City Size, Wage Inequality and Firm Productivity: The Role of the Firm in Economy-wide Income Dispersion $^{\phi}$

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Abstract:

This research addresses the link between city-level wage inequality and firm productivity, and our basic research problem concerns how to interpret changes in economy-wide income dispersion. We build upon a theoretical framework suggested by Card et al (2016) which puts the firm level productivity, market structure and rent-sharing front and center in how to understand these changes. Specifically, our research questions address *i)* to which extent differences in productivity across firms (within different types of industries) affect variation in wages among workers within these firms and industries, and *ii)* how this variation in turn spills over into economy-wide inequality (measured at city level, or local labor markets). Our preliminary results suggest that different levels of firm rent-sharing, associated with variation in market structure among firms and industries across the urban hierarchy, are related to higher average wage income among firms. By extension this also helps explain variation in local levels of wage inequality, thereby lending support for the market structure-inequality hypothesis, recently suggested by Card et al (2016).

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Keywords: wage distribution, rent sharing, monopsony, linked employer-employee data, local labor markets

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1. Introduction; research problem and paper outline

As our title suggests, this article addresses the link between city level wage inequality and firm productivity, and our main research problem concerns how to interpret changes in economy-wide income dispersion. In terms of research design, we build upon a new framework suggested by Card et al (2016) which puts the firm and firm level productivity front and center in how we understand these changes. Specifically, our research questions address *i)* to which extent differences in productivity across firms (within different types of industries) affect variation in wages among workers within these firms and industries, and *ii)* how this variation in turn spills over into economy-wide inequality (measured at city level, or local labor markets).

As we will argue below, our paper hereby addresses an evident gap between two largely separate literatures, one of which concerns the causes and effects of agglomeration and explanations of the so-called urban wage premium (i.e. why larger cities pay more), and another which addresses macro level dispersion in wages and income.

In the first of these two literatures, explanations of higher wages in larger cities usually focus on individual productivity of workers in urban environments. The source of this higher individual productivity is most often related to three basic factors. Either *a)* to learning (sharing of knowledge), i.e., a situation in which human capital accumulation is faster in larger more population dense cities due to facilitated social interaction (Glaeser 1999; Glaeser & Maré 2001; Moretti 2004; Baum-Snow & Pavan 2012; De la Roca & Puga 2012); or to *b)* coordination effects, the "matching hypothesis", which suggests that cities create a context in which there is a better chance of bringing about a good match between workers and firms (Kim 1990; Wheeler 2006; Yankow 2006); or, finally, to *c)* sorting and self-selection, i.e. the notion that relatively higher worker productivity in larger cities is largely due to different types of innate abilities of workers living in and moving into these larger cities (see Combes *et al.* 2008, 2010; Matano & Naticchioni 2012).

Considerable effort has gone into disentangling these effects from one another, and, even though there is still debate, a consensus is emerging that a large share of this urban wage premium can be ascribed to geographical sorting of individuals and differences in underlying worker ability (for overviews, see Rosenthal & Strange 2004; Puga 2010).

In the second literature, addressing increasing wage income inequality, there has in turn recently been a push to extend the more traditional approaches (as related to factor input supply- and demand changes, arising from new technology, trade patterns and immigration, see Katz 1999; Wright *et al.* 2009; Acemoglu & Autor 2011) with research that gauges the link between overall inequality levels on the one hand and variance in firm productivity on the other. In particular, this research highlights how dispersion of TFP (or output per worker) across firms has been rising over time and how this development also closely mirrors the well-known trend of rising wage inequality between workers (Dunne *et al.* 2004; Faggio *et al.* 2010; Barth *et al.* 2016; Card *et al.* 2016). For example, Barth et al (2016) decompose US individual log earnings into dispersion in-between- and within establishments and estimate that in-between variation is related to as much as 67 percent of the increase in total variance in income among all workers, 1992 to 2007. And, when including only workers who do not switch jobs during the observed time-period (to address worker selection into more productive establishments), these estimates are surprisingly even higher; 79 percent of total increase in variance during the same time-period (see Barth et al. 2016, p. S75).

This latter extension of the inequality literature rests upon three somewhat different strands of the literature on worker- and firm productivity. Firstly, it is a long since established fact that there is considerable heterogeneity in firm productivity (TFP or output per worker), even as measured among observably similar firms and establishments (for a review, see Syverson

2011). For example, estimating the 90-10 TFP percentile ratio for US manufacturing firms, Syverson (2004) documents a difference in this measure of approximately two, and even larger gaps – in the order of five – are found for firms in China and India (Hsieh & Klenow 2009). Second, this spread in productivity between firms has also been documented as related to differences in wages for workers within these firms (see e.g. Slichter 1950; Davis & Haltiwanger 1991; Cardoso 1997; Skans *et al.* 2009 among many), but since selection and unobserved heterogeneity among workers is difficult to capture, researchers have been reluctant to pin-point firm level differences in TFP as *causing* this variation in wages. Third, the empirical literature on rent-sharing takes a more direct aim on this issue and relates wages for workers within separate firms and industries to various measures of firm profits or rents. In the past few years, much progress has here also been made to better control for worker ability or "quality", due partly from an increasing employment of panel data and a difference-in-difference framework.

A typical finding in this latter extension of the literature is that a 10 percent increase in value-added per worker leads to somewhere between a 0.5 and 1.5 average percent increase in wages. Even though estimates still vary as to how these wage increases are portioned between different types of workers (for a review, see Card *et al.* 2016) there has also notably been progress in terms of theory as to how we can actually explain why firm level profits or rents may spill into wages of particular worker categories. Building on a monopsony framework first developed Joan Robinson in (1933), Card et al (2016) develop a model of imperfect competition in the labor market, seeking to provide a basic framework for studying the implications of worker- and firm heterogeneity for wage inequality. In this setting, workers are allowed to have heterogeneous preferences of the work environments of different potential employers (related to, for example, firm location and different types of job amenities), which make employers imperfect substitutes in the eyes of employees. This in turn gives employers some degree of wage setting power over workers, which allows employers to post common wages for each skill group which is marked down from marginal product in inverse proportion to the elasticity of labor supply to the firm, and the wages of workers are thus not equal (sub-par) to the average marginal productivity of each group of workers. Important for the purposes of this research proposal, this monopsony framework has however not yet been tested empirically, whether by Card et al or other scholars.

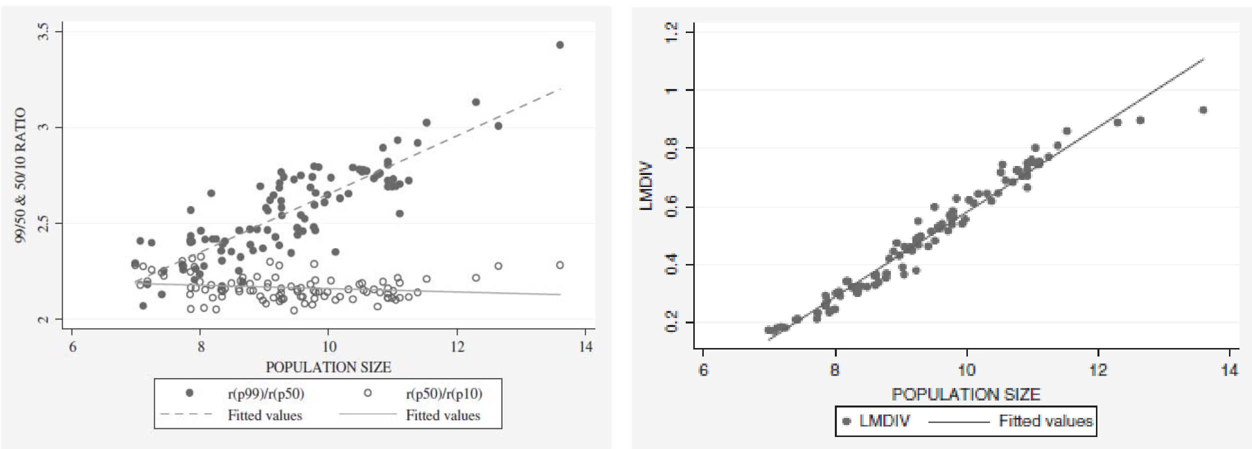
So, as to summarize and to outline our research problem, as highlighted at the outset, we note that in the literature on the urban wage premium most of the focus is on the individual worker and on the potential individual level sources of higher worker productivity in larger cities. Even though there is also some work linking these higher wages to firm and industry sorting across cities of different sizes, little is known about potential firm-level roots of these geographical differences in wages.[1] In the inequality literature, on the other hand, there has been much progress in linking profits or rents to diverging wages between different groups of workers in different firms and industries, but these methodological developments have yet to be applied to a geographical setting, i.e. within the field of geographical economics, or economic geography.

Our paper thus aims to fill this gap between these two broad literatures and apply these recent developments within the field of income inequality to the field of geographical economics and the literature on the urban wage premium and urban income inequality. However, rather than using economy- or industry wide aggregate data (as in many rent-sharing studies referenced above), we focus on wage inequality of Swedish local labor markets and the workers within the firms and industries that are nested in these local labor markets. The reason is that the use of geocoded full population registry data on all individuals and all firms and industries,

[1] There is a somewhat separate literature on city size and income inequality, where higher levels of inequality in larger cities are linked to larger shares of higher educated and firm sorting across geographical space (for overviews, see Korpi 2008; Fallah *et al.* 2011), but here also very little is known about the potential firm- and industry level sources of higher incomes in larger cities.

provides us with an optimal – and as far as we know not yet utilized – setting for testing these competing hypotheses. Figure 1 below shows, in the left hand plot, a strong correlation between local population size and wage inequality within local labor markets, and the right hand plot, a similar strong correlation between local population size and the number of industries (and firms) within these local labor markets, i.e. local population size determines geographical firm-and industry sorting (Figure 1 from Korpi 2008, pages 226-227).

Figure 1. Local labor market wage inequality (p90/p50, p50/p10 ratio), industry diversification (LMDIV) and labor market population size (log values). Sweden, 1995



Further, as compared to earlier research, since we use linked employer-employee full population registry data, we can control for many of the information- and measurement problems often confounding studies within the field. Notably also, since we utilize data on firms within consumer- and producer services (i.e. mostly non-exporting industries), and we have information on both revenue and exact counts of the number of firms within industries at different levels of the urban hierarchy, this allows for various measurements of industry market structure and to empirically test the implications of the theoretical framework provided by Card *et al* (2016), as referenced above.

Thus, as our basic research questions we ask *i)* how differences in firm performance (TFP or revenue per worker) among firms within similar industries affect the average wage of workers within these firms and industries? This link is long since established as regards aggregate data (as in.e.g. Cardoso, 1997 and Nordström Skans et. al. 2009, referenced above), but how does the pattern hold in a regional setting within the urban hierarchy? *ii)* Does local or industry-wide market structure affect rent-sharing and firm performance (as measured by TFP or revenue per worker)? Finally, *iii)* how do these differences in firm- and industry level productivity affect aggregate wage inequality (as measured within local labor markets)?

2. Methodology and empirical outline

In terms of methodology, as to address our research questions we utilize hierarchical simultaneous regression analysis (i.e. multilevel modelling) since this methodology provides a clear venue for studying the interaction of micro-level outcomes and macroeconomic differences. With the primary unit of analysis being the firm and the wage outcomes for individuals within these firms, our first research question delves into the role of rent-sharing in wage determination as a function of firm contextuality. As firms that are nested in the same industry not only share similar technology but also competitive pressure, we investigate whether rent-sharing may be influenced by the heterogeneity present at different levels of agglomeration. While the relationship between firm-level performance and agglomeration remains largely unexplored in the previous literature (van Oort *et al.* 2012), the research gap is arguably even more pronounced as to how these differences translate into individual-level outcomes, such as wages. One explanation for this gap in the literature, echoing Van Oort et al. (2012), is the relatively late arrival of hierarchical- and multilevel modeling in the field of agglomeration economics.

By considering workers as nested in firms, industries and regions, we can directly model how heterogeneity in rent-sharing at the local-industry level along with measures of competition spill over to average wages among firms. Moreover, a multilevel approach allows us to test for *(i)* different levels of aggregation, *(ii)* random intercepts that capture any variation between firms and industries at the outset, and *(iii)* random coefficients that reflect possible differences in how rent-sharing may depend on properties that reside on the regional and sectoral level.

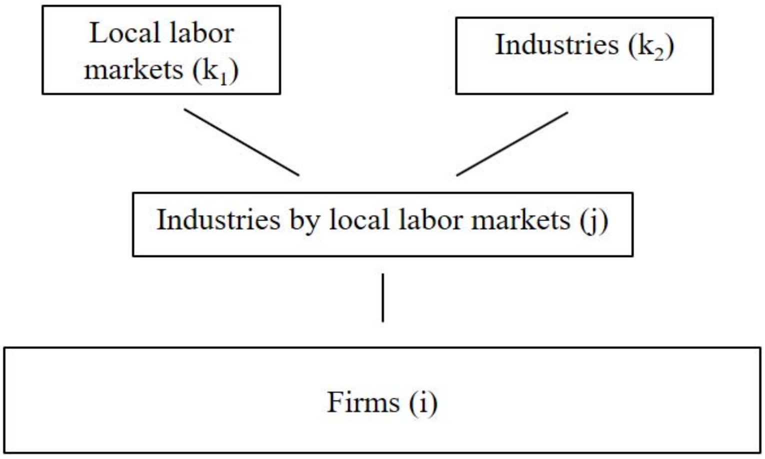


Figure 2. Mixed hierarchical and cross-classified model of external environment of firms

As illustrated in Figure 2 above, our modeling strategy aims to distinguish between four different classifications. First, we have the regional level, made up of 75 local labor markets (k_1) as defined by Statistics Sweden (see footnote below), and second, we have industries (k_2) as represented by 44 consumer- and producer services. These industries are in turn nested within our local labor markets, forming a separate third classification "Industries by local labor markets" (j) and the data allows us to separate between 3300 such categories (44 industries multiplied by 75 local labor markets)[2]. Finally, we have the level of the firm (i) consisting of 47 476 separate firms spread across all different industries and labor markets.

We present a cross-level interaction model for average firm wage denoted by $\ln w_{ijk(j)}$ (level 1) with random intercept and random coefficients at the levels of local industries (level 2) and regional industries (level 3) in which the former are nested:

$$\ln w_{ijk(j)} = \alpha_1 + \alpha_{2j} + \alpha_{3k(j)} + \left(\beta_{2j} + \beta_{3k(j)}\right) \ln r_{ijk(j)} + I_{ijk(j)} + \bar{S}_j + \epsilon_{ijk(j)},$$

where we have two random intercepts, one on the regional industry level (j=1…,J) and one on the local industry level that is nested in geographically delimited (local) labor markets (k(j)=1,…k(J)).

$$\alpha_{2j} = \alpha_{02} + \beta_{02} H_j + \mu_{02j},$$

$$\alpha_{3k(j)} = \alpha_{03} + \beta_{03} H_{k(j)} + \mu_{03k(j)}.$$

At each level, market concentration H is entered as a predictor variable. It is computed as the sum of squared revenue shares for firms at the respective level. In turn, the coefficient for $\ln r_{ijk(j)}$ is modeled as two random variables given by

$$\beta_{2j} = \alpha_{12} + \beta_{12} H_j + \mu_{12j},$$

$$\beta_{3k(j)} = \alpha_{13} + \beta_{13} H_{k(j)} + \mu_{13k(j)},$$

in which H similarly enters as a predictor variable. By substituting for α_{2j}, $\alpha_{3k(j)}$, β_{2j}, and $\beta_{3k(j)}$ in the above equation, the full empirical model can be written as follows:

[2] The classification of these local labor markets follows Statistics Sweden's 2007 definition, where if at least 20 percent of the inhabitants in a municipality commute to another municipality daily, that municipality is part of a broader local labor market (**REF**).

$$\ln w_{ijk(j)} = c + \beta_{02}H_j + \beta_{03}H_{k(j)} + (\alpha_{12} + \alpha_{13})\ln r_{ijk(j)} + \beta_{12}H_j \ln r_{ijk(j)}$$
$$+ \beta_{13}H_{k(j)} \ln r_{ijk(j)} + \boldsymbol{I}_{ijk(j)}\boldsymbol{\Gamma} + \gamma\bar{S}_j$$
$$+ \mu_{ijk(j)} \quad (1)$$

where

$$c = \alpha_1 + \alpha_{02} + \alpha_{03}$$

is a constant in the fixed-effects part in the final model, in which the random-effects part is given by:

$$\mu_{ijk(j)} = \mu_{02j} + \mu_{03k(j)} + \left(\mu_{12j} + \mu_{13k(j)}\right)\ln r_{ijk(j)} + \epsilon_{ijk(j)}.$$

In the above model (1), H_j and $H_{k(j)}$ captures the direct effect of market concentration, at the level 2 and 3 respectively, on average firm wages. Rent-sharing, i.e. the extent to which higher earnings $\ln r_{ijk(j)}$ at the firm level spill over on average worker wages, is captured by the elasticity $(\alpha_{12} + \alpha_{13})$. In the model, rent-sharing are allowed to vary depending on the concentration at either level 2 or level 3. These effects in turn are described by the cross-level interaction terms $H_{k(j)} \ln r_{ijk(j)}$ and $H_j \ln r_{ijk(j)}$ for level 2 and level 3 respectively. As for the final predictor variables $\boldsymbol{I}_{ijk(j)}\boldsymbol{\Gamma}$ and $\gamma\bar{S}_j$, they represent controls at the firm level, such as the number of local establishments in a given firms, and the return from average years of schooling among the working population in a given local labor market.

Sample restrictions

We restrict our sample as follows: as to get reliable estimates of firm average wage income we drop all firm observations with less than five employees. On that same note we also drop all firms with revenues below 150 000 SEK, the equivalent of around 15 000 Euros.

Descriptive statistics

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnW	47,476	6.181417	.3549696	5.011587	10.27923
lnR	47,476	7.239215	.7939304	5.012116	13.57779
NrEst	47,476	1.068624	.7743168	1	65
H_regional	47,476	.0156481	.0449903	.0005123	.8518406
H_local	47,476	.0880982	.1474726	.002284	1
H_regional~R	47,476	.1143111	.3368745	.0027389	8.323701
H_localXlnR	47,476	.6350655	1.060137	.0122689	10.60496
LaHumanCap~l	47,476	12.55183	.3439104	11.47298	12.99875

(TO BE EXTENDED)

3. Results

In the below, in Table 2, we present results from four models. To begin with, we show the results from our baseline model (model 1), where we estimate equation (1) without any random effects using OLS (with standard errors clustered at the local industry level). In model 2, we allow for random intercepts at the regional industrial level. In model 3, random intercepts are also included for the local industry level, nested in the previous model. Model 4 is our main model, here we also allow the interaction terms to vary across hierarchical level, hence allowing for the random slope structure described in equation (1).

Main effects

As for the results from our model no. 3 (main model), the variable log revenue is statistically significant at 99.9 percent level of confidence. This result implies that a 1% increase in average establishment revenue leads to 0.28 percent higher average wage within a firm, results for rent-sharing which are in line with those from for example Bart et al (2016). The number of establishments at the local level is highly significant but with a very small coefficient (0.01). An addition of one establishment at the local labor market level is associated with 0.01 % higher average wage. As for our variables for industry- and local level market structure, based on the Herfindahl index (*H_regional and L_local*), regional market structure is insignificant but our variable capturing local market structure, on the other hand, suggest that local firm concentration is important; A 0.1 increase in *H_local* implies a 0.057 percent increase in average establishment wage. Our model suggests that, as our measure of local industrial concentration moves from low to high concentration, this moderates the rent sharing estimate (correlation) to the negative. Thus, higher local concentration among firms suggest lower levels rent sharing. To the extent that this also implies lower competition, this result is line with Card et al's argument that lower competition is associated with lower levels of rent sharing.

Implications for local labor market wage inequality

(TO BE WRITTEN)

Table 2. Cross-level interaction model for average firm wage

Variable	*OLS*	*Model1*	*Model2*	*Model3*
Main				
LnRevenue	0.24***	0.26***	0.25***	0.28***
	(0.02)	(0.00)	(0.00)	(0.01)
No. Establishments	0.00	0.00***	0.00***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
H_regional	-0.60	-0.65**	-0.53**	0.02
	(0.73)	(0.26)	(0.25)	(0.55)
H_local	1.24***	0.85***	0.75***	0.57***
	(0.33)	(0.08)	(0.08)	(0.08)
H_regional X lnRevenue	0.09	0.09***	0.07**	6.80
	(0.10)	(0.03)	(0.03)	(4.43)
H_local X lnRevenue	-0.15***	-0.13***	-0.11***	-0.09***
	(0.05)	(0.01)	(0.01)	(0.01)
Schooling	0.14***	0.03***	0.03***	0.03***
	(0.05)	(0.00)	(0.01)	(0.01)
Constant	2.65***	4.03***	4.03***	3.73***
	(0.58)	(0.06)	(0.09)	(0.14)
Var (residual)		.0632	.0623	.0584
Var (regional industry)		.0285	.0247	.5265
Var (local indsutry)			.0008	.0009
*Var (revenue*H_regional)*				758.5
N	47476	47476	47476	47476

4. Conclusions and discussion

Seeking to address a gap between two largely separate literatures, one of which concerns the causes and effects of agglomeration and explanations of the so-called urban wage premium (i.e. why larger cities pay more), and another which addresses macro level dispersion in wages and income, this paper addresses the link between firm productivity and city-level wage inequality. Our basic research problem concerns how to interpret changes in economy-wide income dispersion, and we explore and test a new theoretical framework suggested by

Card et al (2016), a framwork which introduces market structure (local levels of competition) as a possible source of differences in firm rent-sharing and wage income inequality. Our preliminary results suggest that, indeed, different levels of rent-sharing among firms, associated with variation in competition among firms and industries across the urban hierarchy, are significantly related to higher average wage income among these firms, even while controlling for local levels of human capital (years of education).

By extension this also helps explain variation in local levels of wage inequality, thereby lending support for the market structure-inequality hypothesis, as suggested by Card et al (2016).

(TO BE EXTENDED)

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