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DISCUSSION PAPER SERIES

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ABSTRACT

Productivity Dynamics: The Role of Competition in a Service Industry*

Using panel data for nearly all service providers in a single industry sector, we examine productivity responses to changes in competition in the United States. The sector offers workplace employee representation through trade union branches which compete with one another for union members whose subscriptions they depend on to cover costs. As such, they have an interest in maximising productivity. Ours is the first study to measure service industry productivity using both price and quantity metrics. Consistent with manufacturing studies, we find market entrants have lower prices and higher Total Factor Productivity (TFP) than incumbents. Increased competition from new entrants leads incumbents to reduce the price of union membership; exit rates then rise among incumbents with the lowest prices who are constrained in adjusting their prices downwards. Those with higher TFP have higher survival probabilities. However, increased competition does not induce incumbents to raise their TFP. These findings are consistent with a market in which incumbents learn about market conditions but face high switching costs limiting their ability to invest in the new techniques that underpin the higher TFP of new entrants.

JEL Classification: J5, L1, L2, L3
Keywords: competition, productivity, TFP, trade unions, survival

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1. Introduction

Empirical studies confirm theoretical expectations that increased competition results in the reallocation of productive resources to more efficient producers as the least productive exit and incumbents increase their productive efficiency in response to competition. Nevertheless, large productivity disparities persist among providers of goods and services in narrowly-defined industries (Griffith et al., 2006), leading some to explore the role of management practices and other aspects of production which are often unobserved (Bloom et al., 2017). Nearly all of these studies are confined to manufacturing industries. The majority also rely on prices to measure productivity. This is problematic since firms may take advantage of a lack of competition to raise prices, but this does not necessarily imply improved productive efficiency. A few studies measure productivity using both price and quantity metrics. The most convincing studies do so for single-product firms thus permitting careful comparison across producers in terms of their productive efficiency.

We contribute to the literature with the first study to examine productivity dynamics in a service industry where we can estimate providers' productivity with measures of both the price of the service offered and the quantity of units sold. We examine the role of competition in determining productivity dynamics and market exit in this industry, where providers offer a single good and where we observe nearly all plants. Using unbalanced panel data we observe those entering and leaving the market, as well as stayers, thus permitting us to identify the contribution of compositional change on the one hand, and within-plant adjustments on the other, to changes in aggregate productivity in the industry.

The industry we examine provides workplace employee representation by trade union locals (branches) in the United States. Union locals compete with one another for union members whose subscriptions they depend on to cover costs. As such, they have an interest in maximising productivity. Consistent with manufacturing studies, we find market entrants have lower prices and higher Total Factor Productivity (TFP) than incumbents. Increased competition from new entrants leads incumbents to reduce the price of union membership; exit rates rise among incumbents with the lowest prices, likely because they are already constrained in adjusting their prices downwards. Those with higher TFP have higher survival probabilities. However, increased competition does not induce incumbents to raise their TFP. Taken together, these findings are consistent with a market in which incumbents learn about market conditions but face high switching costs limiting their ability to invest in the new techniques that underpin the higher TFP of new entrants.

The remainder of this paper is organized as follows. Section Two discusses the literature on productivity dynamics. Section Three describes the market for union membership, the providers of the union good, and sets out the propositions we test regarding the role of competition. Section Four introduces the data and presents our estimation techniques. Results are presented in Section Five and Section Six concludes.

2. The Literature on Productivity Dynamics

A large literature examines productivity dynamics in the for-profit sector, primarily in manufacturing (Syverson, 2004a, 2004b; Hsieh and Klenow, 2009; Griffith et al., 2006; Klepper, 1996, 1997, 2002; Foster et al, 2008; Foster et al., 2016). Six empirical regularities have emerged from this literature. First, increases in market competition – often proxied by market concentration – are associated with higher levels of productivity (Holmes and Schmitz, 2010). Second, new entrants have higher physical productivity than incumbents, but little or no revenue productivity advantage because they charge lower prices than incumbents (Foster et al., 2008). Foster et al. (2016) argue entering businesses set prices low in order to build future demand, taking a hit on current profitability in expectation of future profits. Third, increased competition leads to productivity improvements among surviving firms (Backus, 2019). There is only limited evidence as to *how* incumbents improve their productivity in response to competition, but studies point to mechanisms such as investments in new management practices (Schmitz, 2005; Bloom et al., 2017). Fourth, low productivity incumbents are most likely to exit when faced with increased competition from new entrants, confirming theoretical expectations that increased competition leads to a reallocation of productive resources towards the most efficient producers (Bailey et al., 1992; Foster et al., 2008). Fifth, incumbents with the lowest prices experience the greatest increase in exit probabilities when competition increases, perhaps because they have limited opportunities to respond through cost reductions (Foster et al., 2008). Sixth, despite evidence that competition increases productivity, huge variance in productivity levels and productivity growth persists, even among seemingly "like" plants in the same industry, both in the United States (Syverson, 2004a) and elsewhere (Hsieu and Klenow, 2009). This is even the case among plants in the same firm (Griffith et al., 2006).

From a theoretical perspective it remains unclear why changes in competition should induce changes in productivity. Although it is commonly asserted that those facing low competition have little incentive to invest in productive efficiency, Holmes and Schmitz (2010) ask why "if a monopolist could produce the same output with less inputs, why does it then not do so and pocket the savings as profits?" (Holmes and Schmitz, 2010: 620). They go on to argue "there is no leading workhorse model, one that is ready to be taken to the data, that fully fleshes out the mechanisms through which exposure to competition leads to TFP increases within a plant" (op. cit.).

There are two further shortcomings with the existing empirical literature. First, it focuses largely on the manufacturing sector, although there are recent studies for services. For example, Matsa (2011) shows that, when Wal-Mart entered local markets, incumbents responded by investing in inventory control, resulting in increased product availability.[1] Freeman et al. (2011) also examine the impact of Wal-Mart and show their arrival in local markets resulted in exit among the least productive retailers. The paucity of service sector studies is problematic since Schumperterian growth theory predicts that responses to the threat of competition from innovative entrants will be heterogeneous across firms and industries (Acemoglu et al., 2006). In particular, competition is likely to spur technological innovation among incumbents close to the technological frontier while discouraging innovation in laggard sectors where the threat reduces incumbents' expected rents from innovation (Aghion et al., 2009). Our study provides evidence for one such 'laggard' sector where the opportunities for technological innovation have historically been low (Willman et al, 2019).

The second shortcoming of the literature is that it measures productivity via revenue, typically using measures of the value of sales per employee or hour worked. This makes it difficult for analysts to identify links between competition and TFP due to the confounding effect of price adjustment. Whereas competition will increase the incentive for producers to increase the efficiency with which they produce a single unit of output it will also limit the scope for providers to raise prices. In less competitive environments producers have opportunities to raise prices, thus increasing a revenue-based measure of TFP (TFPR) with no corresponding increase in output efficiency (TFPQ) (Bartlesman and Doms, 2000: 8).

Our data contain the price of union membership charged by each producer so we can distinguish price and TFPQ effects. Foster et al. (2008) find important differences between revenue and

[1] Exploiting standardised practices across McDonald's restaurants in sixty countries, Ashenfelter (2012) suggested huge variance in real wages across workers doing the same job for the same firm was accounted for, in large part, by substantial differences in TFP.

physical productivity in a range of manufacturing industries[2] but ours is the first attempt to make the distinction in the services sector. We examine the role of competition in determining productivity dynamics and market exit among providers in a single industry - union locals - offering a single good and where we observe nearly all service providers. Using unbalanced panel data, we observe those entering and leaving the market, as well as stayers, thus permitting us to identify the contribution of compositional change on the one hand, and within-plant adjustments on the other, to changes in aggregate productivity in the industry.

3. The Market for Union Membership

Union locals in the United States are reliant on the recruitment and retention of members (their customers) as their primary income source.[3] To do so they must organise employees under the Wagner Act by winning majority support among employees in the same bargaining unit and efficiently servicing those members through the provision of union membership (Bryson et al., 2019).

Although it is not always clear how much competition there is in the provision of union services to specific groups of employees (see below), in some industries and occupations it can be intense. "Turf wars" frequently break out between unions with some locals' organising activity coming at the expense of other locals[4]; and many unions face direct competition from employers, some of whom engage 'union busting' consultants to dissuade employees from unionisation. Consequently, locals' survival is likely to depend on the efficient management of capital and labour in the face of market competition (a hypothesis we test in this paper) and, as such, they will be cognisant of the value of organising and servicing members, as well as the marginal returns of doing so.

Union locals deliver a single good, namely union representation. It is a multi-attribute good providing insurance against arbitrary employer behaviour and bargaining over terms and conditions of employment. Standardizing on a single good means we avoid complexities associated with organizations' ability to substitute between goods and services in response to

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[2] Specifically, the production of corrugated and slid fibre boxes; white pan bread; carbon black; roasted coffee beans; ready-mix concrete; oak flooring; motor gasoline; block ice; processed ice; hardwood plywood; and raw cane sugar.

[3] In non-Right To Work states they also receive an agency fee from non-members covered by collective agreements, but these fees are typically small in total value relative to membership subscriptions.

[4] For example see: https://news.bloomberglaw.com/daily-labor-report/union-turf-war-erupts-threatening-organizing-bid-in-brooklyn and https://www.ibtimes.com/union-turf-war-snuffing-out-campaign-organize-uber-drivers-laguardia-airport-2303877.

demand. Union locals may differentiate themselves from one another in the good they offer in terms of price and quality. Although we observe prices, we do not observe quality differentials. However, any quality variation is unlikely to be any greater than would typically be seen in the market for a single type of service. Furthermore, in our empirical analysis, we investigate within-local changes to productivity, so union local fixed effects will capture the time-invariant component of quality differentials.

Union membership was in decline in the US over the period we analyse, as is the case in many developed economies (Schnabel et al., 2013). This decline has its roots in fundamental societal changes (Bryson et al., 2010) which, some argue, has resulted in a secular decline in worker demand for unionisation (Farber and Krueger, 1992). This, in turn, has led some to maintain that unions have little influence over the rate of unionisation, regardless of the price or quality of the union good they are offering. As such, any prospects of "union revival" appear slim or non-existent.[5] The counter-argument is that demand for unionisation among non-union workers has actually been rising, as indicated by polling since the early 1980s (Bryson and Freeman, 2013: 5) such that union decline is, at least in part, a supply side problem: unions have been unable to offer union services in sufficient quantities and suited to those who may wish to pay for them. Yet very little is known about the difficulties unions face in meeting any demand for unionisation in the United States. The literature has focused on the costs of union organizing arising from the National Labour Relations Act (NLRA) system under which unions must win workplace votes to achieve bargaining rights, often in the face of employer hostility, plus the unfavourable political climate unions have faced in recent years. However, declining union organizing activity appears to predate Regan-inspired changes to the NLRA in the 1980s, suggesting that changes in the institutional context cannot entirely explain it.

The existing literature on union decline in the US draws predominantly on household surveys of employees, notably the Current Population Survey (CPS) and administrative data on organizing drives collected by the National Labour Relations Board. The pattern of decline is similar whether one uses individual survey data from the Current Population Survey or the union accounts data – known as the Labor Organisation Reporting System (LORS) – that is used throughout this paper (Figure 1). This literature pays little regard to the performance of individual "suppliers" of membership, apart from what we can discern about the performance

[5] Gomez et al. (2010) argue that the decline in union density in recent years is akin to the final phase in a product life cycle model in which the demand for the good (in this case union membership) is diminishing and suppliers' efforts focus on capturing market share. This has implications for the size and location of suppliers and their entry and exit rates discussed in the next section.

of individual national unions from aggregate data. There are two exceptions. The first is the work of Jack Fiorito and colleagues which investigates the effectiveness of national unions (Fiorito et al., 1995). The second is the study by Holmes and Walrath (2007). Using the annual LORS data, which unions are required to file under federal law, they examine union membership dynamics among union locals between 2000 and 2007.[6] Taking their cue from the employment dynamics literature, their analysis is primarily concerned with identifying the relative importance of entry, exit and within-unit growth in understanding union membership dynamics. They find that despite net decline in union membership there is significant new membership creation and that new gross membership creation occurs differentially across unions.

[FIGURE 1]

Like Holmes and Walrath (2007) we analyse the LORS data (see below) but we take the productivity literature as our starting point, examining links between competition and union locals' productivity. We draw on the existing literature on firm and plant productivity and apply it to union locals: in this framework union locals are akin to plants, and the nationals are the multi-plant firms. The union locals are a set of suppliers all acting in a single industry, in the sense that they are all producing the same type of good (union representation) purchased by customers (union members) through subscription. But like car manufacturers or banks they are supplying heterogeneous consumers and hence not all are competing in exactly the same market. Their competitors come from within the industry (other unions) and, perhaps, from those supplying competing goods.[7] We observe little of the market structure in our data. However, we have detailed information on the location, size and operation of all union locals in the United States. This allows us to establish whether some of the stylised facts from the literature on plant-level productivity in the commercial sector apply in a part of the not-for-profit sector where productivity remains a potentially very important factor in unions being able to survive and prosper.

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[6] Theirs was not the first study to use these data. See Troy's (1965) earlier work on estimating union membership over time and across states.

[7] It is arguable whether, in fact, unions are monopoly suppliers of the union good. Certainly, when they achieve recognition status following an NLRB-sanctioned vote, a union obtains sole rights to act as the bargaining agent of covered workers. However, union membership has been conceived of more widely as a multi-attribute good offering services, such as worker voice, which might conceivably be provided by others, whether it be a solicitor or, even, employer-generated voice mechanisms such as town hall meetings (Bryson and Gomez, 2003).

The general context of declining unionism is an additional motivation for the study of these dynamics. During the period 2000-2016, all the U.S. main nationals experienced a decline in their number of locals. This suggests that many locals have been at risk of being closed or merged with others, hence losing some of their independence. This context provides additional incentives to raise productivity in order to survive. This is reinforced by the fact that, while being non-profit organizations, unions are almost entirely financed through dues and fees.[8] Therefore, their resources are not guaranteed and, in common with for-profit private sector firms, depend on their ability to sell their services. By focusing on productivity differences within and across union locals, its links to survival, and the importance of competition in affecting variance in productivity, we shed light on the issue of union decline from a supply-side perspective, something that is overlooked due to a focus almost exclusively on demand-side factors. The analysis is particularly informative regarding productivity dynamics in sectors where technological change has played only a relatively small role in service delivery to date.

Based on the theory and empirical evidence discussed in Section Two we anticipate the following productivity dynamics to be at work in the union sector. First, we anticipate new entrants to the sector will have greater TFP and lower prices than incumbents. Second, increased competition from new entrants will result in incumbents responding through reductions in their prices and increases in TFP. These responses may be more muted in the union sector than in some other industries because, as Willman et al. (2019) argue, unions conform to Baumol's cost-disease organizations (Baumol and Bowen, 1966; Baumol, 2012) in which costs tend to rise consistently faster than inflation, because the labour input of service delivery is difficult to reduce. Third, we anticipate that when competition increases survival rates will fall among the least productive and among those with the lowest prices who have no margin in which to manoeuvre. Fourth, we anticipate productivity dispersion will fall with competition, whether measured in TFP or prices, due to the death of low productivity locals and incumbents' efforts to improve their productivity in the face of competition.

Our empirical analyses confirm most of these hypotheses. New service providers do enter the market with lower prices and they have higher TFP than incumbents. Increased competition from new entrants does lead incumbents to reduce their prices. As anticipated, exit rates do then rise among incumbents with the lowest prices who are constrained in adjusting their prices downwards. However, whilst it is the case that those with higher TFP have higher survival

[8] According to our data, in 2016, the average local receives 85% of its revenue from membership dues and a further 4% from fees. Locals therefore mostly rely on union members to finance themselves (and survive).

probabilities, increased competition does not induce incumbents to raise their TFP. The findings are consistent with a market in which incumbents learn about market conditions but face high costs of adjustment which limit their ability to invest in the new techniques that underpin the higher TFP of new entrants.

4. Data and Empirical Strategy

4.1. The Union Dataset

Our data are the Labour Organization Reporting System (LORS) for the period 2000-2016. The LORS data are a product of the Labour-Management Reporting and Disclosure Act of 1959 (also called the Landrum-Griffin Act). The legislation requires labour organizations to report annually to the Department of Labour (DOL) detailed financial information about their organizations.[9] Each organization is assigned a permanent unique identifying number. The data are publicly available.[10]

Our data show a similar decline in union membership to the CPS (Figure 1). However, the LORS series shows higher membership than the CPS private sector series, but lower membership than the CPS "all employee" series, just as we would expect given the LORS coverage noted in the Data Appendix.[11]

Our final dataset contains 266,701 local*year observations with union membership data. This corresponds to an average of 15,688 locals per year. It contains 21,281 different locals, implying that a local is present for an average of 12.5 years in the data. Sixty-one percent of locals are present all 17 years between 2000 and 2016.

Appendix Table A1a shows union membership rates recorded by the largest twenty union nationals for each year between 2000 and 2016. A majority suffered membership declines, but in nine nationals' (only one among the 8 largest nationals') membership rose. The most notable

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[9] As Holmes and Walwrath (2007) note: "The intent of the legislation was to provide the members of a given organization–and the general public–with a means of monitoring organizations." One of the motivations behind the original legislation was the desire to limit unions' opportunities to commit fraud, particularly with respect to the use of political funds.

[10] We accessed them on September 5th 2017 at the following address: https://olms.dol-esa.gov/query/getYearlyData.do Full details of the dataset and the way we set it up for this paper are provided in the Data Appendix.

[11] As Holmes and Walwrath (2007: 7-9) note, the LORS may diverge from the CPS because not all state and local government unions file LORS returns and because LORS data may include retired members.

example is the Service Employees union, the SEIU, noted for its particular approach to union organizing under President Andy Stern. It has grown by about 70% between 2000 and 2016.

Consistent with Klepper's (1996: 572-573) assertion that the total number of firms declines as industries mature, Appendix Table A1b shows the number of locals in the data set has fallen by 30% since 2000. This sharp decrease in the number of locals per national has affected almost all large unions. The decline in suppliers is larger in relative terms than the 7% decrease in union membership observed over the same period leading to a growth in the average size of union locals over time. The average number of members in all locals rose from 592 in 2000 to 775 in 2016 - a 30% increase. This is consistent with unions consolidating their resources, thus stripping out some of the fixed costs attached to running smaller locals. In 2016, exactly two thirds of union locals belonged to the 20 largest union nationals. This is the same proportion as in 2000, so the big nationals have accounted for the same proportion of union suppliers over the last decade or so.

Appendix Table A2 shows the entry and exit rates for union locals for each year. The entry rate has fallen over the period, consistent with union service providers being unwilling to invest in setting up new locals in a declining market. The exit rate, on the other hand, has remained above the entry rate, thus explaining the net decline in the number of locals.

4.2. Measures of productivity

We run two production function estimators. The first assumes that the production function for union membership has a Constant Elasticity of Substitution (CES) between labour and capital and therefore we fit the following equation:

$$\ln(y_{it}) = \ln(a_0) + \frac{1}{\rho}\ln(\alpha {L_{it}}^{\rho} + (1-\alpha){K_{it}}^{\rho}) + e_{it} \qquad (1)$$

where y_{it} is the number of members attached to local i in year t, L_{it} the number of employees (organizers, accountants, etc.) of the local, and K_{it} its capital. The plant-specific component of logged TFP at time t is then e_{it} (since a_0 is common across all plants and years).

In the literature this basic equation is sometimes augmented by specifying different types of capital or labour inputs, or by identifying factors which contribute to the variation in e_{it} across plants. These may be internal to plants (e.g. aspects of its compensation structure) or external (e.g. aspects of the market in which it operates). We do not do that here. Furthermore, we ignore intermediate inputs such as materials or electricity as most locals in our data do not report it. As locals provide services rather than transforming an intermediate good into a final one, ignoring intermediate inputs should not be a problem; indeed, those locals that do report it in their annual accounts typically cite very small amounts.

We also run a standard Cobb-Douglas function that is more commonly used in the literature (Syverson, 2011). In the basic Cobb-Douglas specification ln(output) is regressed on ln(capital inputs) and ln(labour inputs):

$$\ln(y_{it}) = a_0 + a_1 \ln(K_{it}) + a_2 \ln(L_{it}) + e_{it} \qquad (2)$$

Table 1 presents standard CES and Cobb-Douglas production function estimates of locals' productivity. Missing values regarding the number of employees or capital mean that we can fit production functions for 179,908 local*year observations out of the 266,701 for which we have non-missing membership information. The labour and capital shares in the CES are respectively around three quarters and one quarter (model 1). The elasticity of substitution between labour and capital $\frac{1}{1-\rho}$ is close to one, suggesting that the use of a Cobb-Douglas is not imposing undue restrictions on the data.[12] We therefore use as our baseline measure of productivity the exponentiated residual from the fitted Cobb-Douglas (model 2). In that model, we see that returns to scale are slightly decreasing and that labour accounts for a larger share of output than capital. The estimated labour share is therefore slightly lower than two-thirds, close to its value for the whole economy. We checked that those basic stylised facts were robust to restricting the sample to relatively large locals (with more than 1000 members) for which inputs may be measured more accurately (models 3 and 4). The main difference is that the relative importance of capital for output is lower in large locals when we fit a Cobb-Douglas production function.

[TABLE 1]

As mentioned earlier, unions sell a relatively standardized product. The quality of the services provided can of course vary, which could be partly captured through variations in prices. Using log membership as output neglects differences in quality across locals. However, using sales to

[12] A Cobb-Douglas corresponds to a CES with an elasticity of substitution equal to 1.

measure output, as is typically done in the literature, is only valid for perfectly competitive firms that have no market power to raise prices above their average cost, an assumption that is well known to be strongly violated in most industries. In the union sector, this might be particularly true for two reasons. First, the number of locals in a given geographic area is usually small (typically no more than 3 locals per zip-code area), so that locals can be seen as local monopolies or oligopolies with at least some market power. Second, even if there is free entry, there are large fixed costs associated with organizing new firms because strong institutional barriers make it a costly process (Ferguson, 2008). For these reasons, and because we want to study both quantity and price reactions to competition and see how prices react to competitiveness, we base our analysis on output measured by quantities.

To highlight the advantage of our data we also fit production functions with output measured in terms of sales, as usually done when output is not directly observed (models 5 and 6). We see that the elasticity of substitution is well above 1 in the CES production function (model 5), implying that the Cobb-Douglas does not capture accurately complementarities between labour and capital. We actually see that the contribution of capital to production flips when switching between the CES, where it is close to zero, and the Cobb-Douglas production function where it plays a more important role than labour. These discrepancies across production functions and the large change in estimated coefficients when output is not measured in terms of units sold highlight the value added of using the quantity of units sold to get rid of price effects.

4.3 Measures of competition and changes in the competitive environment

To test the link between the degree of competition and market dynamics, we use a standard Herfindahl index computed for each year in each zip-code area. It is the sum of the squares of the locals' market shares for all locals present in the zip-code areas. A local's market share is computed as the ratio between its membership and the sum of all the zip-code area locals' memberships (see details in the Data Appendix). Appendix Table A3 shows that there are on average 1.9 locals per zip-code area, implying a high average Herfindahl index of 0.84. Sixty-two percent of the locals are monopoly suppliers in their zip-code area, meaning that they are the sole union local in the area. Nevertheless, there is substantial variation across areas. In at least 10% (respectively 1%) of areas, they are at least 3 (respectively 9) locals (see columns p90 and p99 in Table A3). The Herfindahl index is lower than 0.21 for 1% of the areas and lower than 0.46 for 10% of them, implying substantial competition in these cases.

Our identification comes from changes over time in the Herfindahl index in a given area. However, such changes can occur for a series of reasons, some of them being more endogenous than others. For example, a drop in local demand may lead some locals to exit the market or to merge, leading to a concomitant increase in the Herfindahl index. To get a better grasp on the origin of the variations in the extent of competition that we exploit, in some models we isolate one specific factor that is likely to be less endogenous, namely the entry of new locals.

Such entries, even if they occur for endogenous reasons (good organizing prospects in the area, etc.), represent an exogenous shock for current incumbents and a potential threat for their captive market, as the new local can organize firms in the area that were targeted by the incumbents, or even steal firms where they are present. To focus specifically on variations in the competitive environment that arise due to the entry of new locals, we simply instrument the Herfindahl index measured at the zip-area*year level with the number of entrants in the same year in the same area.

4.4 Controls for variation in demand for the union good

To control for factors affecting the demand for the union good and the maximum size of the market in a given area, we retrieved yearly data on employment, total payroll, average plant size and number of plants available at the county and zip code level on the U.S. Census Bureau website. When matching these data with our main dataset we recover those variables for about 90% of our observations (see Data Appendix). To isolate the effects of competition we condition on four controls for market conditions in a zip area: log of total employment, log of labour cost per employee, number of plants, and average plant size.[13] These variables attempt to capture variations in the demand for unions: the more employees, the more unions can have members, the higher the wages, the lower the need for unions, the higher the number of plants, the higher the potential for organizing, etc. The objective is to make sure that variations in the Herfindahl index are not indirectly capturing changes for product demand in the area.

4.5. Empirical specifications

We estimate the effect of competition on various outcomes using the following empirical model:

[13] The precise functional form used to include them in the empirical models has limited impact on the estimated effects of changes in competition.

$$y_{inlt} = \alpha Herf_{lt} + \gamma X'_{lt} + \theta_i + \varphi_i t + \mu_{nt} + \epsilon_{nlt} \quad (3)$$

where y_{nlt} is the outcome of interest (price, TFP or exit) in local *i,* belonging to national *n* and observed in locality *l* (a zip-area in our baseline specifications) at date *t*. $Herf_{lt}$ is the Herfindahl index in locality *l* at date *t*. X'_{lt} are time-varying controls at the locality level that include proxies for demand (see above). θ_i is a local fixed effect, φ_i a time trend specific to local *i*, and μ_{nt} is national*year fixed effect that control for economic strategies/decisions/orientation taken by each national at each date. The Herfindahl index is instrumented by N_{lt} (and all other controls), which is the number of new entrants in locality *l* at date *t*.

5. Results

5.1 Productivity dispersion

In studies of commercial organizations, it is typical to find that the most efficient plants in an industry are three, four or even five times as productive as the least efficient plants (Syverson, 2011: 326-7). If the market for union goods is comparable to the for-profit sector, as we think, then we anticipate finding similar levels of dispersion across local unions. If, on the other hand, we find little variance in productivity, this might suggest the market for union membership differs from markets for commercial goods and services.

Table 2 presents dispersion in productivity across union locals measured in terms of membership per employee and TFP from a membership production function (Panel A), and sales per employee and TFP from a sales production function (Panel B). The measures of TFP are the exponentiated residuals obtained after estimating equations (1) and (2) (see Table 1 for the other estimated parameters). Whichever measure is used, there is substantial variance in productivity across locals.

[INSERT TABLE 2]

The 75-25 ratio in locals' TFP distribution is around 3-to-1 whether one uses membership or sales as the output indicator, and whether one uses a Cobb-Douglas or CES estimator. The average 90-10 percentile productivity ratios are around 8 or 9 to 1, while the 95-5 percentile productivity ratios are 16 or 18 to 1. These values are at least double those reported by Syverson

(2004b) as the average industry-level productivity dispersion in the US manufacturing sector and by Criscuolo et al. (2003) for UK manufacturing plants. The values reported by Syverson and Criscuolo are considered indicative of a high degree of productivity dispersion in the commercial sector (Griffith et al., 2006). We can thus say that productivity dispersion is also very high among union locals, even higher than among commercial plants. What causes this variance? We first examine the role of workplace demographics. We then turn to our central focus: the role of competition.

Locals belonging to national unions are akin to establishments in multi-plant firms, while the stand-alone locals are akin to single-plant firms. The literature on plant productivity indicates that the firm to which the plant belongs can account for a sizeable part of its productivity. For example, Bailey et al. (1992: 232) show firm-level productivity growth accounts for a substantial part of plant-level productivity growth in U.S. manufacturing. They speculate: "There may be common productivity shocks that hit the plants in the same firm because of similarities in technology or product mix. And these "shocks" may not be simply random events. They could easily be the result of research and development or product development at the firm level."

In the case of union locals, it is conceivable that they will also be hit by shocks at national union level, but it is also possible that locals' productivity is tied to that of the national where they pursue policies and practices that emanate from the centre, or if they learn from others in the same organisation. Although some part of a local's productivity may therefore be accounted for by the national to which it belongs, most of the dispersion in productivity in manufacturing plants in the U.S. over the period 1972-2010 occurs within firms, rather than across firms (Kehrig and Vincent, 2012). Thus, if this finding translates to the service sector and service providers such as union locals we can expect the bulk of productivity dispersion to be accounted for by locals (plants) rather than nationals (firms).

Appendix Table A4 shows how much of the variance in locals' productivity dispersion is accounted for by the nationals to which they belong and locality effects. Almost one quarter (23%) of TFP variance across the 179,908 local*year observations in our sample is accounted for by the 98 union nationals to which they belong, showing that the "firm" effect is quite important. Geography has some impact on productivity: although the 52 state dummies can only explain 2.9% of TFP variance across locals, 7,962 city dummies account for over one-quarter. By far the most important factor is the local's fixed effect: this accounts for 82.1% of the variance in TFP, a finding which is consistent with Bailey et al's (1992) research which emphasizes the importance of the role played by persistent plant-level factors in explaining productivity variance among U.S. manufacturing plants.

In Table A5, we investigate the role played by locals' age and size in determining their productivity differentials. It is apparent that TFP increases among younger cohorts of locals (column 1). This may be because, in a declining market, unions only set up new locals when they are highly productive. Certainly, the result is not consistent with net effects being driven by selection (leading to survival only of the most efficient) nor with active learning. One possibility might be that older locals are "locked" into less efficient methods of recruiting and retaining members, perhaps due to the costs of switching to better methods, costs which new locals do not incur. These cohort effects survive the introduction of controls for locals' size, an important control given the likely correlation between age and growth. TFP is higher among larger locals, the pattern of results being similar whether one conditions on entry cohort or not. The final column incorporates locals' fixed effects and so captures the relationship between growth in membership and TFP: the relationship is positive and highly significant, suggesting that unions can make efficiency gains by moving towards a smaller set of larger locals.

5.2 The effect of competition on productivity, pricing and exit

In Table 3 we estimate locals' log TFP as a function of competition and demand for unionization. Panel A presents results from the estimation of equation (3) by OLS. All four models contain local fixed effects and year dummies so they estimate associations between changes in the Herfindahl index at zip-code level and changes in a local's TFP. Model (1) has no additional controls while models (2) to (4) include the four controls for zip-level demand for unionization. Model (3) further controls for local-specific time trends.[14] Model (4) instead controls for (national*year) fixed-effects.

[INSERT TABLE 3]

Although locals respond to an increase in competition by raising TFP the association is only statistically significant in our preferred model (model (3)) which conditions on demand-side controls, year dummies and local-specific time trends. When we treat competition as

[14] This is done using the Stata command reghdfe.

endogenous and instrument for it using the number of new local entrants to the market in Panel B the competition effect is significant as soon as we control for the potential size of the market.[15] The estimated effects are robust to controlling for local-specific time trends (model 3) or (national*year) fixed-effects (model 4). The estimates imply that a change from no competition at all (the Herfindahl index is equal to one and there is only one local in the zip-area) to very high competition (the Herfindahl index is close to zero and there are several locals with very small market shares) increases TFP by 0.2 to 0.3 log points. Put differently, an increase in competition by one standard deviation of the distribution of the Herfindahl index across zip-areas (0.24, see Table A3) increases TFP by around one tenth of a standard deviation (0.06 to 0.07 log points).

These effects however appear to be driven by new entrants themselves rather than an immediate reaction of incumbents. Indeed, as Panel C indicates, when new entrants are removed from the analysis, the Herfindahl index coefficients fall markedly in size and become statistically non-significant.

Panel D of Table 3 finally shows the first stage estimates, which are very strong (all Fischer statistics are above 400). New entrants decrease the Herfindahl index (they increase competition) as expected. Each additional entrant increases competition by about 15% of a standard deviation of the Herfindahl index.

Figure 2 provides the event-study counterpart of Table 3 (without controls) and makes it possible to examine the evolution of TFP in the longer run. We see that entrants join the market with higher TFP than incumbents, and that this remains so, although there is a tendency towards convergence with the TFP of new entrants falling a little over time. However, there is no TFP response by incumbents to their arrival when compared to locals in zip codes where new entry never occurs.

[INSERT FIGURE 2]

Table 4 is identical to Table 3 but this time the dependent variable is log membership price instead of log TFP. In Panel A increased competition in a zip-code area is associated with lowering membership prices in the two models that control for local-specific time trends or

[15] Panel D confirms we have a strong first stage: the number of local entrants to the zip code is strongly associated with an increase in competition as indicated by the Herfindahl index.

(national*year) fixed effects. These effects are much stronger and statistically significant across all four models in Panel B when competition is treated as endogenous and instrumented by the number of entrants in the area. Empirical estimates imply that moving from the least to the most competitive environment reduces prices by about 60%. Put differently, when competition increases by one standard deviation due to new entrants, prices decrease by about 15%. These effects are however driven by the much lower prices offered by new entrants (Figure 3). Indeed, when new entrants are excluded, the estimated effect of competition on incumbents' prices is two thirds to three quarters smaller. It remains statistically significant, albeit in the third model in which the estimated effects nevertheless remain quantitatively non trivial.

[INSERT TABLE 4 AND FIGURE 3]

Table 5 presents linear probability models estimating the extent to which competition pushes some locals to exit. When filling their LORS report, locals may indicate that they are about to be terminated. We define a local*year observation as an exiter if the local declares it is terminated in years t+1 or t+2 but not in year t. As the variable capturing terminations is likely to be incomplete, we also consider as exiters observations for which the local does not appear in the data in both years t+1 and t+2. Measuring exit over two years avoids treating those who were simply missing for one year as exiters.

[INSERT TABLE 5]

Locals that have a higher TFP and a higher price are less likely to exit (model 1). The negative association between prices and exits may simply capture the fact that locals charging high prices face less competition and exit less for that reason. This endogeneity problem makes the result difficult to interpret. As soon as locals' fixed-effects are included to control for time-invariant characteristics of the locals and the areas in which they operate, prices are not associated anymore with exits. The TFP effect is robust to the inclusion of local fixed effects indicating that locals that are able to raise their TFP over time are less likely to exit.

TFP is clearly a variable that all locals try to maximize and cannot adjust easily. This might be why we do not see any immediate effect of competition on TFP in Table 3, while we see effects on prices.[16] The fact that locals with higher TFP (or which increase their TFP more) are more likely to survive confirms that efficiency matters in a non-profit sector such as trade unionism. In a context of declining unionism with several locals exiting the market or merging, the locals that manage to improve their productivity are more likely to survive. This confirms that supply-side factors play a role in the decline of unions, something we return to in the next section.

In models (3) to (9) of Table 5, we turn our attention to the direct effect of competition (instrumented by the number of entrants) in the zip-code area on exits. All models include fixed-effects and entrants are excluded, so that we focus on changes over time in the probability to exit of incumbents facing changes in competition due to new entrants. Model (3) shows that incumbent locals facing an increase in competition (decrease in the Herfindahl index) are more likely to exit in the following years than those that do not. The magnitude of the estimate implies that an increase by one standard deviation in competition increases incumbents' probability to exit by about 7%. The reduced-form estimated effect of entrants on exits (not shown) is also statistically significant such that each entering local increases the probability of incumbents exiting by half a percent. This is clear evidence of Schumpeterian creative destruction taking place in the union sector: when new unions appear, others disappear.

Models (4) to (9) focus on subsamples of incumbents according to their location in the distributions of TFP and prices. The unions disappearing are those that were already offering low prices (model 7 versus models 8 and 9) and have therefore limited margins to reduce their prices further in response to an increase in competition. The least productive locals are also the most likely to disappear following an increase in competition, but the estimated effect for this group is not statistically different from the positive effect of competition on exits also found for the most productive locals (model 4 versus model 5). It therefore seems that locals' ability to cut prices in response to increased competition is the main factor that can help them to survive.

5.3 The effect of competition on productivity dispersion

To measure productivity dispersion at the zip-code area level, we rely on the standard estimator of a random variable variance. This estimator is constructed as the empirical variance of TFP

[16] We looked for delayed effects of changes in competition on incumbents' TFP and found that increased competition tends to increase incumbents' TFP after about three years. The estimated effects are however too small to be statistically significant.

in a given zip code area in a given year, times n/(n-1), where n is the number of locals in the area. Of course, the estimator is not constructed for local monopolies.

The link between competition and TFP dispersion is estimated from zip-code level regressions relating the estimator of TFP variance to the Herfindahl index. To capture size effects, namely the fact that the number of locals and/or productivity dispersion in a given area can be affected by the size of this area, we control for the log of total employment in the zip-code areas.

Table 6 shows that moving from a very competitive market (Herfindahl index equal to 0) to a local monopoly (Herfindahl index equal to 1) is associated with an increase of about one log point in TFP variance. This is true both in a cross-section of zip-code areas (model 1) and in panel estimates which incorporate fixed effects for zip-code areas. These results can be seen as a direct consequence of the fact that locals located at the tails of the TFP distribution tend to exit more after an increase in competition (Table 5). The results also remain mostly unchanged when we focus on zip-code areas that have at least five locals, so that the computation of the variance of TFP in the area does not rely only on a handful of locals (models 3 and 4).

[INSERT TABLE 6]

Together, Tables 5 and 6 suggest an explanation for the fact that there is even more productivity dispersion in the union sector than in other sectors previously studied. It could simply be because it is less competitive than most private-sector manufacturing or service industries. The fact that once it has gained a certification election in a firm, a union becomes partly entrenched in that firm lowers the degree of competition as compared to other sectors, inducing more TFP dispersion.

In columns (5) to (9) of Table 6, we study in a similar manner the relationship between competition and the variance in prices in an area. Results from models that include zip-code areas fixed effects show that competition also reduces the variance in prices (by pushing out the low-pricing locals, as shown in Table 5). The estimated relationship is however much smaller as moving from a monopoly situation to a very competitive environment "only" reduces the variance in prices by 20 per cent.[17]

[17] We checked that our results are not driven by extreme values. We found that results in Tables 3 to 6 are very similar when observations in the top or bottom percentiles of either the productivity or the price variable are removed from the sample

Since our data are the population of locals we can see what happened to the dispersion in TFP over time. We see from Figure A1 that TFP has become more dispersed over time and has shifted to the left - that is, aggregate TFP has fallen a little. Furthermore, although new entrants have higher TFP than exiters and incumbents, TFP is falling for all subsets of the population (Figure 2).

7. Conclusions

We contribute to the literature seeking to isolate the impact of competition on workplace productivity and survival. We have done so using panel data for a 15-year period on providers of a fairly homogeneous good in a single service sector. The sector offers workplace employee representation through trade union branches which compete with one another for union members whose subscriptions they depend on to cover costs. As such, they have an interest in maximising productivity.

The data are unique in the literature in that they contain both the quantity and price of the service sold by nearly all providers in the sector. We believe ours is the first study to measure service industry productivity using both price and quantity metrics. Consistent with manufacturing studies, we find market entrants have lower prices and higher Total Factor Productivity (TFP) than incumbents. Increased competition from new entrants leads incumbents to reduce the price of union membership; exit rates then rise among incumbents with the lowest prices who are constrained in adjusting their prices downwards. Those with higher TFP have higher survival probabilities. However, increased competition does not induce incumbents to raise their TFP. These findings are consistent with a market in which incumbents learn about market conditions but face high switching costs limiting their ability to invest in the new techniques that underpin the higher TFP of new entrants.

One natural question arising from this analysis is what happens to the number of providers in the sector and their productivity? We see that the total number of locals has strongly decreased over the period, much more than actual membership (Appendix Tables A1a and A1b). It is likely some of this is due to locals merging and restructuring, as is standard in mature markets such as the union representation sector where producers seek economies of scale in pursuit of market share. Although lower productivity providers die more quickly (Table 5) and new entrants are more productive than incumbents (Appendix Table A5) aggregate productivity in the sector has been declining (Figure A1). This may be because the reduction in the number of providers over time creates weaker competition leading to falling TFP, potentially fueling new mergers and exits which further decrease competition. In this way decreasing demand for the good generates a decrease in competitiveness that may itself decrease productivity in the sector, notwithstanding the importance of provider productivity for survival. Such problems may be exacerbated in labor intensive service sectors where there is little scope for TFP improvements via capital investments (cost-disease industries) since, as we have shown, incumbents are limited in their ability to respond to new entrants who have better TFP.

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Figures and Tables

Figure 1: Series of aggregate union membership in the U.S.

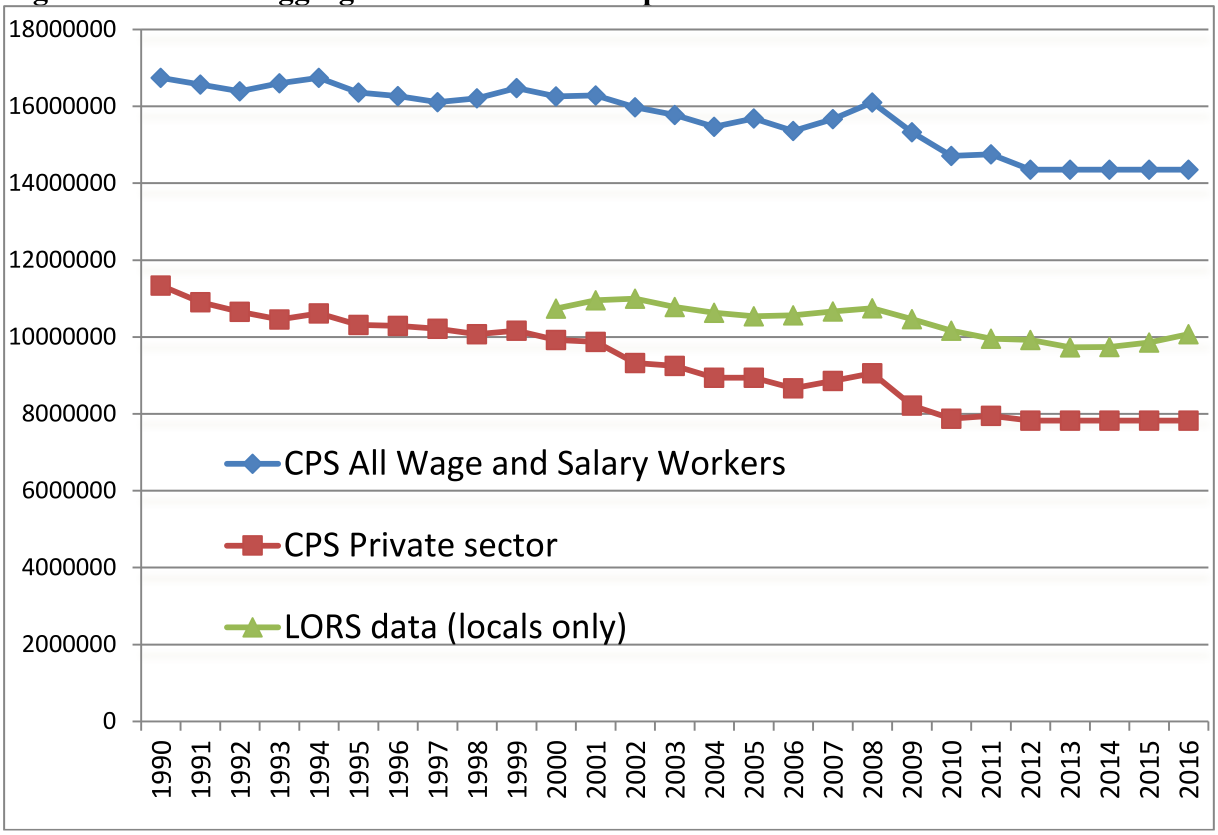


Figure 2: Evolution of TFP of entrants and incumbents before and after an entry

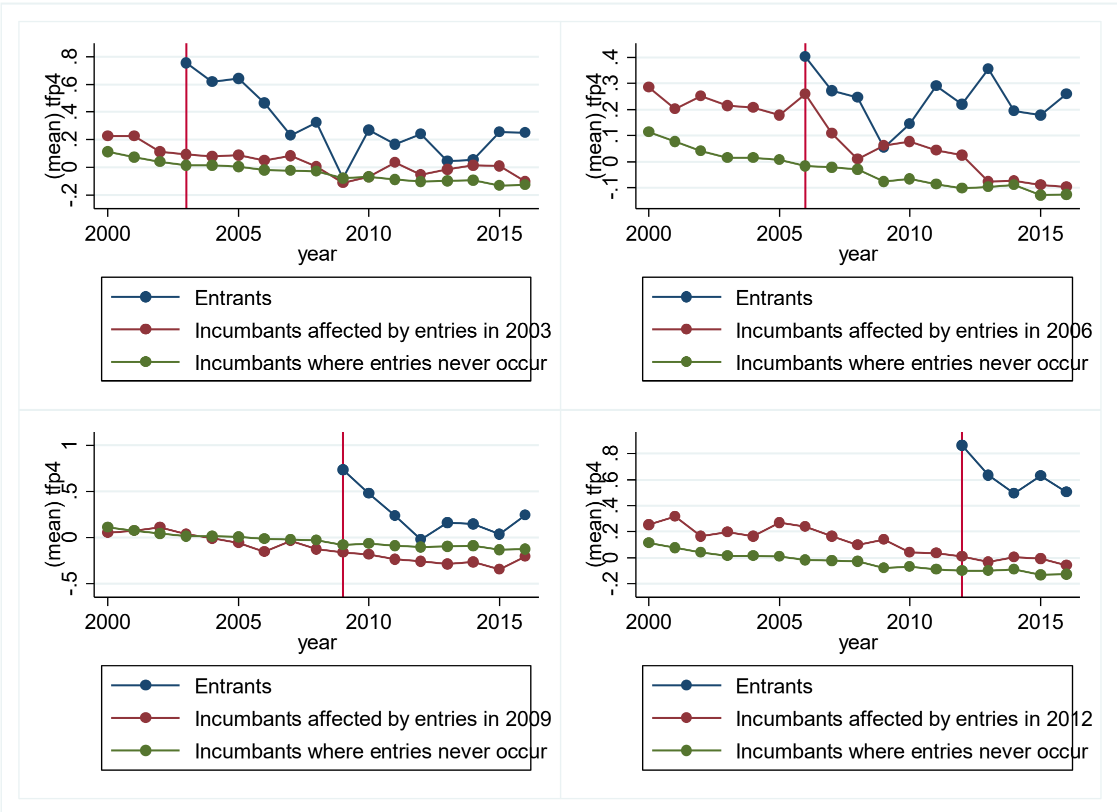


Figure 3: Evolution of prices of entrants and incumbents before and after an entry

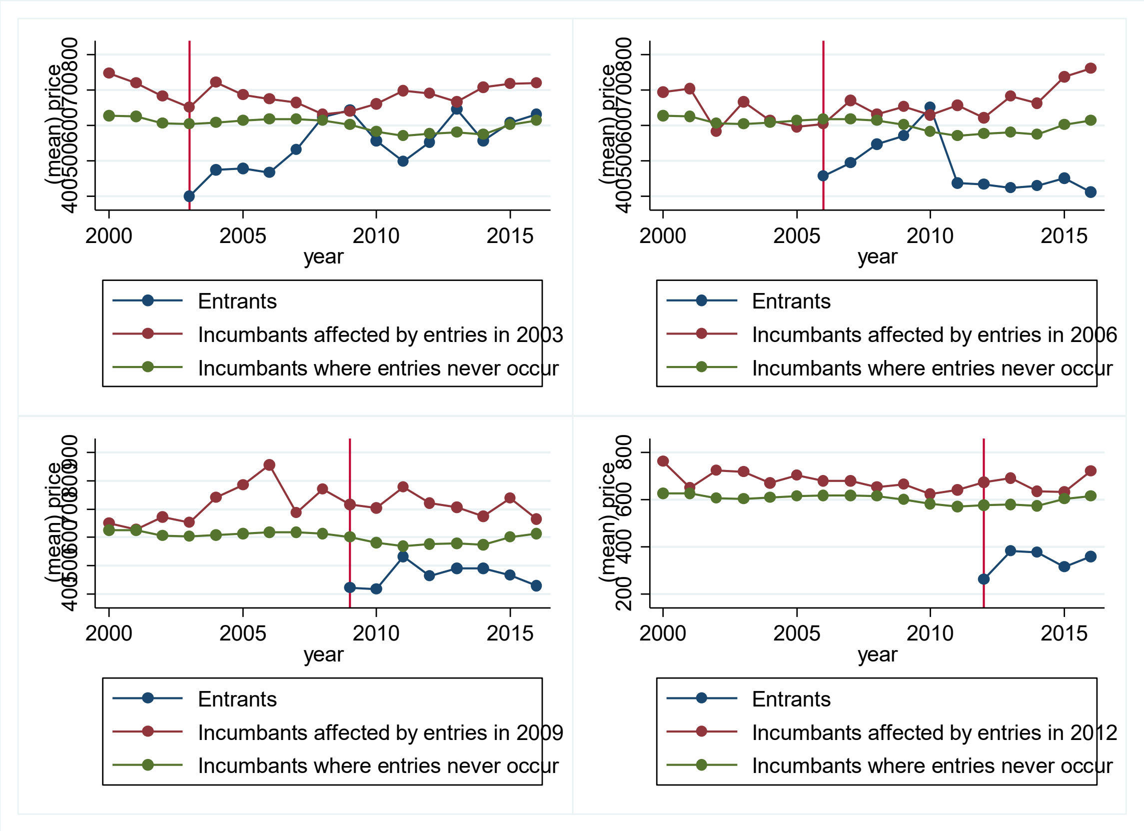


Table 1: Union locals' production function

Dependent variable:	*Y=log(membership)*		*Y=log(membership), large locals only*		*Y=log(sales)*	
	CES	*Cobb-Douglas*	*CES*	*Cobb-Douglas*	*CES*	*Cobb-Douglas*
Elasticity of substitution σ=1/(1-r)	1.100	1	0.879	1	1.917	1
	(0.005)	*by definition*	(0.038)	*by definition*	(0.027)	*by definition*
Labour share:	0.774	0.511	0.778	0.669	0.982	0.458
	(0.008)	(0.003)	(0.094)	(0.006)	(0.001)	(0.003)
Capital share:	0.226	0.418	0.222	0.067	0.018	0.625
	(0.008)	(0.001)	(0.094)	(0.003)	(0.001)	(0.001)
Constant A:	1.71	0.74	36.57	144.44	1757.59	34.33
	(0.074)	(0.009)	(13.73)	(5.05)	(47.73)	(0.49)
Observations	179,908	179,908	30,774	30,774	163,930	163,930
R-squared	0.619	0.619	0.379	0.432	0.723	0.714

Note: CES production function fitted by non-linear least squares. Standard errors in parentheses. Large locals are those with more than one thousand members.

Table 2: Productivity dispersion across locals

Productivity measure	**Mean**	**Median**	**75-25 productivity ratio**	**90-10 productivity ratio**	**95-5 productivity ratio**
Panel A: output is membership					
Labour productivity	64.61	34.25	4.69	17.11	34.07
TFP from Cobb-Douglas	1.51	0.97	2.98	8.42	15.95
TFP from CES	1.51	0.97	3.01	8.46	15.91
Panel B: output is sales					
Labour productivity	42243	16408	8.8	40.28	84.39
TFP from Cobb-Douglas	1.58	1.00	3.20	9.25	18.60
TFP from CES	1.51	0.99	3.10	9.11	18.10

Table 3: Competition and locals' productivity 2000-2016

	dependent variable is log of TFP			
	(1)	(2)	(3)	(4)
Panel A: OLS				
Herfindahl index (zip level)	-0.006	-0.011	-0.019**	-0.009
	(0.007)	(0.007)	(0.008)	(0.007)
Observations	179,071	163,713	163,713	163,557
R-squared	0.820	0.823	0.896	0.830
Panel B: IV (2002-2016)				
Herfindahl index (zip level)	-0.105	-0.242**	-0.239**	-0.283***
	(0.084)	(0.101)	(0.121)	(0.103)
Observations	154,463	139,709	139,709	139,569
R-squared	0.834	0.837	0.905	0.842
Panel C: IV with new entrants excluded (2002-2016)				
Herfindahl index (zip level)	0.074	0.003	-0.053	-0.012
	(0.081)	(0.095)	(0.117)	(0.098)
Observations	153,635	138,923	138,923	138,787
R-squared	0.835	0.839	0.907	0.844
Panel D: First stage of the IV (dependent variable is the Herfindahl index)				
Number of entrants (zip level)	-0.043***	-0.039***	-0.031***	-0.040***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	154,463	139,709	139,709	139,569
R-squared	0.732	0.768	0.857	0.771
Fisher stat.	425	1304	854	1324
Controls (common to all panels):				
Locals' fixed effects	Yes	Yes	Yes	Yes
Demand-side controls	No	Yes	Yes	Yes
Local-specific time trends	No	No	Yes	No
Year dummies	Yes	Yes	Yes	N/A
National*year fixed effects	No	No	No	Yes

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year dummies. Log TFP is the residual of a regression of log(membership) on log(assets) and log(N employees). Demand-side controls include log employment, log of payroll per worker, average plant size and number of plants within the zip area in which the local is based. National*year fixed effects are a set of dummies for 98 national unions interacted with year indicators. Merging locals are always excluded from the analysis.

Table 4: Competition and locals' pricing 2000-2016

	dependent variable is log of membership price			
	(1)	(2)	(3)	(4)
Panel A: OLS				
Herfindahl index (zip level)	0.010	0.008	0.018**	0.017**
	(0.007)	(0.008)	(0.008)	(0.008)
Observations	174,368	158,918	158,918	158,766
R-squared	0.804	0.807	0.884	0.827
Panel B: IV (2002-2016)				
Herfindahl index (zip level)	0.556***	0.615***	0.570***	0.630***
	(0.081)	(0.093)	(0.118)	(0.102)
Observations	153,568	138,628	138,628	138,493
R-squared	0.806	0.807	0.887	0.827
Panel C: IV with new entrants excluded (2002-2016)				
Herfindahl index (zip level)	0.243***	0.203**	0.131	0.165*
	(0.066)	(0.086)	(0.111)	(0.093)
Observations	152,676	137,792	137,792	137,657
R-squared	0.815	0.818	0.893	0.837
Controls (common to all panels):				
Locals' fixed effects	Yes	Yes	Yes	Yes
Demand-side controls	No	Yes	Yes	Yes
Local-specific time trends	No	No	Yes	No
Year dummies	Yes	Yes	Yes	N/A
National*year fixed effects	No	No	No	Yes

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year dummies. Demand-side controls include log employment, log of payroll per worker, average plant size and number of plants within the zip area in which the local is based. National*year fixed effects are a set of dummies for the 98 national unions interacted with year indicators.

Table 5: Exit, 2000-2014

	Dependent variable: exit in t+1 or t+2								
Period:	*2000-2014*		*2002-2014*						
Sample:	*All locals*		*All locals except entrants*	*TFP bottom third*	*TFP middle third*	*TFP top third*	*Price bottom third*	*Price middle third*	*Price top third*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(TFP)	-0.011***	-0.025***							
	(0.001)	(0.002)							
log(price)	-0.006***	0.000							
	(0.001)	(0.001)							
Herfindahl index (zip level)			-0.304***	-0.146**	0.073	-0.104**	-0.201***	-0.020	-0.037
			(0.056)	(0.072)	(0.051)	(0.053)	(0.054)	(0.061)	(0.071)
Observations	140,387	139,451	189,887	42,168	42,339	41,347	40,488	41,427	42,363
R-squared	0.004	0.212	0.147	0.244	0.276	0.244	0.236	0.267	0.255
Locals' fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demand-side controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Herfindahl index instrumented by N entrants	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Incumbents only	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Exit in t+1 or t+2 equals 1 for locals that declare they are terminated in years t+1 or t+2 but not in year t, and for locals that are absent from the data sample in both years t+1 and t+2. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year dummies. Log TFP is the residual of a regression of log(membership) on log(assets) and log(N employees). Demand-side controls include log employment, log of payroll per worker, average plant size and number of plants within the zip area in which the local is based.

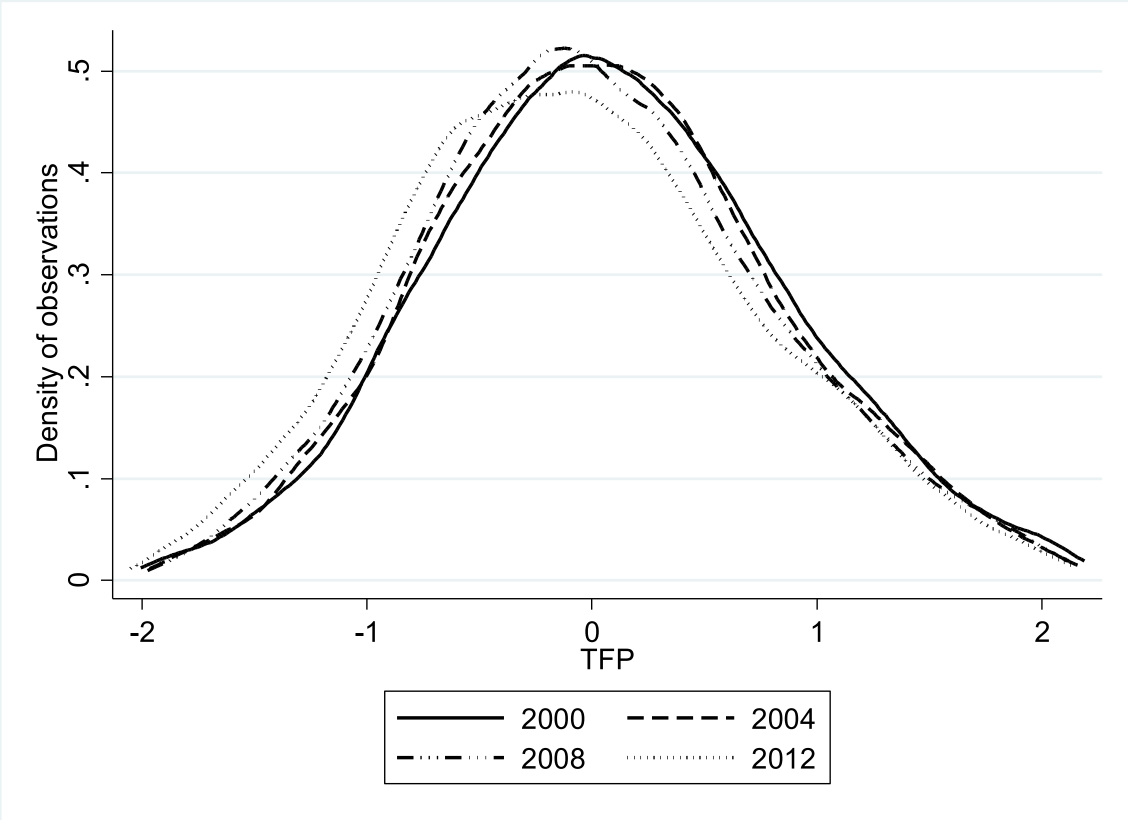
Table 6: Competition and productivity or price dispersion 2000-2016 (zip-level regressions)

Dependent variable:	*zip-level log TFP variance estimator*				*zip-level log price variance estimator*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Herfindahl index (zip level)	1.191***	0.902***	1.014***	0.775***	0.054	0.193***	0.254***	0.190**
	(0.031)	(0.046)	(0.058)	(0.087)	(0.034)	(0.046)	(0.071)	(0.090)
log total employment in zip area	0.147***	0.057**	0.181***	0.078	0.139***	0.015	0.138***	0.208***
	(0.005)	(0.023)	(0.010)	(0.050)	(0.005)	(0.023)	(0.012)	(0.052)
Observations	34,099	34,099	7,646	7,646	33,365	33,365	7,622	7,622
R-squared	0.061	0.595	0.079	0.672	0.022	0.643	0.024	0.745
Restricted to zip areas with at least 5 locals	No	No	Yes	Yes	No	No	Yes	Yes
Fixed effects for zip areas	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include year dummies. Log TFP is the residual of a regression of log(membership) on log(assets) and log(N employees). Variance estimators are obtained by multiplying in each zip area for each year the empirical variance of locals' log(TFP) or membership price by n/(n-1) where n is the number of locals in the zip area the year considered. To check that results where not driven by the number of locals used to compute the variance, we narrow the analysis to areas and years where at least 5 locals are present in columns 3, 4, 7 and 8. Alternatively, we have directly controlled for the number of locals in the zip area. Results (not shown) do not substantially change.

Additional Figures and Tables

Figure A1: Distribution of TFP across locals: evolution over time



Notes: Log TFP is the residual of a regression of log(membership) on log(assets) and log(N employees).

Table A1a: Membership for 20 largest nationals over 2000-2016

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Membership (in 1000s)																
All unions	10736	10957	10996	10781	10628	10538	10562	10661	10751	10462	10168	9954	9922	9728	9737	9855	10075
For the 20 largest nationals in 2000:																	
TEAMSTERS	1230	1198	1196	1174	1131	1165	1176	1167	1159	1091	1068	1064	1062	1077	1104	1106	1111
FOOD & COMMERCIAL WKRS	1045	1083	1082	1058	1021	998	953	1009	1026	1018	985	983	982	987	990	985	975
SERVICE EMPLOYEES	942	1036	1181	1283	1339	1302	1422	1501	1584	1605	1571	1481	1467	1461	1445	1544	1587
AUTO WORKERS AFL-CIO	770	695	645	621	595	591	538	486	438	363	363	371	375	378	381	380	378
STEELWORKERS AFL-CIO	732	686	648	609	588	581	550	531	509	471	458	452	434	425	415	406	388
ELECTRICAL WORKERS IBEW AFL-CIO	653	672	663	639	627	620	621	624	629	615	593	584	575	578	575	578	574
COMMUNICATIONS WORKERS AFL-CIO	591	576	536	503	481	459	446	435	424	402	374	356	340	335	332	327	322
CARPENTERS IND	455	486	487	471	469	471	467	475	481	460	419	394	398	353	349	354	361
STATE COUNTY & MUNI EMPLS AFL-CIO	386	435	455	395	400	390	394	399	407	461	434	421	419	399	402	399	393
LABORERS	345	367	406	398	392	389	394	400	430	416	407	400	394	388	389	396	394
ENGINEERS, OPERATING, AFL-CIO	332	346	349	349	350	351	355	361	361	353	332	335	330	325	328	331	331
PLUMBERS AFL-CIO	260	277	279	279	280	283	287	291	301	293	290	283	280	280	279	279	282
POSTAL WORKERS, AMERICAN, AFL-CIO	246	254	237	232	220	217	215	210	201	180	171	167	162	149	149	151	151
TEACHERS AFL-CIO	219	260	269	281	287	286	292	307	317	323	326	323	340	341	340	337	346
UNITE HERE	216	216	217	216	221	238	243	248	240	230	233	233	242	254	263	262	274
GOVERNMENT EMPLOYEES AFGE AFL-CIO	199	186	184	187	185	195	197	198	196	181	175	174	194	180	178	177	382
SHEET METAL WORKERS AFL-CIO	186	193	198	200	207	208	209	215	225	235	250	268	285	287	291	302	293
WORKERS UNITED, SEIU	122	114	105	99	92	94	91	86	81	72	67	72	74	73	74	72	69
POSTAL MAIL HANDLERS, LIUNA	112	106	111	106	104	124	129	136	172	166	162	149	139	132	123	120	116
PAINTERS AFL-CIO	107	113	113	110	110	108	111	111	113	107	99	91	84	82	80	83	85

Table A1b: Number of locals for 20 largest nationals over 2000-2016

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	Number of locals																
All unions	18700	18555	18212	17726	17259	16872	16403	16076	15931	15762	15390	14923	14665	14256	13900	13656	13140
For 20 largest nationals in 2000																	
TEAMSTERS	476	464	456	448	428	412	409	399	389	380	374	369	365	358	347	340	337
FOOD & COMMERCIAL WKRS	468	440	412	400	381	370	344	342	332	325	309	300	291	278	273	266	257
SERVICE EMPLOYEES	249	226	222	223	223	218	198	148	117	107	105	98	95	93	95	96	92
AUTO WORKERS AFL-CIO	915	898	873	847	828	799	766	738	723	707	677	634	617	584	570	559	537
STEELWORKERS AFL-CIO	2574	2573	2527	2453	2408	2364	2298	2213	2174	2110	1999	1924	1869	1816	1750	1708	1628
ELECTR. WORKERS IBEW AFL-CIO	838	852	843	829	815	808	797	791	786	786	776	771	761	750	738	733	718
COMMUNIC. WORK. AFL-CIO	1182	1161	1130	1101	1071	1024	982	953	928	914	878	840	803	780	733	717	694
CARPENTERS IND	741	767	749	719	695	691	676	668	650	649	630	538	500	471	435	430	403
STATE COUN&MUN EMP AFL-CIO	247	250	246	261	265	283	288	284	295	299	304	319	329	329	329	329	296
LABOURERS	469	470	457	434	402	389	379	370	362	362	360	358	347	336	321	301	292
ENGINEERS, OPERATING, AFL-CIO	123	126	125	124	122	121	118	118	118	118	111	106	105	104	101	100	98
PLUMBERS AFL-CIO	280	284	279	275	274	271	273	269	269	265	265	265	263	251	244	243	242
POSTAL WORKERS, AFL-CIO	1370	1270	1310	1273	1213	1171	1125	1110	1098	1054	1030	961	924	879	842	822	779
TEACHERS AFL-CIO	86	90	95	97	98	103	101	107	131	133	135	135	139	139	140	133	133
UNITE HERE	115	117	119	120	123	122	123	123	120	118	116	115	113	109	107	105	95
GOVERN. EMPL. AFGE AFL-CIO	633	622	621	617	611	613	609	607	606	606	607	605	604	599	596	596	572
SHEET METAL WORKERS AFL-CIO	962	988	998	1001	994	1017	993	1006	1006	996	1005	1021	1043	1038	1030	1025	945
WORKERS UNITED, SEIU	401	425	437	435	445	448	451	465	463	469	453	445	459	434	426	418	403
POSTAL MAIL HANDLERS, LIUNA	35	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	35
PAINTERS AFL-CIO	361	366	362	356	355	351	348	341	336	337	330	324	314	310	292	288	285

Note: The full name of the 20 largest nationals is displayed in the first column of Table A1.

Table A2: entry, exit and growth of locals 2000-2012

year	Entry rate	Exit rate	Growth of survivors- excluding abnormaly large growths (i.e. potential mergers)					
			mean	p10	p25	p50	p75	p90
2000		3.30%						
2001		3.71%	-3.01%	-19.35%	-8.22%	-0.64%	3.08%	11.13%
2002	1.54%	3.91%	-2.65%	-18.18%	-8.00%	-0.52%	2.94%	11.62%
2003	1.24%	3.61%	-3.08%	-18.18%	-8.27%	-1.30%	1.99%	10.00%
2004	1.33%	3.94%	-2.12%	-16.62%	-7.32%	-0.71%	2.70%	11.65%
2005	1.29%	3.40%	-1.93%	-16.67%	-7.14%	-0.29%	3.33%	12.21%
2006	0.84%	3.39%	-1.31%	-15.61%	-6.42%	0.00%	3.81%	12.28%
2007	1.28%	2.98%	-1.29%	-16.67%	-6.57%	0.00%	3.64%	11.76%
2008	1.42%	2.45%	-1.72%	-17.33%	-6.78%	0.00%	3.73%	12.24%
2009	1.10%	3.29%	-4.67%	-22.22%	-10.34%	-2.44%	1.21%	9.44%
2010	1.07%	3.63%	-1.69%	-16.67%	-7.58%	-1.29%	2.38%	12.29%
2011	1.39%	2.97%	-0.94%	-14.58%	-6.59%	-0.45%	3.09%	12.50%
2012	1.35%	3.27%	-1.51%	-14.88%	-6.59%	-0.54%	2.86%	11.76%
2013	0.81%	2.92%	-1.83%	-16.39%	-6.94%	-0.96%	2.49%	10.75%
2014	0.76%	2.42%	-0.67%	-14.12%	-5.77%	0.00%	3.95%	12.50%
2015	0.76%		-0.49%	-14.29%	-5.56%	0.00%	4.68%	13.21%
2016	0.77%		-0.50%	-14.85%	-5.56%	0.00%	4.26%	12.50%

Table A3: Zip-level Descriptive statistics on employment, number of locals and Herfindahl index

Variable	mean	sd	p1	p10	p50	p90	p99	N
Total Employment in zip	7656.7	12896.1	10	175	3806.5	19610	47694	130134
N locals in zip	1.91	2.87	1.00	1.00	1.00	3.00	9.00	139482
Zip-level Herfindahl	0.84	0.24	0.21	0.46	1.00	1.00	1.00	139482
Monopoly in zip area	0.62	0.48						139482

Differences in the number of observations come from a different number of missing values on the three variables.

Table A4: Accounting for Variance in Locals' TFP

TFP explained by fixed effects for:	Share of the variance explained (R2)	Observations
98 nationals	22.8%	179,908
52 states	2.9%	179,908
2027 states*nationals	34.6%	179,908
7962 cities	27.0%	179,907
18540 cities*nationals	68.9%	179,908
15301 locals	82.1%	179,908

Note: Results from OLS regression of log(TFP) for each local on various sets of fixed effects. All models include year dummies. log(TFP) is the residual of a regression of locals' log membership on their log assets and log number of employees.

Table A5: the effect of size and age on log TFP

	Dependent variable: log TFP			
	(1)	(2)	(3)	(4)
Created before 1970	REF	REF		
Created in the 1970s	0.0775***	0.180***		
	(0.00725)	(0.00590)		
Created in the 1980s	0.0965***	0.182***		
	(0.00793)	(0.00645)		
Created in the 1990s	0.288***	0.253***		
	(0.00817)	(0.00664)		
Created in the 2000s	0.488***	0.438***		
	(0.00969)	(0.00788)		
1st quintile of membership		REF	REF	REF
2sd quintile of membership		0.740***	0.742***	0.707***
		(0.00838)	(0.00850)	(0.00660)
3rd quintile of membership		1.108***	1.113***	1.136***
		(0.00813)	(0.00825)	(0.00744)
4th quintile of membership		1.398***	1.399***	1.530***
		(0.00804)	(0.00815)	(0.00825)
5th quintile of membership		1.897***	1.897***	1.941***
		(0.00800)	(0.00810)	(0.00957)
Observations	179,908	179,908	179,908	179,908
R-squared	0.024	0.356	0.337	0.858
Fixed effects	None	None	None	21532 locals
Year dummies	Yes	Yes	Yes	Yes
Other controls	No	No	No	No

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. log(TFP) is the residual of a regression of locals' log membership on their assets and number of employees.*

Data appendix

1) Setting up the data

The files contain the reports labour organizations have to submit as part of the Labour Organization Reporting System (LORS). The reports cover a specific year and are identified by a unique identification number (*rpt_id*). When we extracted them in September 2017, the reports were sorted according to the year they cover and they were available from 2000 to 2016 in text format. For each year covered, the Office of Labour Management Standards (OLMS) splits the reports and provide a folder including several files that can then be re-merged using the reports' ids *rpt_id*. We use five of these files for each year: (1) "lm_data_data" contains information on organizations' main characteristics (name, number of members, date of creation, main accounting information, etc.), and (2) "ar_disbursements_total_data", (3) " ar_assets_total_data",(4) "ar_liabilities_total_data", (5) " ar_receipts_total_data" which contain more specific and more detail information on disbursements, assets, liabilities and receipts for each organization.

Preparing the LORS files for Stata software

We did our analysis using Stata software. In order to transfer the text files into Stata format we had to correct some problems by hand in the original files. Typically, some observations included wrongly placed line breaks (usually in the variable "union_name"), inducing swaps between the different variables for those observations. We removed these line breaks by hand. Some special characters also stopped the transfer into Stata so that all observations located after the special character in the initial text files were omitted in Stata. We detected those characters, removed them from the original files and then checked by hand that the last observation of each text files had indeed been included in the Stata data.

Creating a panel of locals 2000-2016

For each covered year between 2000 and 2016, we started by merging together the 5 Stata files described above using the report id *rpt_id*. Some variables are present both in the core summary dataset "lm_data_data" and in one of the four other datasets. When information contained in those overlapping variables was non-missing and in conflict between different datasets, we used the information from the core file "lm_data_data". However if the information was missing in the core dataset we tried to use the other datasets to get it. As a second step, we appended together all years from 2000 to 2016.

The report id *rpt_id* is year-specific. However, organizations are also assigned a permanent file number *f_num* that makes it possible to follow them from one year to the next. We noticed that in some rare cases (less than 1% of all observations), an organization had more than one report included in the data for a given covered year. This might be because its first report was incomplete or erroneous, or because it needed to add a specific detail. The additional reports can be added at the request of the organization or may be added by OLMS without consultation with the organization. In those cases, we kept only one duplicate in terms of organization and year covered. We kept the most recent report registered in LORS (identified using the variable *register_date*) when it included non-missing information on membership, or when all reports contained missing information on membership. Otherwise, we applied the same logic to the second most recent report, and so on. We finally corrected a few errors that we detected in the affiliation of some locals and the national union they belong to.

2) Time series of number of locals and aggregate membership

After a thorough cleaning of the initial LORS files, Holmes and Walrath (2007) provide aggregate number of locals and membership for years 2000 and 2007. We extend their analysis up to 2016. We also adopt an alternative approach to construct our series and deal with the mistakes and typographical errors in the data. It consists in exploiting the fact that most locals are present in the data over several years to check for discrepancies across years in the membership rates reported by each organization.

Exclusions:

We miss the smallest units, that is, those who are so small that they are not required to file an LM report. We only focus on locals, so we omit those few organizations that only file reports at a higher level of aggregation. This is to avoid double counting of members in a local and in the branch or national union this local belongs to. A few organizations have filed an LM report as a local for some years in the period and as another type of organization for other years. As their status is ambiguous and they usually have very large memberships as compared to typical locals, we also exclude them, thus removing 3041 *local*year* observations from the data sample. We finally exclude 5882 *local*year* observations corresponding to locals that declare they have terminated.

Dealing with discrepancies in locals' membership time series and filling gaps

We then design an algorithm to detect typos and obvious mistakes in the membership variable and smooth the membership series for each local. To do so, we look for large year-to-year variations in membership growth that are followed by a similar variation in the opposite direction. If, for example, a local declares 100 members in year t-1, 500 in year t and 100 again in year t+1, we consider that membership in year t is likely to be erroneous. When such irregularities are found, we simply replace membership in year t by the average of membership in years t-1 and t+1. We also impute a local membership from the average of previous and future years' memberships when this local is missing whereas it was observed with positive membership in years t-1 and t+1. In total, our imputation process yields 8976 imputations for years 2001 to 2016. For each of these years, we checked that the additional membership that can be attributed to these imputations is lower than 1%, leaving the trend in membership mostly unaffected.

We finally focus on large changes in membership growth that are not matched by opposite changes the next year. These changes are not necessarily oddities: they can result for example from a merger between two locals. We thus checked by hand large changes in membership, leading us to remove local number 540282 that clearly reported an erroneous membership in 2012.

3) Statistical analyses

For our statistical analyses of locals' TFP and prices, we focus exclusively on the raw data to which we apply almost no corrections. Therefore we do not fill gaps in the membership series, nor do we apply systematic corrections. We only remove or apply corrections to a few locals (less than a dozen) exhibiting clear mistakes in their reported membership. We express membership prices and all other accounting variables in 2016 prices using current price index deflator.

4) Competition variables

To measure competition, we compute Herfindahl indexes at the zip-code level. This is done with the dataset that is used to compute aggregate membership, i.e. we fill the gaps for locals that disappear in a given year but are present before and after. Doing so avoids jumps in the Herfindahl index due to missing data rather than an actual local entry or exit.