt} - w_{ijt} n_{ijt}
\]

Taking first order conditions for \( k_{ijt} \) yields \( R_t k_{ijt} y_{ijt} = (1 - \alpha) \gamma \). We substitute this expression into the profit function

\[
\max_k [1 - (1 - \alpha) \gamma] y_{ijt} - w_{ijt} n_{ijt}
\]

We solve for capital using the first order condition for capital (again):

\[
k_{ijt} = \left( \frac{(1 - \alpha) \gamma z_{ijt} Z}{R_t} \right)^{\frac{1}{1-(1-\alpha)\gamma}} n_{ijt}^{\frac{\alpha\gamma}{1-(1-\alpha)\gamma}}
\]

We substitute this into the expression for \( y_{ijt} \) to obtain firm-level output as a function of \( n_{ijt} \):

\[
y_{ijt} = \left( \frac{1}{R_t} \right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} \left( z_{ijt} Z \right)^{\frac{1}{1-(1-\alpha)\gamma}} n_{ijt}^{\frac{\alpha\gamma}{1-(1-\alpha)\gamma}}
\]

The firm optimization problem becomes:

\[
\pi_{ijt} = [1 - (1 - \alpha) \gamma] \left( \frac{1}{R_t} \right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} \left( z_{ijt} Z \right)^{\frac{1}{1-(1-\alpha)\gamma}} n_{ijt}^{\frac{\alpha\gamma}{1-(1-\alpha)\gamma}} - w_{ijt} n_{ijt}
\]

Defining \( \tilde{\alpha} := \frac{\alpha\gamma}{1-(1-\alpha)\gamma} \), \( \tilde{z}_{ijt} := [1 - (1 - \alpha) \gamma] \left( \frac{1}{R_t} \right)^{\frac{(1-\alpha)\gamma}{1-(1-\alpha)\gamma}} z_{ijt}^{1-(1-\alpha)\gamma} \), and \( \tilde{z} := Z^{1-(1-\alpha)\gamma} \) yields the firm profit maximization problem, expression (6), in the text.

Define \( MRPL_{ijt} = \tilde{\alpha} \tilde{z}_{ijt} \tilde{z} n_{ijt}^{\tilde{\alpha} - 1} \). Define \( X_t = \frac{1}{\phi^\theta / \theta} N_t^{\frac{1}{\phi-1/\theta}} \) and substitute this into the inverse labor supply function to derive the following expression:

\[
w_{ijt} = n_{ijt}^{1/\eta} n_{jt}^{1/\theta - 1/\eta} X_t
\]

(26)

We substitute this expression into the profit function to obtain,

\[
\pi_{ijt} = \max_{n_{ijt}} \tilde{z}_{ijt} \tilde{z} n_{ijt}^{\tilde{\alpha}} - n_{ijt}^{\frac{1}{\eta} + 1} n_{jt}^{\frac{1}{\theta} - 1/\eta} X_t
\]
Before taking first order conditions, we derive a useful result, \( \frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = s_{ijn} \).

**Lemma C.1.** \( \frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = s_{ijn} \)

**Proof:** Using the definition of
\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left[ \sum_i n_{ijt}^{\eta + 1} \right]^{\frac{\eta}{\eta + 1}} \frac{\eta + 1}{\eta + 1} - 1
\]
\[
= \left[ \sum_i n_{ijt}^{\frac{\eta + 1}{\eta}} \right]^{\frac{1}{\eta + 1}} - \frac{1}{\eta + 1} n_{ijt}^{\frac{1}{\eta}}
\]
\[
= n_{jt}^{\frac{1}{\eta}} n_{ijt}^{\frac{1}{\eta}}
\]

This yields the elasticity of market level labor supply:

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

Substituting (27) into the definition of the wage-bill share:

\[
s_{ijn} = \frac{w_{ijt} n_{ijt}}{\sum_i w_{ijt} n_{ijt}} = \frac{n_{ijt}^{\frac{1}{\eta + 1}} n_{jt}^{\frac{1}{\eta}} - \frac{1}{\eta + 1} X}{\sum_i n_{ijt}^{\frac{1}{\eta + 1}} n_{jt}^{\frac{1}{\eta}} - \frac{1}{\eta + 1} X} = \frac{n_{ijt}^{\frac{1}{\eta + 1}} n_{jt}^{\frac{1}{\eta}} - \frac{1}{\eta + 1} X}{\sum_i n_{ijt}^{\frac{1}{\eta + 1}} n_{jt}^{\frac{1}{\eta}} - \frac{1}{\eta + 1} X} \Rightarrow s_{ijn} = \frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt}
\]

**Lemma C.2.** The equilibrium markdown \( \mu_{ijt} \) is a wage bill share weighted harmonic mean of the monopsonistically competitive markup under \( \eta \) or \( \theta \).

\[
\mu_{ijt} = \frac{\mu_{ijt} MRPL_{ijt}}{s_{ijt}^{\frac{1}{\eta + 1}}} n_{ijt}^{\frac{1}{\eta}} - \frac{1}{\eta + 1} X
\]

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

Substituting (27) into the definition of the wage-bill share:

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

\[
\frac{\partial n_{jt}}{\partial n_{ijt}} n_{jt} = \left( \frac{n_{ijt}}{n_{jt}} \right)^{\frac{\eta + 1}{\eta}}
\]

**Proof:** Using Lemma C.1, we take first-order conditions to derive the optimal employment
decision:

\[
0 = MRPL_{ijt} - \left( \frac{1}{\eta} + 1 \right) \left[ n_{ijt}^{\frac{1}{\eta}} n_{jt}^{\frac{1}{\eta}} - \frac{1}{\eta} X \right] - \left( \frac{1}{\theta} - \frac{1}{\eta} \right) \left[ n_{ijt}^{\frac{1}{\theta}} n_{jt}^{\frac{1}{\theta}} - \frac{1}{\theta} X \right] \frac{1}{n_{jt} \partial n_{ijt}} \]

\[
MRPL_{ijt} = \left[ \eta + \frac{1}{\eta} \right] + \left( \frac{1}{\theta} - \eta + \frac{1}{\eta} \right) \frac{s_{ijt}^{wn}}{w_{ijt}} \]

\[
w_{ijt} = \left[ 1 + \left( 1 - s_{ijt}^{wn} \right) \frac{1}{\eta} + s_{ijt}^{wn} \frac{1}{\theta} \right]^{-1} \cdot MRPL_{ijt}
\]

C.3  Equilibrium properties - Labor Share

Using Lemma C.2, an individual firm’s labor share, \( l_{s_{ij}} \), can be written in terms of the equilibrium markup:

\[
l_{s_{ij}} = \frac{w_{ij} n_{ij}}{\tilde{z}_{ij} \tilde{z}_{ij} n_{ij}^{\alpha}}
\]

\[
l_{s_{ij}} = \tilde{\alpha} \frac{w_{ij}}{\tilde{\alpha} \tilde{z}_{ij} \tilde{z}_{ij} n_{ij}^{\alpha - 1}}
\]

\[
l_{s_{ij}} = \tilde{\alpha} \frac{w_{ij}}{MRPL_{ij}}
\]

\[
l_{s_{ij}} = \tilde{\alpha} \mu_{ij}
\]

Let \( y_{ij} = \tilde{z}_{ij} \tilde{z}_{ij} n_{ij}^{\alpha} \). At the market level, the inverse labor share in market \( j, LS_{j}^{-1} \), is given by the following expression:

\[
LS_{j}^{-1} = \frac{\sum_i y_{ij}}{\sum_i w_{ij} n_{ij}}
\]

\[
= \sum_i \left( \frac{w_{ij} n_{ij}}{\sum_i w_{ij} n_{ij}} \right) \frac{y_{ij}}{w_{ij} n_{ij}}
\]
Using the definition of the wage-bill share,

\[ LS_j^{-1} = \sum_i s_{ij}^{wn} \alpha^{-1} \mu_{ij}^{-1} \]

\[ LS_j^{-1} = \tilde{\alpha}^{-1} \sum_i s_{ij}^{wn} \left[ \frac{\eta + 1}{\eta} + s_{ij}^{wn} \left( \frac{\theta + 1}{\theta} - \frac{\eta + 1}{\eta} \right) \right] \]

\[ LS_j^{-1} = \tilde{\alpha}^{-1} \frac{\eta + 1}{\eta} + \tilde{\alpha}^{-1} \left( \frac{\theta + 1}{\theta} - \frac{\eta + 1}{\eta} \right) HH_{j}^{wn} \]

Define the inverse Herfindahl at the market level as \( IHH_{j}^{wn} = (HH_{j}^{wn})^{-1} \). Aggregating across markets yields the economy-wide labor share:

\[ LS^{-1} = \frac{\int \sum y_{ij}}{\int \sum w_{ij} n_{ij}} = \frac{\int \sum w_{ij} n_{ij} \sum y_{ij}}{\int \sum w_{ij} n_{ij} \sum w_{ij} n_{ij}} \]

\[ = \int s_{j}^{wn} LS_{j}^{-1} \]

\[ LS^{-1} = \frac{1}{\tilde{\alpha}} \left( \frac{\eta + 1}{\eta} + \left( \frac{\theta + 1}{\theta} - \frac{\eta + 1}{\eta} \right) \right) \int s_{j}^{wn} \left( IHH_{j}^{wn} \right)^{-1} \]}

C.4 Equilibrium properties - Wage Pass-Through

In this section, we adopt the approach of Amiti, Itskhoki, and Konings (2014) to solve for the pass-through of shocks to the marginal product of labor to wages. Let \( mr_i = \log MRPL_i \) be the log marginal revenue of the firm. In this section, variables in levels are capitalized and variables in logs are non-capitalized, and we focus on the single market case, where \( j = 1 \) and thus we omit the market subscript \( j \) (e.g. \( S_i \) will denote an individual firm’s wage bill share, \( S_i = s_{ij}^{wn} \)). The following accounting identity holds in our model \( w_i = mr_i + \mu_i \). While we cast the problem in terms of shares \( \{S_i\} \), the optimal markdown can \( \mu_i \) can be computed in terms of competitor wages, \( w_i^* = mr_i + M_i^* (w_i^*, w_{-i}) \).

Taking the total derivative yields:

\[ dw_i^* = dmr_i + \mu_i^* (w) dw_i + \sum_{j \neq i} \mu_{ij}^* (w) dw_j \]

where \( \mu_{ij}^* (w) = \frac{\partial \mu_i^* (w)}{\partial w_j} \).
This implies the following expression for pass-through:

\[ dw_i = \frac{1}{1 + \Gamma_i(w)} dmr_i + \frac{\Gamma_{-i}(w)}{1 + \Gamma_i(w)} \sum_{j \neq i} \omega_{ij}(w) dw_j \]

where

\[ \Gamma_i(w) = -M_{ii}^*(w) > 0 \]
\[ \Gamma_{-i}(w) = \sum_{j \neq i} \mu_{ij}^*(w) > 0 \]
\[ \omega_{ij}(w) = \frac{\mu_{ij}^*(w)}{\sum_{k \neq i} \mu_{ik}^*(w)} \]

Define the expenditure of a market, \( E(W, \bar{N}) \), as follows:

\[ E(W, \bar{N}) = \max_{\{N_i\}} \sum_i W_i N_i \quad s.t. \quad N (N_1, \ldots, N_N) = \bar{N} \]

In words, this is the maximum amount of earnings attainable for a given level of disutility of labor. We will predominately work with the log expenditure of a market, \( e(w, \bar{v}) \).

\[ e(w, \bar{v}) = \log \left( \max_{\{n_i\}} \sum_i \exp (w_i + n_i) \right) \quad s.t. \quad V(n_i, \bar{v}) = 1 \]

\( e(w, \bar{v}) \) is the maximum amount of log earnings that can be achieved in the sector when the household has a maximum labor disutility from that sector of \( \bar{N} = e^\bar{\nu} \).

Define \( \varepsilon_i \) (dropping the j subscript from equation (28)) to be the perceived elasticity of labor supply.

**Lemma C.3.** 1. If \( e = e(w) \) is a sufficient statistic for competitor wages, i.e. if the supply can be written as \( n_i(w_i, w_{-i}) = n_i(w_i, e(w)) \), then the weights are such that \( \omega_{ij} = \frac{\mu_{ij}^*(w)}{\sum_{k \neq i} \mu_{ik}^*(w)} = S_j \).

2. If, in addition, the perceived elasticity of supply is a function of the price of the firm relative to industry expenditure, i.e. \( \varepsilon_i = \varepsilon_i(w_i, w_{-i}) = \varepsilon_i(w_i - e(w)) \), then the two markup elasticities are equal, \( \sum_{j \neq i} \mu_{ij}^*(w) = -M_{ii}^*(w) \), and \( \Gamma_{-i} = \Gamma_i \).

**Proof:** By the envelope theorem: \( \frac{\partial e(w, \bar{v})}{\partial w_i} = S_i(w, \bar{v}) \). If the optimal hiring rule can be written in terms of own wages and the industry expenditure share, \( n_i(w_i, e(w)) \), then \( \mu_i^*(w) = \)

---

\[ 1^{9} \text{For example, CES yields: } \bar{N} = \left[ \sum_i n_i^{\frac{q+1}{q}} \right]^\frac{q}{q+1}, \quad 1 = \sum_i (n_i/\bar{N})^{\frac{q+1}{q}} \equiv V(n_i, \bar{N}) \]
\( \mu_i^* (w_i, e (w)) \). In that case \( \mu_{ij}^* (w) = \frac{\partial \mu_i^*}{\partial w_j} \), and so \( \mu_{ij}^* (w) = \frac{\partial \mu_i^*}{\partial w_j} S_j \).

This breaks the expression into \( i \) and \( j \) components that are independent. Therefore when substituting into \( \omega_{ij} \), the derivatives of \( \mu_i^* \) with respect to earnings cancel out: \( \omega_{ij} = \frac{\partial \mu_i^*}{\partial w_j} S_j = \frac{s_i}{\sum k \neq i, s_k} \).

If \( \epsilon_i = \epsilon_i (w_i, w_{-i}) = \epsilon_i (w_i - e (w)) \), then from equation (4.3), \( \mu_i^* (w) = \log \frac{\epsilon_i (w)}{\epsilon_i (w)+1} = \log \frac{\epsilon_i (w_i - e (w))}{\epsilon_i (w_i - e (w)) + 1} = \mu_i^* (w - e (w)) \). Taking first order conditions with respect to the argument \( x = e - e (w) \) of \( \mu_i^* (x) \) yields, \( \mu_{ii}^* (w) = \frac{\partial \mu_i^*}{\partial e} [1 - S_i] \). Noticing that \( \partial \mu_i^* / \partial e = -\partial \mu_i^* / \partial x \) implies that \( \mu_{ii}^* (w) = -\frac{\partial \mu_i^*}{\partial e} [1 - S_i] \). Now using the definition of \( \Gamma_{-i} \), we can prove equivalence:

\[
\Gamma_{-i} = \sum_{j \neq i} \mu_{ij}^* (w) = \sum_{j \neq i} \frac{\partial \mu_i^*}{\partial e} (w) S_j = \frac{\partial \mu_i^*}{\partial e} (w) \sum_{j \neq i} S_j = \frac{\partial \mu_i^*}{\partial e} (w) [1 - S_i] = -\mu_{ii} (w) = \Gamma_i
\]

\( \square \)

We can verify that in our model economy that labor supply satisfies \( n_i (w) = n_i (w_i, e (w)) \) and that the perceived labor supply elasticity satisfies \( \epsilon_i = \epsilon_i (w_i - e (w)) \)

Using the definition of the wage index, the log wage expenditure is given by the sum of the log wage index and log labor supply index: \( e (w, \bar{v}) = w (w) + \bar{v} \). Assume \( \bar{v} = 0 \) (i.e. the CES aggregate disutility of labor supply is restricted to equal 1, \( \bar{N} = 1 \), for simplicity. Using equation (3), log labor supply can be written similarly, \( n_i (w) = \eta w_i - (\eta - \theta) e (w) = n_i (w_i, e (w)) \).

We can use properties of the CES aggregator to show,

\[
\frac{\partial W (w)}{\partial W_i} = \frac{W_i}{W (w)} = \left( \frac{W_i}{W (w)} \right)^{1+\eta}
\]

Now use the definition of the wage index (along with our simplifying assumption that \( \bar{N} = 1 \), to see that \( E (w) = W (w) \bar{N} = W (w) \)). Substitute that into equation 29. Then the derivative of the expenditure function is given by, \( \frac{\partial e (w)}{\partial w_i} = (1 + \eta) (w_i - e (w)) \).

Lastly, the perceived labor supply elasticity \( \epsilon_i \) is a function of shares. The shares, however, can be written \( S_i = \frac{\partial e (w)}{\partial w_i} \). Substituting this relationship into the labor supply elasticity implies \( \epsilon_i (w) = g (S_i; \eta, \theta) = g \left( \frac{e (w)}{w_i}; \eta, \theta \right) = \epsilon_i (w) \). Substitute in \( \frac{\partial e (w)}{\partial w_i} = (1 + \eta) (w_i - e (w)) \) to see that the final condition is satisfied, \( \epsilon_i (w) = g ((1 + \eta) (w_i - e (w)), \eta, \theta) = \epsilon_i (w_i - e (w)) \).
With these results in hand, the wage pass-through in our model is given by,

\[ dw_i = \frac{1}{1 + \Gamma_i (w)} dm_i + \frac{\Gamma_i (w)}{1 + \Gamma_i (w)} \sum_{j \neq i} S_j dw_j \]

In our framework \( \mu_{ii} = \epsilon_{ii} \) where \( \epsilon_{ij} = \left( \left( 1 - s_{ij}^{wn} \right) \frac{1}{\eta} + s_{ij}^{wn} \frac{1}{\theta} \right)^{-1} \). Applying this to our model yields,

\[ \mu_{ii}^* (w) = \frac{\partial \mu_{ii}^*}{\partial w_i} = \frac{\partial \log \epsilon_{ii}^*}{\partial \log s_{ij}^{wn}} = - \frac{(\eta - \theta)(1 + \eta)s_{ij}^{wn}(1 - s_{ij}^{wn})}{\theta(1 - s_{ij}^{wn}) + \eta s_{ij}^{wn} + \theta \eta} \]

We can therefore write the pass-through expression as follows:

\[ dw_i = \Omega \left( s_{ij}^{wn} \right) dm_i + \left( 1 - \Omega \left( s_{ij}^{wn} \right) \right) \sum_{k \neq i} s_{kj}^{wn} dw_j \]

\[ \Omega \left( s_{ij}^{wn} \right) = \frac{1}{1 + \Gamma \left( s_{ij}^{wn} \right)} \]

\[ \Gamma \left( s_{ij}^{wn} \right) = \frac{(\eta - \theta)(1 + \eta)}{\theta(1 - s_{ij}^{wn}) + \eta s_{ij}^{wn} + \theta \eta} \left( 1 - s_{ij}^{wn} \right) s_{ij}^{wn} \]

In the limit as the wage bill share approaches zero or one, pass-through declines to zero: \( \Omega (1) = \frac{(\eta - \theta) + \theta(\eta + 1)}{[1(\eta - \theta) + \theta(\eta + 1)]} = 1 \) and \( \Omega (0) = \frac{\theta(\eta + 1)}{\theta(\eta + 1)} = 1 \).

### D  Constant Returns to Scale Computation (\( \gamma = 1 \))

**Lemma D.1.** A firm’s wage-bill share is defined by their relative wage:

\[ s_{ij}^{wn} = \left( \frac{w_{ij}}{w_j} \right)^{1+\eta} \]

**Proof:** To see this, first take the derivative of the wage bill index:

\[ \frac{\partial w_j}{\partial w_{ij}} = \left[ \int_0^1 w_{ij}^{1+\eta} dj \right]^{\frac{1}{1+\eta} - 1} w_{ij}^\eta = w_j^{-\eta} w_{ij}^\eta \]

This yields the following expression for the elasticity of the sectoral wage with respect to the
individual wage:

\[ \frac{\partial w_j}{\partial w_{ij}} w_{ij} = \left( \frac{w_{ij}}{w_j} \right)^{1+\eta} \]

We now express the wage bill in terms of idiosyncratic and market level components. Let

\[ X_{jt} = \hat{\varphi} \left( \frac{1}{w_{jt}} \right)^{\eta} \left( \frac{w_{jt}}{W_t} \right)^{\theta} \left( W_t \right)^{\varphi}. \]

Using the worker’s labor supply curve (3), the wage bill is given by:

\[ w_{ij} n_{ij} = w_{ij}^{1+\eta} X_{jt} \]

So that the wage bill payment share is

\[ s_{ij}^{wn} = \frac{w_{ij} n_{ij}}{\sum_i w_{ij} n_{ij}} = \frac{w_{ij}^{1+\eta}}{\sum_i w_{ij}^{1+\eta}} = \frac{w_{ij}}{w_j^{1+\eta}} \]

Combining these equations yields the desired result:

\[ s_{ij}^{wn} = \left( \frac{w_{ij}}{w_j} \right)^{1+\eta} = \frac{\partial w_j}{\partial w_{ij}} \frac{w_{ij}}{w_j} \]

Within a market, an equilibrium can be solved by iterating through the following conditions
given a guess of \( s_{wn}^j = (s_{wn1}^j, \ldots, s_{wnM}^j) \)

\[
\varepsilon_{ij} = \begin{cases} 
\frac{s_{wn}^j \theta + (1 - s_{wn}^j) \eta}{[s_{wn}^j \frac{1}{\theta} + (1 - s_{wn}^j) \frac{1}{\eta}]}^{-1} & \text{Bertrand} \\
\varepsilon_{ij} & \text{Cournot}
\end{cases}
\]

\[
\mu_{ij} = \frac{\varepsilon_{ij}}{\varepsilon_{ij} + 1}
\]

\[
w_{ij} = \mu_{ij} \MRPL_{ij}
\]

\[
\mathbf{w}_j = \left[ \int_0^1 w_{ij}^{1+\eta} d_j \right]^{\frac{1}{1+\eta}}
\]

\[
\hat{s}_{wn}^{\text{NEW}} = \left( \frac{w_{ij}}{\mathbf{w}_j} \right)^{1+\eta}
\]

We guess equal shares, and then iterate until \( \hat{s}_{wn}^{\text{NEW}} = s_{wn}^j \).

**E  Non-Constant Returns to Scale Computation \( \gamma \neq 1 \)**

We solve the model by (i) guessing a vector of wage-bill shares, \( s_{wn}^j = (s_{wn1}^j, \ldots, s_{wnM}^j) \), (ii) solving for firm-level markdowns, firm-level wages, and the sectoral wage index, and (iii) updating the wage-bill share using firm-level wages and the sectoral wage index.

From the main text, we define the marginal revenue product of labor as follows:

\[
\MRPL_{ij} = \frac{\frac{e_{ij}}{\mu_{ij}}}{1 - \eta} - \frac{\theta}{1 - \eta}
\]

Substituting for \( n_{ijt} \) using the labor supply equation (3), and defining \( \hat{z}_{ij} = \frac{z_{ij}}{\hat{z}_{ij}} \) and \( \omega = \frac{\hat{z}_{ij}}{\hat{z}_{ij}} \), then the marginal revenue product of labor can be written as:

\[
\MRPL_{ij} = \omega W^{(1-\hat{z})(\theta - \phi)} \hat{z}_{ij} \left\{ \frac{w_{ij} - \eta w_{ij} \eta - \theta}{w_{ij}} \right\}^{1-\hat{z}}
\]

Use Lemma C.2 to write the wage in terms of the marginal revenue product of labor:

\[
w_{ij} = \mu_{ij} \MRPL_{ij}
\]

\[
w_{ij} = \mu_{ij} \omega W^{(1-\hat{z})(\theta - \phi)} \hat{z}_{ij} \left\{ \frac{w_{ij} - \eta w_{ij} \eta - \theta}{w_{ij}} \right\}^{1-\hat{z}}
\]
Use Lemma D.1 (which implies \( w_j = w_{ij} s_{ij}^{-1/(\eta+1)} \)) to write this expression in terms of wage-bill shares, and then solve for \( w_{ij} \). The resulting expression is given below:

\[
w_{ij} = \omega^{1/(\eta+1)} W^{(1-\bar{z})/\eta} \mu_{ij}^{1/(\eta+1)} \omega^{1/(\eta+1)} \theta_{ij} s_{ij}^{\eta/(\eta+1)} \bar{w}_{ij}^{(1-\bar{z})/(\eta+1)} \frac{1}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s} - \frac{(1-\bar{z})/(\eta+1)}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s}
\]

We will solve for an equilibrium in ‘hatted’ variables, and then rescale the ‘hatted’ variables to recover the equilibrium values of \( n_{ij} \) and \( w_{ij} \). Define the following ‘hatted’ variables:

\[
\hat{w}_{ij} := \mu_{ij}^{1/(\eta+1)} \omega^{1/(\eta+1)} \theta_{ij} s_{ij}^{\eta/(\eta+1)} \bar{w}_{ij}^{(1-\bar{z})/(\eta+1)} \frac{1}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s} - \frac{(1-\bar{z})/(\eta+1)}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s} \frac{1}{1+\alpha_{ij}^s}
\]

\[
\hat{w}_j := \left[ \sum_{i \in j} \hat{w}_{ij}^{\eta+1} \right]^{1/(\eta+1)}
\]

\[
\hat{W} := \left[ \int \hat{w}_j^{\theta+1} d_j \right]^{1/(\eta+1)}
\]

\[
\hat{n}_{ij} := \left( \frac{\hat{w}_{ij}}{\hat{w}_j} \right)^{\eta} \left( \frac{\hat{w}_j}{\hat{W}} \right)^{\theta} \left( \frac{1}{\hat{W}} \right)^{\varphi}
\]

These definitions imply that

\[
w_{ij} = \omega^{1/(\eta+1)} W^{(1-\bar{z})/\eta} \hat{w}_{ij}
\]

\[
w_j = \omega^{1/(\eta+1)} W^{(1-\bar{z})/\eta} \hat{w}_j
\]

\[
W = \omega^{1/(\eta+1)} W^{(1-\bar{z})/\eta} \hat{W}
\]

These definitions allow us to compute the equilibrium market shares in terms of ‘hatted’ variables:

\[
s_{j}^{\omega n} = \left( \frac{w_{ij}}{w_j} \right)^{\eta+1} = \left( \frac{\hat{w}_{ij}}{\hat{w}_j} \right)^{\eta+1}
\]

For a given set of values for parameters \( \{ \phi, \bar{z}, \bar{z}, \beta, \delta \} \), we can solve for the non-constant returns to scale equilibrium as follows:

1. Guess \( s_{j}^{\omega n} = (s_{1j}^{\omega n}, \ldots, s_{Mj}^{\omega n}) \)

2. Compute \( \{ e_{ij} \} \) and \( \{ \mu_{ij} \} \) using the expressions in Lemma C.2.
3. Construct the ‘hatted’ equilibrium values as follows:

\[ \hat{w}_{ij} = \mu_{ij}^{\frac{1}{1+\gamma}} \hat{z}_{ij}^{\frac{1}{1+\gamma}} s_{ij}^{-\frac{(1-\delta)(\delta-\eta)}{\eta+1}} \]

\[ \hat{w}_j = \left( \sum_{i \in j} \hat{w}_{ij}^{\eta+1} \right)^{\frac{1}{\eta+1}} \]

\[ \hat{W} = \left[ \int \hat{w}_j^{\theta+1} d_j \right]^{\frac{1}{\theta+1}} \]

\[ \check{n}_{ij} = \left( \frac{\check{w}_{ij}}{\check{w}_j} \right)^{\eta} \left( \frac{\check{w}_j}{\check{W}} \right)^{\theta} \left( \frac{1}{1} \right)^{\varphi} \]

4. Update the wage-bill share vector using equation (30).

5. Iterate until convergence of wage-bill shares.

**Recovering true equilibrium values from ‘hatted’ equilibrium:** Once the ‘hatted’ equilibrium is solved, we can construct the true equilibrium values by rescaling as follows:

\[ \omega = \frac{\bar{z}}{\bar{\phi}^{1-\bar{\kappa}}} \quad (31a) \]

\[ W = \omega^{\frac{1}{1+\theta}} \bar{W}^{\frac{1}{1+\theta}} \quad (31b) \]

\[ w_{ij} = \omega^{\frac{1}{1+\theta}} W^{\frac{(1-\delta)(\delta-\eta)}{\eta+1}} \check{w}_{ij} \quad (31c) \]

\[ w_j = \omega^{\frac{1}{1+\theta}} W^{\frac{(1-\delta)(\delta-\eta)}{\eta+1}} \check{w}_j \quad (31d) \]

\[ n_{ij} = \bar{\phi} \left( \frac{w_{ij}}{w_j} \right)^{\eta} \left( \frac{w_j}{W} \right)^{\theta} \left( \frac{1}{1} \right)^{\varphi} \quad (31e) \]

### E.1 Scaling the economy

We set the scale parameters \( \bar{\phi} \) and \( \bar{z} \) in order to match average firm size observed in the data \( \text{AveFirmSize}^{\text{Data}} = 27.96 \) from Table 8, and average earnings per worker in the data \( \text{AveEarnings}^{\text{Data}} = \)
To compute the values of $\bar{\phi}$ and $\bar{z}$ that allow us to match $\text{AveFirmSize}_{\text{Data}}$ and $\text{AveEarnings}_{\text{Data}}$, we substitute the model’s values for $n_{ij}, w_{ij},$ and $M_j$ into $\text{AveFirmSize}_{\text{Data}}$ and $\text{AveEarnings}_{\text{Data}}$. We repetitively substitute equations (31a) through (31e) into (32a) and (32b). We then solve for $\bar{\phi}$ and $\bar{z}$ in terms of ‘hatted’ variables as follows:

$$\bar{\phi} = \frac{\text{AveFirmSize}_{\text{Data}}}{\text{AveFirmSize}_{\text{Model}}} \phi$$

$$\bar{z} = \bar{\phi}^{1-\hat{\alpha}} \left( \frac{\text{AveEarnings}_{\text{Data}}}{\text{AveEarnings}_{\text{Model}}} \right)^{1+(1-\hat{\alpha})\phi} \times \hat{W}^{-(1-\hat{\alpha})(\theta-\phi)}$$

where

$$\text{AveFirmSize}_{\text{Model}} = \int \left\{ \sum_{i \in j} n_{ij} \right\} dj$$

$$\text{AveEarnings}_{\text{Model}} = \int \left\{ \sum_{i \in j} w_{ij} n_{ij} \right\} dj$$

The scaled model equilibrium values (defined by (31a) through (31e) evaluated at (33) and (34)) will now match $\text{AveFirmSize}_{\text{Data}}$ and $\text{AveEarnings}_{\text{Data}}$.

F Corporate Taxes and Labor Demand

Consider a single firm $i$. Assume constant returns to scale. Let the corporate tax rate be given by $\tau_c$, and let the fraction of capital financed by debt be $\lambda$. Accounting profits of a firm (on
which taxes are based) are given by

$$\pi^A = Pz_i k_i^{1-\alpha} n_i^{\alpha} - w_i n_i - \lambda r k_i - \delta k_i$$

The pre-tax economic profits of a firm are given by

$$\pi^E = Pz_i k_i^{1-\alpha} n_i^{\alpha} - w_i n_i - rk_i - \delta k_i$$

The after-tax economic profits of a firm are given by

$$\pi = \pi^E - \tau c \pi^A$$

Define $\tilde{z}_i = (1 - \tau_c) z_i$, $\tilde{w}_i = (1 + \tau_r) w_i$, and $\bar{r} = (1 + \lambda \tau_c) r + (1 + \tau_c) \delta$. After substituting and solving, the profit maximization problem of the firm becomes:

$$\max_{k_i, n_i} \tilde{z}_i P k_i^{1-\alpha} n_i^{\alpha} - \tilde{w}_i n_i - \bar{r} k_i$$

Substituting for capital, the profit maximization problem becomes

$$\pi = \max_{n_i} \left[ (1 - \alpha) \frac{1}{\alpha} - (1 - \alpha) \frac{1}{\alpha} \tilde{z} \frac{1}{\tilde{r}^{\frac{1}{\alpha}}} - \tilde{w} \right] n_i$$

We can scale the profits by $\frac{1}{1+\tau_c}$ and then use the definition of $\tilde{w}_i$ to write profits as follows:

$$\hat{\pi} = \frac{\pi}{1+\tau_c} = \max_{n_i} \left[ \tilde{MRL}_i - \tilde{w}_i \right] n_i$$

Where the marginal product is given by,

$$\tilde{MRL}_i = \left[ (1 - \alpha) \frac{1}{\alpha} - (1 - \alpha) \frac{1}{\alpha} \tilde{z} \frac{1}{\tilde{r}^{\frac{1}{\alpha}}} - \tilde{w} \right]$$

In the estimation, we do not need to take a stance on the value of $\lambda$ (the share of capital financed by debt), but this expression shows how corporate tax rates map to labor demand.

G Calibration Details

We assume there are 5,000 markets. For computational reasons, we must cap the number of firms per market since the Pareto distribution has a fat tail. We set the cap equal to 200 firms per
market. Our results are not sensitive to the number of markets or the cap on firms per market. Figure 7 plots the mixture of Pareto distributions from which we draw the number of firms per market, $M_j$. The distribution of the number of firms per market, $G(M_j)$, is a mixture of Pareto distributions. The thin tailed Pareto has the following parameters: Shape=0.67, Scale=5.7, Location=2.0. The fat tailed Pareto has the following parameters: Shape=0.67, Scale=6.25×5.7, Location=2.0.