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ABSTRACT

Using data on the near-universe of online US job vacancies collected by Burning Glass Technologies in 2016, we calculate labor market concentration using the Herfindahl-Hirschman index (HHI) for each commuting zone by 6-digit SOC occupation. The average market has an HHI of 4,378, or the equivalent of 2.3 recruiting employers. 60% of labor markets are highly concentrated (above 2,500 HHI) according to the DOJ/FTC guidelines. Highly concentrated markets account for 20% of employment. For manufacturing industries, we show that labor market concentration is distinct from product market concentration, and is negatively correlated with wages in each industry's top occupation.

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1 Introduction

While interest in labor market monopsony power has increased in recent years (Ashenfelter, Farber and Ransom, 2010; Manning, 2011; CEA, 2016), the effects of mergers and other anti-competitive conduct on labor markets are generally not taken into account in antitrust practice. Antitrust enforcement is based on the consumer welfare standard, i.e. examining the adverse effects of anticompetitive behavior for consumers. This is despite substantial evidence of market power in the labor market (Staiger, Spetz and Phibbs, 2010; Falch, 2010; Ransom and Sims, 2010; Dube, Lester and Reich, 2016). But this empirical work has generally focused on particular labor markets (e.g. Matsudaira, 2013), and there is little evidence to inform the debate about how widespread labor market concentration is, and how it varies across occupations and geographies in the US.

In this paper, we directly quantify the level of labor market concentration across nearly all occupations and for every commuting zone in the US. Adequately measuring concentration is important because concentration is associated with lower wages (Azar, Marinescu and Steinbaum, 2017)[1], and the antitrust authorities rely on the levels of concentration for enforcement. We use a dataset from Burning Glass Technologies (BGT) covering the near-universe of online US vacancy postings in 2016. This allows us to give a comprehensive picture of labor market concentration in the US. Furthermore, this paper carefully discusses the definition of a labor market. In particular, we make use of a hypothetical monopsonist test analogous to the hypothetical monopolist test in antitrust practice. The essence of such a test is to ask whether significant wage suppression is profitable for firms; the profitability of wage suppression depends on how many workers will leave in the face of wage suppression, i.e. the labor supply elasticity.

We calculate Herfindahl Hirschman Indices (HHIs) for labor markets at the occupation (6-

[1]This working paper uses data for the most frequent occupations from one single online job board (CareerBuilder.com), therefore presenting a partial measure of concentration.

digit SOC), commuting zone, and quarterly level. For manufacturing, we can show that labor market concentration is barely correlated with product market concentration, which shows that, practically speaking, it would make a difference if antitust authorities examined labor market concentration rather The average market has an HHI of 4378, which is the equivalent of 2.3 recruiting firms with equal shares of the total vacancy pool. 60% of markets are highly concentrated (above 2,500 HHI) by the standard of the Department of Justice / Federal Trade Commission 2010 horizontal merger guidelines. To understand the threshold for high concentration, note that a market with four firms and equal market shares has an HHI of 2,500, so an HHI of 2500 is the equivalent of 4 recruiting firms with equal shares of the total vacancy pool. Another 11% of markets are moderately concentrated by the standard of the Department of Justice / Federal Trade Commission 2010 horizontal merger guidelines, i.e. have an HHI between 1,500 and 2,500. When we weight markets by BLS total employment, we find that 20 percent of workers work in highly concentrated labor markets (by our measure of concentration from Burning Glass), and a further 8 percent work in moderately concentrated markets. Concentration is lower in large commuting zones, which explains why weighting by employment lowers the prevalence of high concentration.

We discuss the definition of a labor market, and provide a justification for our choice of the 6-digit SOC by commuting zone by quarter; we also calculate concentration for a number of alternative market definitions in terms of occupation, location and time. According to several plausible alternative market definitions, we find that at least 40% of markets are highly concentrated. Given the observed level of concentration, company mergers have the potential to significantly increase employers' *labor* market power. The labor market concentration measure we develop here can be usefully leveraged in merger reviews and the litigation of other anti-competitive behaviors in the labor market, as detailed in Marinescu and Hovenkamp (2018) and Naidu, Posner and Weyl (2018).[2]

[2]Examples include no-poaching agreements (Ashenfelter and Krueger, 2017), and, in some cases, non-competition agreements (Starr, Prescott and Bishara, 2017).

Our measure of concentration is distinct from the industry concentration measures used in antitrust practice and by Autor et al. (2017) and Barkai (2016). Our measure is based on concentration in the labor market rather than concentration in the product market. Our contribution is complementary to the existing literature on product market concentration, and it is the first economy-wide measure of labor market concentration to have been made in many decades.[3] Using the case of manufacturing in 2012, we demonstrate that labor market concentration in an industry's top occupation is much greater than product market concentration: based on an unweighted average across NAICS-4 industries, product market concentration is 411 and labor market concentration (weighted by local employment) is 3,955. Furthermore, there is only a correlation of 0.1 between labor market concentration and product market concentration across NAICS-4 manufacturing industries, implying that some industries that have relatively low product market concentration can have relatively large labor market concentration in their top occupation. Finally, labor market concentration is significantly negatively correlated with occupational wages across NAICS-4, but not with product market concentration. This suggests that antitrust enforcement guided by labor market concentration would be different from antitrust enforcement guided by product market concentration alone.

The recent working paper that comes closest to our approach is Benmelech, Bergman and Kim (2018), which uses Census data for manufacturing industries over a long time horizon to measure employment concentration (as opposed to vacancy concentration) and its negative effect on wages. Even more recently, Rinz (2018) calculated labor market concentration by county and industry for the whole economy and investigated the impact on wage inequality. Those authors focus on county-industries as the analogues to local labor markets, whereas we use commuting zones and six-digit SOC occupations.

In contrast to Benmelech, Bergman and Kim (2018), we measure concentration using job openings rather than employment because we view vacancies as a better gauge of how likely searching workers (whether employed or unemployed) are to receive a job offer. Recent stud-

[3]The last, to our knowledge, is Bunting (1962); see review of literature by Boal and Ransom (1997).

ies show that workers remain in jobs for longer.[4] The corollary is that jobs are vacated less frequently, and so the concentration of employment is a less relevant gauge of available work and employer market power than is the concentration of vacancies among the relatively few firms who are likely to be hiring at any given time.

Section 2 describes the Burning Glass data, section 3 addresses market definition for labor markets, and section 4 gives our estimates of labor market concentration. Section 6 places our results in the larger debate over inter-firm inequality compares concentration in the labor market to concentration in the product market, and section 7 concludes.

2 Data

We use data from Burning Glass Technologies (BGT). The company examines about 40,000 websites and believes to be able to capture the near-universe of online US vacancies. Hershbein and Kahn (2016); Deming and Kahn (2017); Modestino, Shoag and Ballance (2016) have used this data and provide a more in-depth description. Importantly, BGT data is fairly similar in terms of industry composition when compared to all vacancies recorded in the Job Openings and Labor Turnover Survey (JOLTS) (Hershbein and Kahn, 2016). Furthermore, the occupational distribution is similar to the one found in the Occupational Employment Statistics (Hershbein and Kahn, 2016).

We restrict the data to 2016 because this is the year with the highest data quality and the greatest coverage for vacancies across the US. Indeed, the tools used by BGT improve over time, and more and more of the US vacancies are online.[5] To understand the share of job openings captured by BGT, it is important to note BGT only measures new postings (the same posting appears only on the first month it is recorded) while JOLTS measures active postings (the same posting can appear in two or more consecutive months if time to fill is more than 30 days). Help Wanted Online (HWOL) measures both. Therefore, the number of postings on

[4] See Haltiwanger et al. (forthcoming), Molloy et al. (2016), and Konczal and Steinbaum (2016).
[5] Average concentration levels in 2007-2015 are comparable to average concentration levels in 2016.

BGT can be inflated using the new jobs to active jobs ratio in HWOL, i.e. the same method used in Carnevale, Jayasundera and Repnikov (2014). Based on this calculation, BGT shows that the share of jobs online as captured by BGT is roughly 85% of the jobs in JOLTS in 2016. The jobs that are not online now are usually in small businesses (the classic example being the "help wanted" sign in the restaurant window) and union hiring halls. Overall, however, research shows the online job market has consistently expanded over the last few years.

The data is cleaned by Burning Glass to remove vacancy duplicates and extract key characteristics for each vacancy. Of interest to our work are the location of the vacancy (county), name of the employer, and the occupation. The name of the employer is normalized by BGT so that similar employer names are grouped together into a single employer: for example, "Bausch and Lomb", "Bausch Lomb", and "Bausch & Lomb" would be grouped together. Still, 35.9% of employer names are missing, partly due to staffing companies not disclosing which employer the job is at. To calculate concentration, we will assume that all these missing employer names are different, thus providing a lower bound for labor market concentration.

The BGT dataset contains many variables describing the occupation of each vacancy. These include the SOC code, the standardized job title, and the BGT occupation. The standardized job title is based on the full text job title of the job vacancy: the full text job title is cleaned and similar job titles are grouped together. The BGT occupation starts with the SOC code, and either consolidates SOC codes or divides them into several categories based on the similarity of skills, education and knowledge requirements.

We drop internships and data with missing SOC or commuting zones, which represents 5.2% of the initial sample. We are left with a sample of 22,682,265 observations.

For our benchmark analysis, we keep 200 occupations, which represent 90% of vacancy postings in the BGT dataset. We trim away very small occupations because they may be defined too narrowly. We note that this choice results in lower HHI than if we had included all occupations. The total number of markets (6-digit SOC occupation by commuting zone) we consider in our main analysis is 117,369.

Our main summary statistics on HHI treat each cell (commuting zone by 6-digit SOC by quarter) as an observation. But we also want to understand how the summary statistics change when we weight by employment in each of these markets. When we report HHI weighted by employment, we include every occupation in the data, since small and possibly ill-defined occupations will not be overly influential after weighing by employment. To analyze HHI weighted by employment, we use the May 2016 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage estimates from the Bureau of Labor Statistics (BLS). The BLS data is only available at the CBSA level, and not at the commuting zone level. To get commuting zone employment, we first estimate BLS county-level employment: we use county population shares within a CBSA and multiply these shares with the BLS employment by 6-digit SOC at the CBSA level. Finally, to get commuting zone 6-digit SOC employment numbers, we aggregate the 6-digit SOC employment numbers across the counties that form a commuting zone.

3 Herfindahl-Hirschman Index and Labor Market Definition

3.1 Herfindahl-Hirschman Index

Our baseline measure of concentration in a labor market is the Herfindahl-Hirschman Index (HHI) calculated based on the share of vacancies of all the firms that post vacancies in that market. The HHI is directly related to wages in the Cournot model of oligopsonistic competition. An increase in HHI leads to a proportional increase in the gap between the marginal productivity of labor and wages, i.e. Pigou's rate of exploitation or the wage markdown (Boal and Ransom, 1997).

The HHI is widely used as a measure of market concentration in the industrial organization literature and in antitrust practice. Nocke and Schutz (2018) show that it provides an adequate measure of the welfare distortions introduced by market power in the horizontal merger con-

text. A further practical advantage of this measure of market concentration is that there are guidelines for what represents a high level of market concentration. The DOJ/FTC guidelines: an HHI above 1500 is "moderately concentrated", and above 2500 is "highly concentrated". Also, a merger that increases the HHI by more than 200 points, and leads to a highly concentrated market is "presumed likely to increase market power".

While these measures and thresholds are generally used to evaluate market concentration in product markets, the antitrust agency guidelines state that "[t]o evaluate whether a merger is likely to enhance market power on the buying side of the market, the Agencies employ essentially the framework described above for evaluating whether a merger is likely to enhance market power on the selling side of the market." This implies that adverse effects of mergers on the inputs market, including the labor market, are part of the legal framework for evaluating mergers.

The formula for the HHI in market m and time t is

$$\text{HHI}_{m,t} = \sum_{j=1}^{J} s_{j,m,t}^2 \tag{3.1}$$

where $s_{j,m}$ is the market share of firm j in market m expressed as a number between 0 and 100. The market share of a firm in a given market and time is defined as the sum of vacancies posted by a given firm in a given market and time divided by total vacancies posted in that market and time. The inverse of the HHI multiplied by 10,000, 10,000/HHI, gives the "equivalent" number of firms in the market, or the number of firms that would result in such an HHI if each had the same share of the market. When reporting average HHI, we first take the average over time t for each market m. A key question is how the labor market should be defined.

3.2 Frictions to worker mobility across markets

The economic literature shows that there are substantial frictions associated with transitioning between labor markets, however defined (Artuc, Chaudhuri and McLaren, 2010; Dix-

Caneiro, 2014; Artuc and McLaren, 2015; Traiberman, 2017; Macaluso, 2017). Marinescu and Rathelot (2017) (and Manning and Petrongolo (2017) for the UK) find that job search behavior is quite local, implying that geographic labor markets are also narrowly defined.

No work, to our knowledge, attempts to define labor markets in the education space. Macaluso (2017) defines the concept of "skill remoteness" on the supply and demand sides of a labor market and finds that workers whose skills are further away from the available jobs in their local labor market (defined by city and occupation) are more likely to either move or exit the labor force in response to a layoff. Hershbein and Kahn (2017) and Modestino, Shoag and Ballance (2016) use the same dataset we employ in this paper to characterize the skill distribution of job vacancies as changing in response to the severity of local labor market recessions. But the extent to which workers confine their job searches to an education- or skills-delimited segment of available jobs has not yet been systematically explored (but see some evidence on search across occupations in Marinescu and Rathelot (2017)).

It is important to note that monopsony and market power may render observed transition rates endogenous. For example, workers displaced from their job in a local labor market will be more likely to transition to an unconcentrated than a concentrated labor market.

Based on this literature, it is clear that labor markets are relatively narrow, but how exactly a labor market should be defined remains unclear.

Conceptually, to define a market, we have to strike a balance between too narrow a definition and too broad a definition. If the definition is too narrow, there are plenty of opportunities outside the market. If the definition is too broad, it overestimates the similarity of jobs within the market, and therefore overestimates the opportunities available within a market. Given that workers do transition occasionally across essentially any market, it is not reasonable to define a market by the requirement that no worker ever goes outside the boundaries of this market. Instead, a market can conceptually be defined by a threshold level of across-market transitions such that if transitions are above this threshold, the market is too narrow, and if they are below this threshold the market is too broad.

We now turn to the legal practice of product market definition, which develops a threshold concept, the critical elasticity. We will show how this concept can be applied to the labor market.

3.3 Market definition: legal framework

In this subsection and the next two, we discuss our choice of the commuting zone by 6-digit SOC by quarter as our baseline market definition.

Under §7 of the Clayton Act the court must identify some "line of commerce" and "section of the country" in which a contemplated merger threatens lower output and higher prices. Ever since the Supreme Court's Brown Shoe decision, it has become conventional to identify these two statutory requirements, respectively, as a relevant product market and a relevant geographic market. Under the approach laid out in the 2010 Horizontal Merger Guidelines, the government first makes out a prima facie case that a merger is likely to result in an anticompetitive price increase in at least one affected market. A merger challenge only needs to identify one market and geography in which anticompetitive results would be substantially likely to occur.

3.4 Market definition: time and geography

For our baseline analysis, we calculate HHI at the quarterly level, since the median duration of unemployment is about 10 weeks in 2016 BLS (2017).[6] We consider for our market share calculations all vacancies that occur within a given quarter. We will also show results for other time aggregations.

We use commuting zones (CZs) to define geographic labor markets. Commuting zones are geographic area definitions based on clusters of counties that were developed by the United States Department of Agriculture (USDA) using data from the 2000 Census on commuting pat-

[6]While most job transitions are employment-to-employment, no equivalent concept of search duration exists for such transitions.

terns across counties to capture local economies and local labor markets in a way that is more economically meaningful than county boundaries. According to the USDA documentation, "commuting zones were developed without regard to a minimum population threshold and are intended to be a spatial measure of the local labor market." Marinescu and Rathelot (2017) also show that 81% of applications on CareerBuilder.com are within the commuting zone, with the probability of submitting an application strongly declining in the distance between the applicant's and the job's zip code. We also conduct robustness checks using other geographical areas for our market definition instead of commuting zones.

3.5 Market definition: occupation

To organize the discussion of market definition in terms of line of work (corresponding to the "line of commerce" in the Clayton Act), we can think of it in terms of the "hypothetical monopsonist test" (HMT). The HMT is analogous to the hypothetical monopolist test that is commonly used for product market definition. Since 1982, the horizontal merger guidelines have included the hypothetical monopolist test to determine whether a product market could be profitably monopolized. The idea of the hypothetical monopolist test is to use as the relevant antitrust market the smallest market for which a hypothetical monopolist that controlled that market would find it profitable to implement a "small significant non-transitory increase in price" (SSNIP).

In the 1982 horizontal merger guidelines, there were no specific instructions about how this SSNIP test could be applied, but an influential paper soon defined a methodology (Harris and Simons, 1991): critical loss analysis. Analogously, the hypothetical monopsonist test would suggest as the relevant antitrust market the smallest labor market for which a hypothetical monopsonist that controlled that labor market would find profitable to implement "small significant non-transitory reduction in wages" (SSNRW).

Consider a simple model of monopsony, with a constant value of marginal product of labor given by a, a wage w which depends on the employment level of the monopsonist L. The

profits of the monopsonist are

$$\pi(L) = (a - w)L.$$

If the monopsonist changes wages by Δw, and this generates a change in labor supply ΔL, the change in profits is

$$\Delta\pi = \Delta L \times (a - w - \Delta w) - \Delta w \times L.$$

Thus, the SSNRW is profitable for the monopsonist if and only if

$$\Delta L \times (a - w - \Delta w) > \Delta w \times L.$$

Dividing on both sides by wL, we obtain

$$\frac{\Delta L}{L} \times \left(\underbrace{\frac{a - w}{w}}_{\text{Markdown } \mu} - \frac{\Delta w}{w} \right) > \frac{\Delta w}{w}.$$

Rearranging terms (and taking into account that the change in wage is negative, which changes the direction of the inequality):

$$\frac{\Delta L / L}{\Delta w / w} < \frac{1}{\mu - \Delta w / w}.$$

Since the left-hand side is approximately the elasticity of labor supply, which we denote η, we have that the critical elasticity (see Harris and Simons (1991) for the corresponding concept in the product market) for the wage reduction to increase profits is:

$$\eta \approx \frac{1}{\mu - \Delta w / w}.$$

The antitrust practice typically considers a 5% increase in price (for at least a year) as the SSNIP. Therefore, we will consider a 5% "small significant non-transitory reduction in wages" (SSNRW). The market is too broad if the actual labor supply elasticity is less than the critical

elasticity. For example, if the markdown μ of wages relative to the value of the marginal product of labor is 45% and the wage reduction is 5%, then the critical elasticity is 1/(.45+.05)=2, implying that if the market-level elasticity of labor supply corresponding to the proposed market definition is less than 2, the market definition is too broad, and it should be defined more narrowly. On the other hand, if the market-level elasticity of labor supply is higher than 2, the market is too narrow, and it should be defined more broadly.

Empirically, we have estimates of the labor supply elasticity to the individual firm, which should be larger than the labor supply elasticity to an entire market η. Estimates of the elasticity of labor supply to the individual firm typically range between 0.1 and 4, with most estimates being below 2 (Manning, 2011). Even in online labor markets like Amazon Mechanical Turk, where frictions should be minimal, the labor supply elasticity is only 0.1 (Dube et al., 2018). Therefore the elasticity of labor supply to the market is typically below 2. This implies that, unless we believe that the markdown is above 45%, markets with an elasticity below 2 are well defined according to the SSNRW.

The low elasticity of labor supply to the individual firms found in the literature suggests that even the narrowest definition of a labor market can pass the test: most *individual* firms already have very low elasticities of labor supply, and so each firm may be seen as a market of its own. For the purpose of the present paper, we take a less radical approach. We want to determine whether our baseline choice of the 6-digit SOC occupation is a reasonable market definition. Using online job board data from CareerBuilder.com, Marinescu and Wolthoff (2016) show that, within a 6-digit SOC, the elasticity of applications with respect to wages is *negative*. Therefore, the 6-digit SOC is too broad of a market according to the SSNRW.

When narrowing the market definition to look at job titles, as opposed to 6-digit occupations, the elasticity of applications with respect to wages is positive and equal to 0.77 (Marinescu and Wolthoff, 2016). The elasticity of applications with respect to wages, when interpreted as a recruitment elasticity, is roughly equal to half the elasticity of labor supply (Ashenfelter, Farber and Ransom, 2010). Therefore, the elasticity of labor supply for job titles is around

1.5, which is below the critical elasticity of 2 implied by a 45% markdown on wages. This analysis suggests that, according to the SSNRW test, a job title is a legitimate labor market for the purpose of antitrust analysis.

Ultimately, we choose to define the line of work as a 6-digit SOC as the baseline. This choice is conservative in that the 6-digit SOC is likely too broad, and therefore labor market concentration as measured by HHI will tend to be underestimated. In any case, we will report the HHI for alternative definitions of the occupation.

4 Labor Market Concentration Estimates

Table 1 shows summary statistics for the HHI. In our baseline market definition as a SOC-6 occupation by commuting zone by quarter, the average HHI is 4378. 60% of markets are highly concentrated, i.e. above the 2,500 HHI threshold established by the horizontal merger guidelines. To put the average HHI into perspective, one firm with 50% of vacancies, another one with 35% of vacancies, and a third with 15% yield an HHI of 3,950. On average, the number of firms is 12.6, which seems high[7], but the average HHI of 4378 indicates that most vacancies are posted by just a few firms. In fact, the average HHI implies that the equivalent number of firms recruiting is just 2.3 on average. Furthermore, note that the 25th percentile for the number of firms is 1.5, i.e. in a quarter of the markets there are fewer than two firms recruiting on average.

Looking at percentiles of the HHI beyond the mean, the 75th percentile of HHI is 7279. Again, to place this 7279 number in perspective, a market with one firm having 80% of vacancies and another one having 20% yields an HHI of 6,800. While 60% of markets are highly concentrated, another 11% of markets are moderately concentrated, i.e. have an HHI between 1,500 and 2,500. Only 29% of markets have low concentration (below 1,500 HHI).

[7]The maximum number of firms, at 1983.8, is the average number of firms across the four quarters of 2016 for "Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products" in the New York commuting zone. Overall, there are 29 markets with more than 1000 firms.

To complement these national statistics, Figure 1 shows a map of all the commuting zones in the United States color-coded by the average HHI, based on vacancy shares. Commuting zones around large cities have lower levels of labor market concentration than smaller cities or rural areas. Figure 3 illustrates the relationship between commuting zone and concentration: we see that the relationship is roughly linear in logs, with commuting zones with larger populations having lower concentration. This suggests a new explanation for the city-wage premium (Yankow, 2006; Baum-Snow and Pavan, 2012): cities, and especially large cities, tend to have less concentrated labor markets than rural areas.[8]

In Figure 2, we show the quartiles of HHI across the US, and reveal substantial heterogeneity in concentration across occupations even within a commuting zone. For each commuting zone, we define quartiles of concentration of the top 200 6-digit SOC: the first quartile contains the 25% least concentrated occupations on average over 2016 Q1-Q4 in that commuting zone, the second quartile contains the next 25% least concentrated occupations in the commuting zone, etc. Therefore, the quartiles can contain different occupations in each commuting zone depending on the local level of the HHI. The map is color coded according to the average level of the HHI in each quartile for each commuting zone. There are few commuting zones that have highly concentrated occupations in the first quartile of concentration. Most of the commuting zones with highly concentrated occupations in the first quartile are in the middle of the country at the west end of the Great Plains. At the other extreme, occupations in the fourth quartile of concentration are extremely highly concentrated with an HHI above 5,000 in almost all (86%) of the US commuting zones. Therefore, for much of the country, the least concentrated 25% of occupations have low concentration, while the most concentrated 25% of occupations have extremely high concentration.

To further explore the variation in HHI by occupation, we report the average HHI in the largest 30 occupations in Figure 4. There is substantial heterogeneity across the most frequent occupations: over a third are highly concentrated, about one third are moderately concentrated

[8] Manning (2010) shows evidence on plant size that is consistent with lower monopsony power in cities.

and less than one third have low concentration. The most concentrated frequent occupation is marketing managers and the least concentrated frequent occupation is registered nurses. The top 5 most concentrated occupations are all high skilled occupations, while the rest of occupations are more of a mix and of high and low skill.

The majority of labor markets are highly concentrated according to our baseline definition of concentration. The frequency of highly concentrated labor markets is important for merger policy because, as mentioned above, a merger challenge needs to identify only one market in which anticompetitive results would be substantially likely to occur. At the same time, it is also interesting to examine the extent to which US workers as a whole face high concentration. When weighing each labor market by the number of employed workers, we find that HHI is 1638 on average, implying an equivalent number of recruiting firms of 6.1. This relatively low level of concentration is due to the fact that, as mentioned above, concentration is lower in commuting zones with higher population. However, even after taking into account the unequal distribution of employment across markets, we find that 20% of employment is in SOC-6 by CZ by quarter cells that have high levels of concentration. Another 8% of employment is in markets that are moderately concentrated. Overall, 28% of employment is in moderately or highly concentrated markets, and these markets represent 71% of all labor markets.

The legal standard for merger review is that a merger that substantially reduces competition in any market is illegal, and under the precedent of United States v. Philadelphia National Bank, pro-competitive benefits in one market cannot be used to offset the loss of competition in another. Therefore, the existence of many highly concentrated labor markets matters for antitrust enforcement, even if most workers work in less concentrated markets.

So far, we have discussed variation in concentration while holding the market definition in terms of 6-digit SOC by commuting zone by quarter fixed. We now examine how concentration changes when we vary the definition of each one of these elements. Starting with occupation, we report HHI for four alternative definitions. As mentioned above, there are reasons to think that the job title may be the most appropriate definition of the labor market. When using

standardized job titles to define an occupational labor market, we find that the average concentration is higher than in the benchmark, at 5,892 (Table 1). This higher concentration was to be expected, since job titles are more detailed than 6-digit SOC. When using job titles as the definition of an occupation, 78% of markets are highly concentrated.

Next, instead of using the SOC-6 definition, we use the Burning Glass Technology (BGT) occupation. This classification is based on the SOC, but expands or consolidates SOC categories using the similarity of skills, education and knowledge requirements. This classification gives results (Table 1) that are almost identical to the baseline. We then broaden the occupational categories by using either the BGT broader occupation group or the 3-digit SOC (for the 3-digit SOC, we use top 60 occupations, representing 98% of vacancies). The BGT broader occupation group categorizes occupations based on similar work functions, skills, and profiles of education and training. When using either the BGT broader occupation group or the 3-digit SOC, HHI levels are very similar: the average market is a few hundred points above the 2,500 threshold for high concentration, and 40% of markets are highly concentrated.

We now examine the impact of alternative geographical market definitions. As would be expected, county-level HHIs are higher than CZ-level HHIs, and state-level HHIs are lower than CZ-level HHIs (Table 1). State-level HHIs are very low and only 7% of markets are highly concentrated according to this definition. However, a state is very likely too broad a market. By contrast, a county is smaller than a commuting zone and is sometimes used to define a geographic market, e.g. by the Federal Reserve to calculate banking concentration (Federal Reserve Bank of St. Louis, 2017). If we adopt the county as a definition of the geography for a labor market, 78% of labor markets are highly concentrated.

Finally, we examine time aggregations other than the quarter. Table 1 shows that the average HHI calculated using monthly data is higher than the baseline, and the HHI using semesters is lower but still highly concentrated.

In summary, we find that reasonably defined local labor markets are highly concentrated on average. In our preferred definition of the labor market, the majority of US labor markets

are highly concentrated (above 2,500 HHI).

5 Labor Market Concentration and Product Market Concentration in Manufacturing

Antitrust enforcement is focused on product market competition, and product concentration (HHI) is one of the ways to measure competition. To illustrate how taking into account labor market concentration would make a difference, we examine the case of manufacturing. We choose to focus on manufacturing because, unlike labor markets, the manufacturing product market is generally national (Ashenfelter, Hosken and Weinberg (2013), for example), so we expect important differences between product market and labor market concentration. We compare labor market concentration and product market concentration, and examine the relationship of each with occupational wages.

Since the most recent available product market HHI for manufacturing is 2012, the analysis in this section uses 2012 data from all sources. Product market HHI is from the Economic Census at the national NAICS-4 level. The HHI is based on the value of shipments, in order to measure concentration in sales, as is customary in antitrust enforcement. We compute labor market concentration for each industry based on the occupation with the largest national employment in each industry; call this occupation the "top occupation". By choosing the largest occupation in each industry, we are more likely to find a positive correlation between labor and product market concentration than if we were using all employment, including occupations that are not particularly specific to that industry. Using the Occupational Employment Statistics (OES), we calculate the national average hourly wage for the top occupation in each industry. Using Burning Glass Technologies data, we calculate the labor market HHI for the top occupation in each industry at the commuting zone (CZ) by quarter level. To calculate HHI, we include vacancies in that occupation that are not in that industry, so that the HHI calculated here is calculated in exactly the same way as our baseline HHI for 2016. We calculate the aver-

age national labor market HHI for the top occupation in each industry by averaging first over quarters by CZ, and then over CZ weighing by OES employment in the top occupation and NAICS-4 in each CZ. Because in Azar, Marinescu and Steinbaum (2017), we have shown that the relationship between wages and concentration is linear in the log-log space, we log each measure of concentration here in order to correlate it with wages.

Overall, labor market and product market concentration are positively but not very strongly correlated (Figure 5). The raw correlation between log labor market HHI and log product market HHI is 0.11 across the 86 industries, and 0.33 when weighing by OES employment in the top occupation. In a weighted regression of labor market HHI on product market HHI, the coefficient is significant at the 5% level. In general, labor market HHIs are much higher than product market HHI: across industries, the average product market HHI is 411 and the average labor market HHI (weighted by local employment) is 3,955. Therefore, while the manufacturing product market is unconcentrated on average, the labor markets for the top occupations employed by each industry are highly concentrated on average according to the FTC/DOJ standards. One reason is that labor markets are, inherently, local, while product markets for durable goods like manufacturing are often national.

While labor and product market HHIs are positively correlated, they are far from being perfectly aligned. For example, we can compare two large (by employment) industries with similarly low product market HHI: plastics product manufacturing and cement and concrete product manufacturing, with each industry employing about 50,000 people in its top occupation. In plastics product manufacturing, the top occupation is "Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic". Plastics product manufacturing has a product market HHI of 30 (83rd most concentrated out of 86) and a labor market HHI of 5,726 (21st most concentrated): this industry is thus relatively unconcentrated in the product market but highly concentrated in the labor market both in relative and absolute terms (the industry that has a log HHI between 3 and 4 and is well above the fitted line in Figure 5). For comparison, consider cement and concrete product manufacturing, where the top

occupation is "Heavy and Tractor-Trailer Truck Drivers". The cement and concrete products industry has a product market HHI of 100 (the 70th most concentrated industry) and a labor market HHI of 473 (the 85th most concentrated industry, essentially the least concentrated): the industry appears well below the fitted line in Figure 5, having a log product market HHI between 4 and 5 and a log labor market HHI between 6 and 6.5. In cement and concrete product manufacturing, the labor market concentration in the top occupation is low by the FTC/DOJ standards, presumably because truck drivers work in many industries besides cement and concrete products. Based on HHIs in the product market and the top occupation, mergers in the cement and concrete product manufacturing industry are unproblematic, at least with respect to the top occupation, truck drivers. In contrast, while mergers in the plastics product manufacturing industry are not problematic for the product market, they merit scrutiny for the labor market due to the high levels of labor market concentration in this industry's top occupation.

Labor market concentration is different from product market concentration, and occupational wages are lower when labor market concentration is higher, not when product market concentration is higher. Using the OES, we calculate the national average hourly wage by industry for the top occupation in each industry. Across industries, labor market concentration has a negative and statistically significant effect on wages (Figure 6), and the elasticity of the wage with respect to labor market concentration is about -0.1, whether weighing by employment or not (Table 2, col. 1 and 2). So, across industries, a 10% increase in labor market concentration is associated with a 1% lower wage in the top occupation. This magnitude is of the same order of magnitude as the one obtained in our previous work with CareerBuilder.com data on labor market concentration and posted wages (Azar, Marinescu and Steinbaum, 2017). What about product market concentration? The impact of product market HHI on wages is positive and marginally significant in unweighted regressions, but smaller and insignificant in weighted regressions (Table 2, col. 3 and 4). The positive effect of product market concentration on wages, if it exists indeed, may be due to rent sharing with workers, especially in more unionized industries. Including both labor market and product market HHIs in the same

regression does not alter the conclusions (Table 2, col. 5 and 6): labor market concentration is negatively associated with wages while product market concentration has a much smaller positive and not always significant association with wages.

In a nutshell, we have shown that labor market concentration in manufacturing is higher than product market concentration and not perfectly predicted by product market concentration. Occupational wages are negatively associated with labor market concentration, but not product market concentration. These results suggest that broadening antitrust policy to include labor markets on top of product markets can make a difference to enforcement and workers' outcomes.

6 Discussion

One potential explanation of firm-specific earnings premia (Card et al., 2016; Song et al., 2016) is a lack of competition among employers: if job offers are not frequent enough to equilibrate earnings of similar workers across firms, then firms likely have market power in wage setting. The increase in the degree of inter-firm earnings inequality for similar workers in similar industries is an indication that firm-level wage-setting power has become relatively more important as job offers become less frequent. Empirical studies of the declining frequency of incoming job offers for employed workers (Hyatt and Spletzer (2016) and Molloy et al. (2016)) are thus consistent with a decrease in labor market competition among employers.

The estimates we offer of labor market concentration are comparable with estimates of market concentration in many antitrust product markets that are considered concentrated in the Industrial Organization literature. For example, Kwoka, Hearle and Alepin (2016) report an average HHI of 3930 in their sample of high-traffic airline routes. Azar, Schmalz and Tecu (forthcoming) estimate mean route-level concentration at 5202.

Cooper et al. (2015) find that mean HHI in hospital markets, defined by number of beds within a 15-mile radius, is 4160. For health insurers, for which the relevant market is the state,

given state-level insurance regulation, the same authors calculate mean HHI as 2120. Another commonly-studied output market in which geography matters is retail groceries: Hosken, Olson and Smith (2012) find that in markets in which a merger occurred during their study period (2005-2009), the ex-ante HHI averaged 2334, while in their control group of markets that experienced no consolidation, concentration was 3368. Finally, concentration in local banking markets is typically measured at the county level; Azar, Raina and Schmalz (2016) estimate mean HHI for deposit-taking institutions is 1840. Altogether, many antitrust markets are very concentrated. In this sense, what we find in labor markets is not anomalous.

However, a crucial final point to be made is that labor markets are different from the goods markets which are the usual domain of antitrust analysis and hence of the concentration thresholds contained in the Horizontal Merger Guidelines. Goods markets are typically thought of as one-sided, and hence the extent of the market is delimited by the options among which consumers substitute. Labor markets, on the other hand, are two-sided: workers not only have to find an employer; they have to find an employer who is willing to hire them (Naidu, Posner and Weyl, 2018). This implies that traditional concentration measures overestimate the options available to workers, and thus underestimate concentration. Indeed, 55% of job offers are accepted by the non-employed, showing that in practice workers have few offers they could have accepted (Faberman et al., 2017). The two-sided nature of labor markets therefore implies that job choice sets are typically more restricted than product choice sets.

7 Conclusion

Since the release of Barkai (2016), Autor et al. (2017) and De Loecker and Eeckhout (2017), and other papers documenting rising product market concentration and discussing its effect on the labor market, there has been a great deal of academic and popular interest in whether market concentration might be the cause of monopsony power, wage stagnation, and other macro labor trends.

In this paper, we contribute to this growing debate by calculating measures of market concentration in local labor markets for the near-universe of 2016 online vacancy postings constructed by Burning Glass, and building on Azar, Marinescu and Steinbaum (2017). We have shown that concentration is high (above 2,500 HHI) in 60% of US labor markets according to our baseline market definition, and in at least a third of US labor markets according to alternative labor market definitions. Employment-weighted average concentration is lower at 1638, but still moderately concentrated. Finally, we show that in manufacturing in 2012, labor market concentration in top occupations is associated with significantly lower wages (elasticity of -0.1), while product market concentration does not have a robust impact on wages. Our results suggest that the anti-competitive effects of concentration on the labor market could be important, and are not captured by product market concentration. As detailed in Marinescu and Hovenkamp (2018), the type of analysis we provide could be used to incorporate labor market concentration concerns as a factor in the legal review of company mergers.

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Table 1. Summary statistics for labor market concentration, for the baseline and alternative market definitions. This table shows summary statistics for labor market Herfindahl-Hirschman Index (HHI) under various market definitions, for the year 2016 using data from Burning Glass Technologies (BGT). The baseline is calculated using commuting zones for the geographic market definition, 6-digit SOC codes for the occupational market definition, aggregating the data at the quarterly level (and then averaging over quarters for a given CZ×SOC). In the alternative definitions, the calculation is done by changing the baseline along one dimension (occupation, geography, time horizon). Except for the HHI weighted by employment, concentration is calculated over the top occupations (top 200 ranked based on the number of vacancies in the case of 6-digit SOC, representing 90% of vacancies; or BGT occupation definitions, and top 60 in the case of 3-digit SOC (representing 98% of vacancies) or BGT broader occupation group definitions) over the period 2016Q1–2016Q4.

	Mean	Min	Max	25th Pctile.	75th Pctile.	Fraction Moderately Concentrated	Fraction Highly Concentrated
Baseline market definition:							
Number of Firms (Unweighted)	12.6	1.0	1983.8	1.5	8.3		
HHI (Unweighted)	4378	4	10000	1232	7279	0.11	0.60
HHI (Weighted by BLS Employment)	1638	4	10000	187	1774	0.08	0.20
Alternative occupational definition:							
HHI (By Job Title)	5892	11	10000	2896	10000	0.08	0.78
HHI (By BGT Occupation)	4384	4	10000	1230	7333	0.11	0.60
HHI (By BGT Broader Occupation Group)	2943	6	10000	568	4744	0.12	0.40
HHI (By 3-digit SOC)	2956	10	10000	570	4774	0.12	0.40
Alternative geographical definition:							
HHI (By County)	6029	5	10000	2971	10000	0.08	0.78
HHI (By State)	859	2	10000	141	769	0.05	0.07
Alternative time aggregation:							
HHI (Monthly)	5926	9	10000	3043	8750	0.07	0.78
HHI (Semesterly)	3466	2	10000	788	5278	0.14	0.47

Table 2. Labor market concentration, product market concentration, & occupational wages in manufacturing.

Only manufacturing industries are included; all data is for year 2012. Product market HHI is from the Economic Census at the national NAICS-4 level (based on the value of shipments). Using the Occupational Employment Statistics (OES), we calculate the national average hourly wage for the highest employment occupation in each industry; call this occupation the "top occupation". Using Burning Glass Technologies data, we calculate the labor market HHI for the top occupation in each industry at the commuting zone (CZ) by quarter level; to calculate HHI, we include vacancies in that occupation that are not in that industry, so that the HHI calculated here is calculated in exactly the same way as our baseline HHI for 2016. We calculate the average national labor market HHI for the top occupation in each industry by averaging first over quarters by CZ, and then over CZ weighing by OES employment in the top occupation and NAICS-4 in each CZ.

	Dependent Variable: Log Hourly Wage (OES)					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Labor Market HHI	-0.0920**	-0.105**			-0.101**	-0.125***
	(0.0402)	(0.0432)			(0.0396)	(0.0469)
Log Product Market HHI			0.0481*	0.0104	0.0554**	0.0335
			(0.0253)	(0.0378)	(0.0234)	(0.0323)
Constant	3.505***	3.588***	2.497***	2.699***	3.267***	3.581***
	(0.327)	(0.337)	(0.132)	(0.186)	(0.325)	(0.378)
Weighted by national industry employment in top occupation.		✓		✓		✓
Observations	86	86	86	86	86	86
R-squared	0.064	0.097	0.037	0.003	0.113	0.126

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

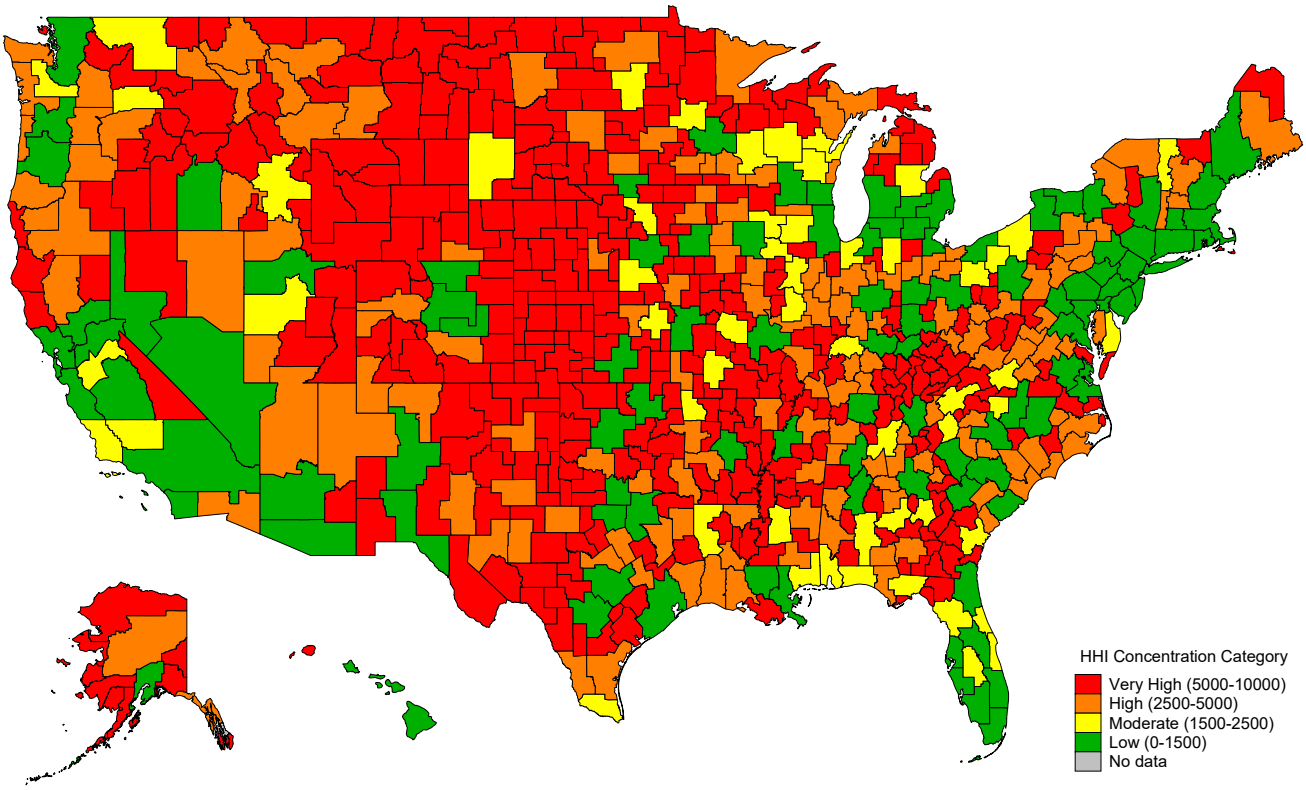
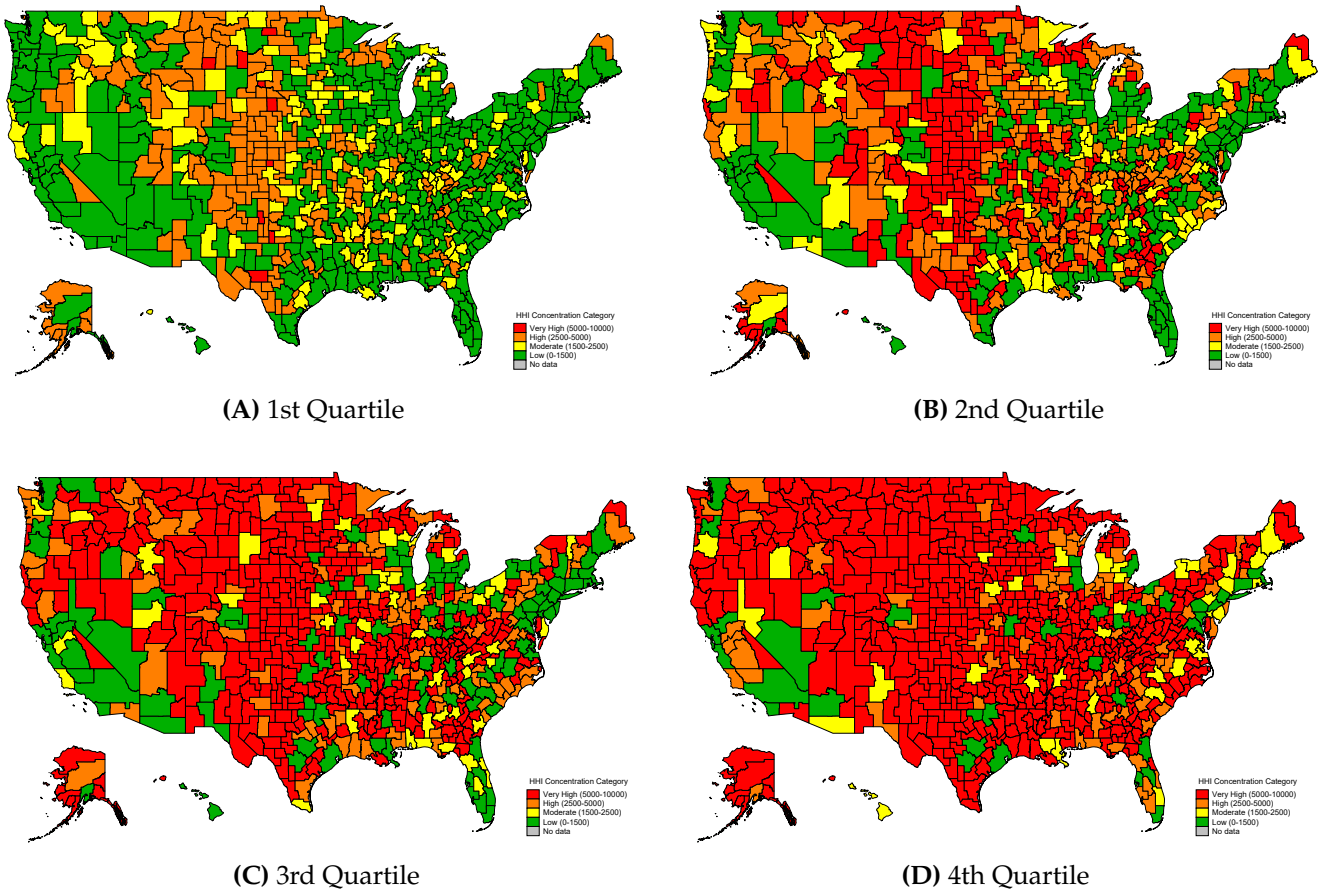


Figure 1. Average HHI by commuting zone, based on vacancy shares. This figure shows the average of the Herfindahl-Hirschman Index by commuting zone code for the top 200 SOC-6 occupations (ranked based on the number of vacancies) over the period 2016Q1–2016Q4 in the Burning Glass Technologies dataset. The categories we use for HHI concentration levels are: "Low": HHI between 0 and 1500; "Moderate": HHI between 1500 and 2500; "High": HHI between 2500 and 5000; "Very High": HHI between 5000 and 10000. These categories correspond to the DOJ/FTC guidelines, except that we add the additional distinction between high and very high concentration levels around the 5,000 HHI threshold. Market shares are defined as the sum of vacancies by a given firm in a given market (6-digit SOC by commuting zone) and year-quarter divided by total vacancies posted in that market and year-quarter.



(A) 1st Quartile **(B)** 2nd Quartile

(C) 3rd Quartile **(D)** 4th Quartile

Figure 2. Map of average HHI by commuting zone, by quartile of HHI. This figure shows averages by quartile of the Herfindahl-Hirschman Index by commuting zone for the top 200 SOC-6 occupations (ranked based on the total number of national-level vacancies) over the period 2016Q1–2016Q4 in the Burning Glass Technologies dataset. Within each commuting zone (CZ), we order the 200 occupations by concentration to form four quartiles. The map for the first quartile represents the average concentration across 2016Q1–2016Q4 among first quartile occupations for each CZ, and similarly for other quartiles. The categories we use for HHI concentration levels are: "Low": HHI between 0 and 1500; "Moderate": HHI between 1500 and 2500; "High": HHI between 2500 and 5000; "Very High": HHI between 5000 and 10000. These categories correspond to the DOJ/FTC guidelines, except that we add the additional distinction between high and very high concentration levels around the 5,000 HHI threshold. Market shares are defined as the sum of vacancies by a given firm in a given market and year-quarter divided by total vacancies posted in that market (6-digit SOC by commuting zone) and year-quarter.

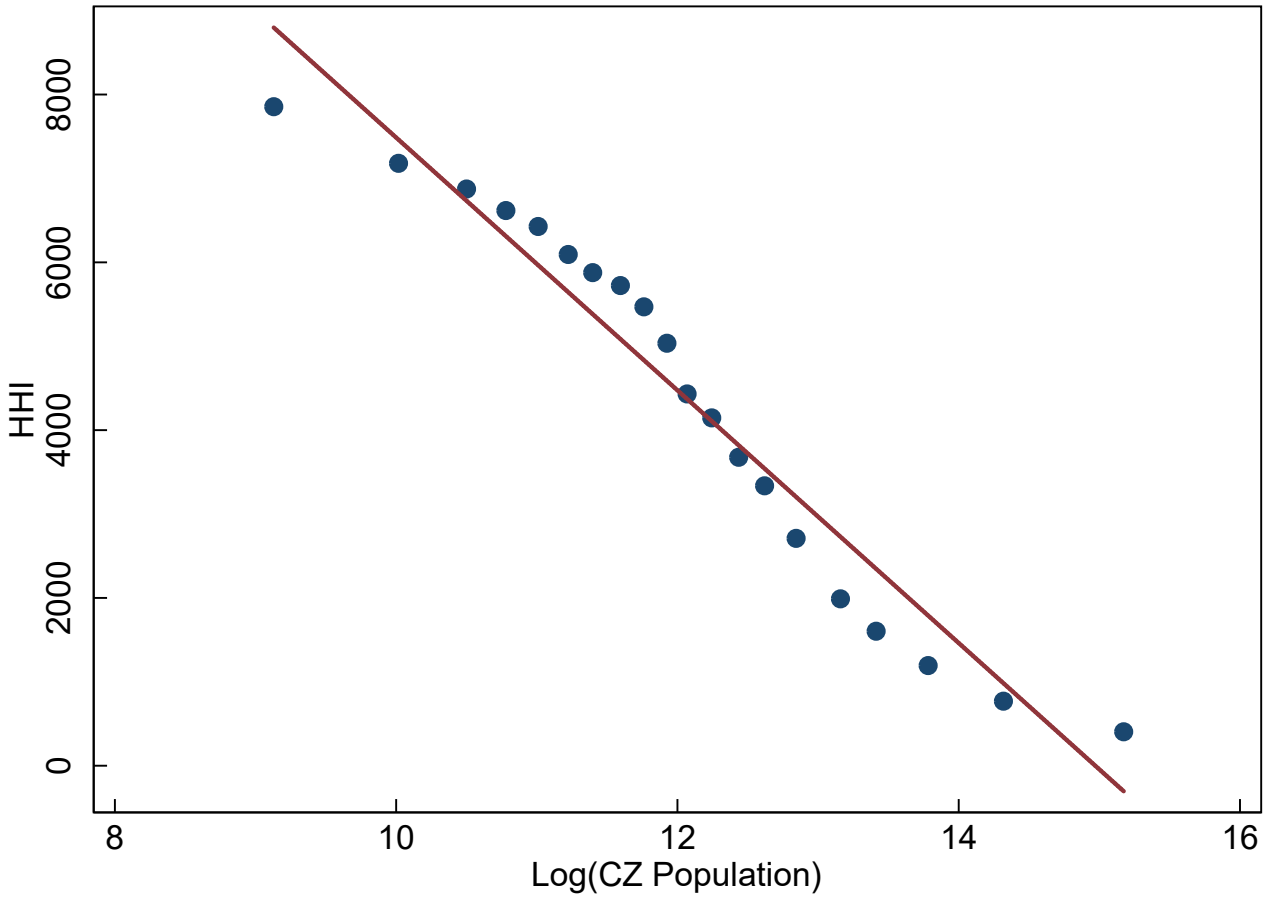


Figure 3. Binned scatter of HHI and Population. This figure shows a binned scatter of the Herfindahl-Hirschman Index by commuting zone for the top 200 SOC-6 occupations (ranked based on the number of vacancies) over the period 2016Q1–2016Q4 in the Burning Glass Technologies dataset, and log of population in the corresponding commuting zone in 2016 (based on Census data).

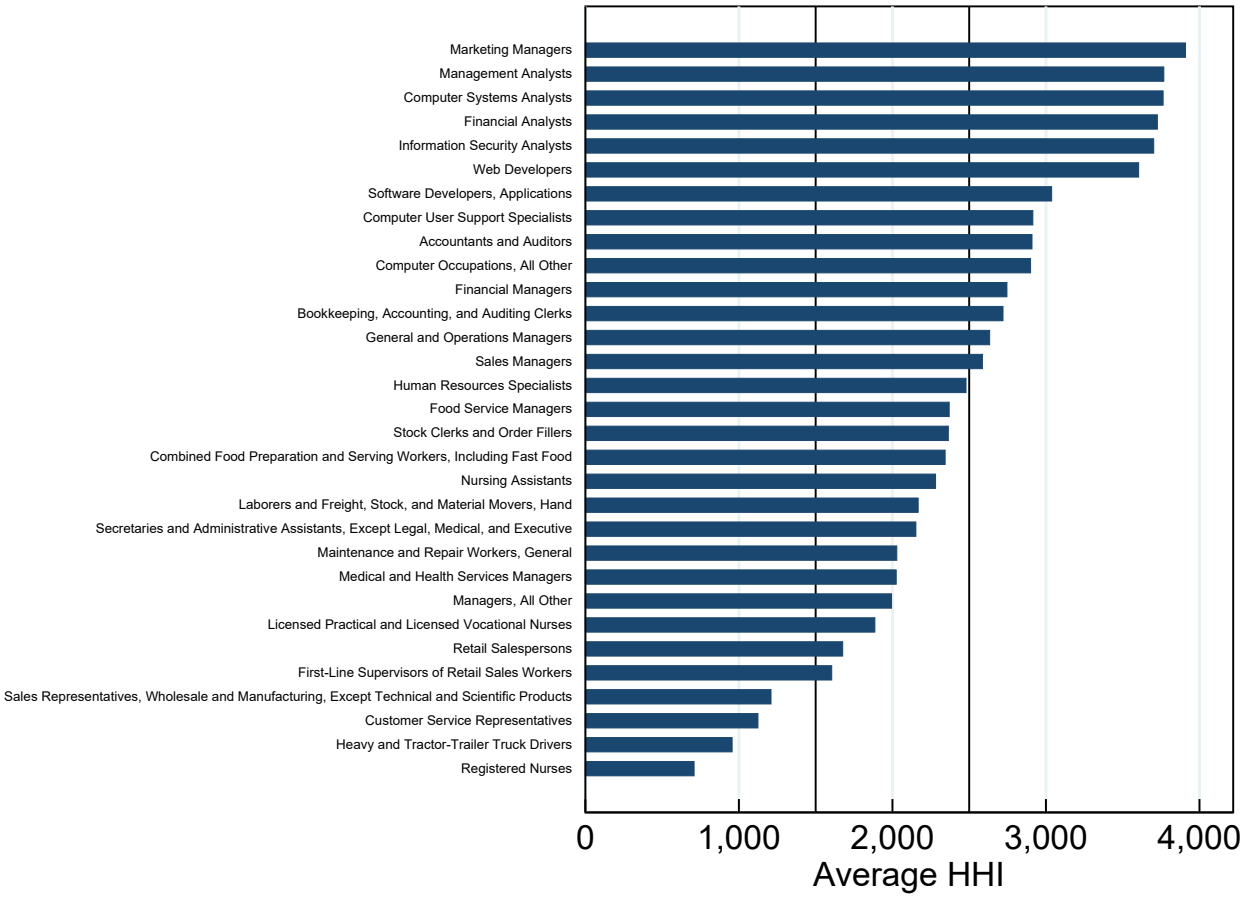


Figure 4. Average HHI by occupation, based on vacancy shares, for the largest 30 occupations. This figure shows the average of the Herfindahl-Hirschman Index by 6-digit SOC occupation code for the 30 largest occupations as measured by number of vacancies over the period 2016Q1–2016Q4 in the Burning Glass Technologies dataset. Market shares are defined as the sum of vacancies posted by a given firm in a given market (6-digit SOC by commuting zone) and year-quarter divided by total vacancies posted in the website in that market and year-quarter.

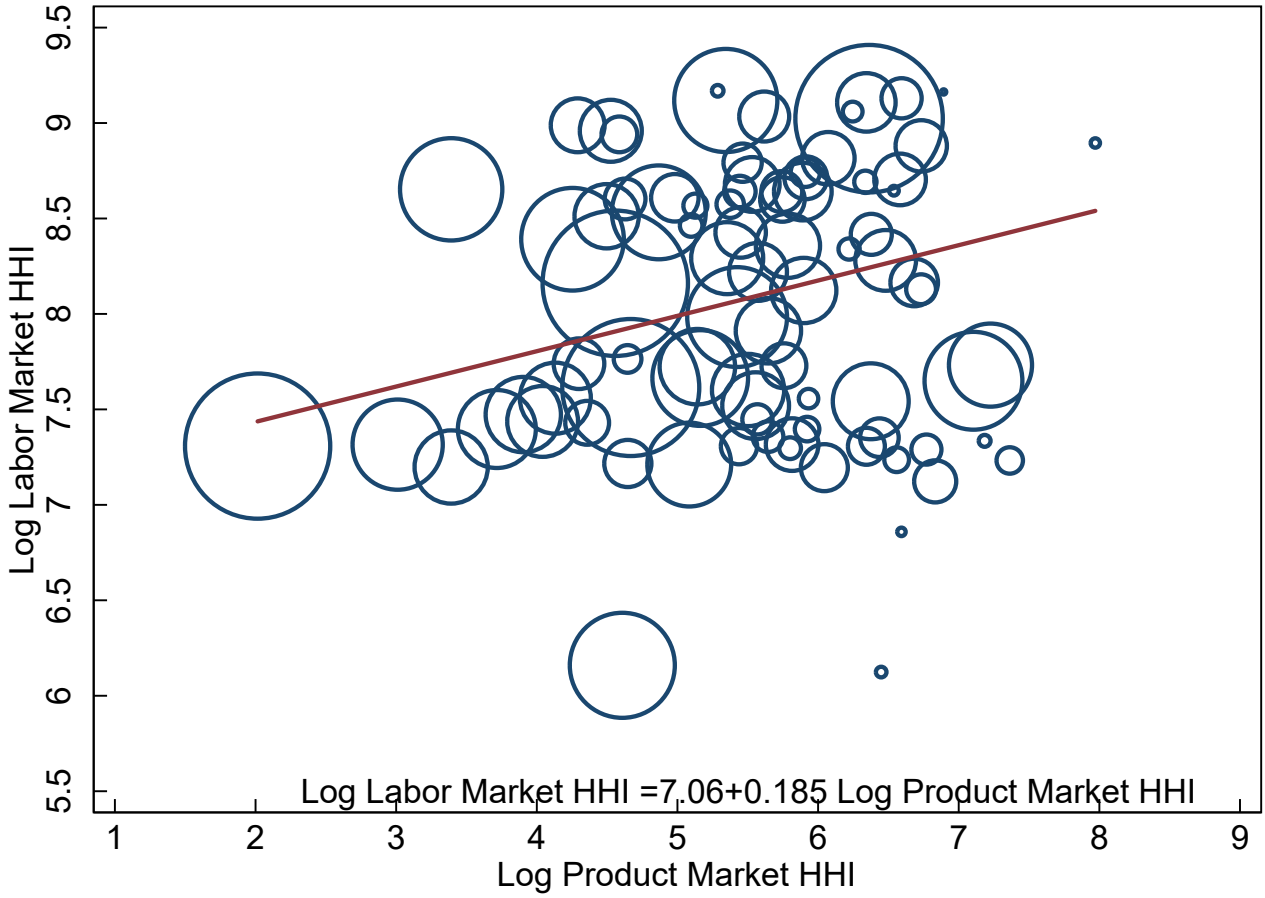


Figure 5. Scatter of Product Market and Labor Market HHIs for Manufacturing in 2012. Only manufacturing industries are included; all data is for year 2012. Product market HHI is from the Economic Census at the national NAICS-4 level (based on the value of shipments). Using the Occupational Employment Statistics (OES), we determine the highest employment occupation in each industry; call this occupation the "top occupation". The size of the circles in the scatter is proportional to NAICS-4 employment in the top occupation. Using Burning Glass Technologies data, we calculate the labor market HHI for the top occupation in each industry at the commuting zone (CZ) by quarter level; to calculate HHI, we include vacancies in that occupation that are not in that industry, so that the HHI calculated here is calculated in exactly the same way as our baseline HHI for 2016. We calculate the average national labor market HHI for the top occupation in each industry by averaging first over quarters by CZ, and then over CZ weighing by OES employment in the top occupation and NAICS-4 in each CZ. The fitted line is from a regression weighing by OES national employment in the top occupation in the NAICS-4; the estimated coefficients are displayed at the bottom of the figure, and the coefficient on product market concentration is significant at the 5% level.

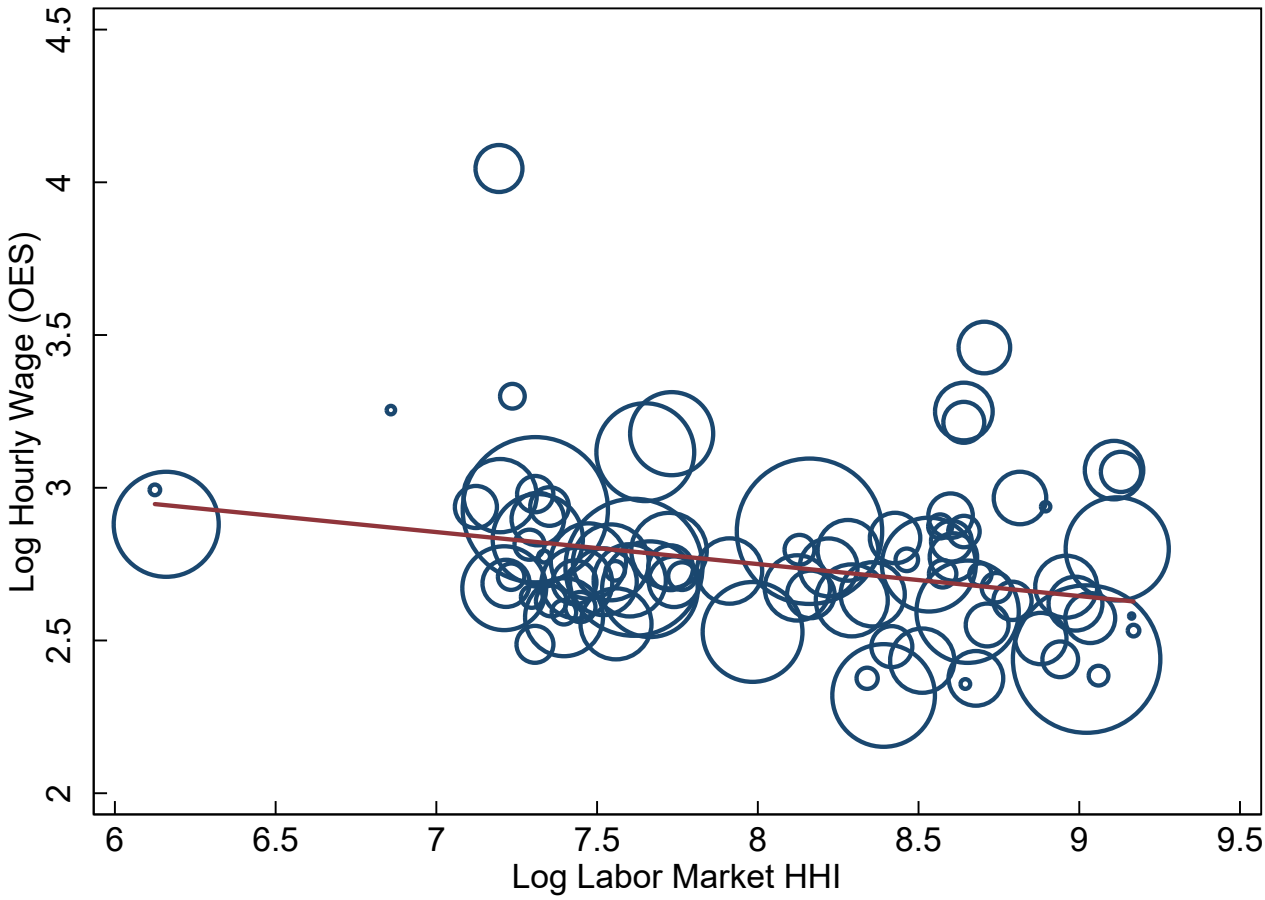


Figure 6. Scatter of Log Wages and Labor Market HHIs for Manufacturing in 2012. Only manufacturing industries are included; all data is for year 2012. Product market HHI is from the Economic Census at the national NAICS-4 level (based on the value of shipments). Using the Occupational Employment Statistics (OES), we calculate the national average hourly wage for the highest employment occupation in each industry; call this occupation the "top occupation". The size of the circles in the scatter is proportional to NAICS-4 employment in the top occupation. Using Burning Glass Technologies data, we calculate the labor market HHI for the top occupation in each industry at the commuting zone (CZ) by quarter level; to calculate HHI, we include vacancies in that occupation that are not in that industry, so that the HHI calculated here is calculated in exactly the same way as our baseline HHI for 2016. We calculate the average national labor market HHI for the top occupation in each industry by averaging first over quarters by CZ, and then over CZ weighing by OES employment in the top occupation and NAICS-4 in each CZ. The fitted line is from a regression weighing by OES national employment in the top occupation in the NAICS-4.