AGGLOMERATION AND HOURS WORKED

Stuart S. Rosenthal and William C. Strange*

Abstract—This paper establishes the existence of a previously overlooked relationship between agglomeration and hours worked. Among nonprofessionals, hours worked decrease with the density of workers in the same occupation. Among professionals, the relationship is positive. This relationship is stronger for the young than for the middle-aged. Moreover, young professional hours worked are especially sensitive to the presence of rivals. The paper shows that these patterns are consistent with the selection of hard workers into cities and with the high productivity of agglomerated labor. The behavior of young professionals is also consistent with the presence of keen rivalry in larger markets, a kind of urban rat race.

I. Introduction

"*[In New York] [e]very man seems to feel that he has got the duties of two lifetimes to accomplish in one, and so he rushes, rushes, rushes, and never has time to be companionable—never has any time at his disposal to fool away on matters which do not involve dollars and duty and business.*" Mark Twain. Letter to Alta California, August 11, 1867

It is not a new idea that cities are busy places. It is also not an idea without current relevance. If anything, modern life is more hurried than it was in Mark Twain's New York.[1] Despite this, the connection between spatial concentration and the intensity of work has received little attention in either labor or urban economics. In the literature on labor supply (see Pencavel, 1986, for a survey), there has been almost no attention paid to agglomeration.[2] In the literature on agglomeration economies, the focus has been on labor productivity and growth rather than on hours worked.[3]

This paper considers the relationship between agglomeration and hours worked. It makes three contributions. First, it shows that there is a systematic relationship between agglomeration and the intensity of work. Second, it establishes that the impact of agglomeration varies across the labor market, with important differences between young and middle-aged workers and between professionals and nonprofessionals. The paper's third contribution is to provide evidence of various mechanisms that contribute to the agglomeration–hours worked patterns in the data. We find that selection and urban productivity both contribute to the agglomeration–hours worked relationship. This is consistent with prior research showing that these forces can explain the urban wage premium. However, the effect of selection and urban productivity on hours has not previously been documented. We also find that young professionals behave in a more rivalrous manner in agglomerated areas, a kind of urban rat race. This evidence of a rat race is nearly unique in the literature.[4]

We begin with an illustration that highlights the paper's themes. Using data from the 5% Integrated Public Use Microdata Series (IPUMS), table 1 reports average hours worked by full-time male employees for the three largest cities and three much smaller nearby cities located beyond typical commuting distance (respectively, New York, Chicago, Los Angeles and Hartford, Milwaukee, Sacramento). The table is partitioned into young men in their thirties and middle-aged men in their forties, and also into professionals and nonprofessionals. This grouping by age and professional status will be retained throughout the paper. The logic behind this approach is explained later.[5]

Table 1 documents a clear relationship between hours worked and agglomeration. For nonprofessionals, average hours worked are similar for the two groups of cities and age classes. In contrast, professionals work substantially longer in the larger cities. The difference in hours worked is greatest among the young workers. This pattern is especially clear among lawyers and judges, a profession famous for its long hours worked (Landers et al., 1996). Young lawyers, for example, worked more than 2 hours longer in the bigger cities on average, 50.32 versus 48.26. In contrast, among middle-aged male lawyers there is little difference in average hours worked. Taken as a whole, table 1 suggests that there is a positive relationship between agglomeration and hours worked for professionals, but not for nonprofessionals.

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* Department of Economics, Syracuse University; and RioCan Real Estate Investment Trust, Professor of Real Estate and Urban Economics, Rotman School of Management, University of Toronto, respectively.

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[1] Schor (1991), for instance, uses CPS data on reported work hours to conclude that leisure has declined since the late 1960s.

[2] The only exceptions have been the inclusion of metropolitan area population or urban dummies.

[3] See Rosenthal and Strange (2004) for an empirical survey or Fujita and Thisse (2001) for theory. Glaeser et al. (1992), Henderson, Kuncoro, and Turner (1995), and Ciccone and Hall (1996) are important empirical contributions.

[4] We are aware of only one other paper that provides empirical evidence of rat race effects. Landers, Rebitzer, and Taylor (1996).

[5] Full-time is defined as working at least 35 hours per week. Summary measures based on a cutoff of 40 hours per week are similar, with average hours worked slightly higher for each category. Professionals are defined as individuals in Census occupations in the professional-technical group who also have a master's degree or higher. Nonprofessionals are defined as individuals who have less than a college degree and who work in all other occupations except managers and agriculture. Person sampling weights available in the IPUMs (perwt) are used to ensure that the estimates in table 1 are representative. Although table 1 focuses only on male workers for select cities, later in the paper we expand the analysis to include the entire United States and also women. As will become apparent, results for men and women are similar.

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TABLE 1.—AVERAGE HOURS WORKED AMONG FULL-TIME WORKERS (35 HOURS OR MORE PER WEEK) IN SELECT METROPOLITAN AREAS[a]

Occupation Category	Metropolitan Area	Young Males	Middle-Aged Males
Nonprofessional workers[b]	New York, Chicago, Los Angeles	44.08	44.08
	Hartford, Milwaukee, Sacramento	44.01	44.27
Professional workers (including lawyers & judges)[b]	New York, Chicago, Los Angeles	49.06	48.01
	Hartford, Milwaukee, Sacramento	47.74	47.15
Lawyers and judges	New York, Chicago, Los Angeles	50.32	48.94
	Hartford, Milwaukee, Sacramento	48.26	48.88

[a]All data are weighted to be representative using the perwt variable in the IPUMs. Hours worked are based on the "usual hours worked per week." Full-time is defined as 35 or more hours per week.
[b]Professional workers are individuals in occupations categorized as professional-technical in the OCC1950 variable of the IPUMS *and* who have a master's degree or more. Nonprofessionals include all other workers except managers and agricultural workers *and* who have less than a bachelor's degree.

This evidence of work behavior differing between professionals and nonprofessionals echoes Colemen and Pencavel (1993a, 1993b), who report that hours worked have increased over time among educated workers in the United States, but have fallen among less educated workers.[6]

What forces might be responsible for this pattern? One is that big-city workers may choose longer hours because their work is more productive and therefore better rewarded. Another is that hard workers may be drawn to large cities. A third explanation is that there is more rivalry in large markets, leading workers to choose long hours as a way to signal ability. We characterize this as an urban rat race. On the other hand, it is also possible that adding workers to a local labor market could reduce individual hours worked as the total workload is spread over a larger number of individuals.[7] These forces yield different predictions about the agglomeration–hours worked relationship. It is entirely possible—in fact, it is likely—that *all* of these mechanisms influence observed patterns of hours worked.

We test for the presence of these forces using full-time workers throughout the United States from the 1990 5% IPUMS of the Decennial Census (http://www.ipums.org). Among nonprofessionals, we find that increased spatial concentration of workers in the individual's occupation is associated with fewer hours worked, consistent with work-spreading. The opposite is true for professional workers of all ages. Among these professional workers, hours increase with the density of employment in the worker's occupation and location, consistent with the presence of selection and productivity effects. Moreover, the latter effect is several times as large for young professionals as for middle-aged professionals.

To investigate these patterns further, we augment the wage models with controls for local labor market rivalry and the financial rewards to advancement. We take two approaches to defining a worker's rivals. The first includes as rivals those workers who work nearby, are of similar age, and earn a similar wage. The second definition is based only on location and age. For both definitions, when the rewards to getting ahead are zero, the presence of rivals has a negative effect on hours worked for both young and middle-aged professionals. This effect is similar in magnitude for both age groups. However, as the rewards to getting ahead increase, the presence of rivals has a positive influence on hours worked that is sharply higher for young professionals than for middle-aged professionals or for both young and middle-aged nonprofessionals. Our estimates imply that in large cities such as New York, Los Angeles, and Chicago, the presence of rivals increases young professional work hours by the equivalent of at least a standard work week over the course of a year—a large effect. These findings are consistent with the rivalry explanation of the urban rat race. The key results are robust, holding for a range of specifications for both male and female workers, including models with over 6,000 occupation/MSA fixed effects.

Although the paper's primary purpose is to advance the understanding of urban labor markets by documenting the relationship between labor supply and agglomeration, the paper also advances the understanding of rat race effects. Akerlof's (1976) paper is fundamental in the vast literature on adverse selection in labor markets. He shows that workers may, in some situations, work long hours in order to signal their unobservable productivity. Despite the importance of Akerlof's paper, there has been little empirical work on the rat race. The best test to date is Landers et al. (1996), who survey lawyers in two large firms in large northeastern cities. They identify a rat race in several ways. First, they show that lawyers work long hours, especially young ones, and that these lawyers would like to reduce hours even if this were to mean lower income. Second, they show that both associates and partners perceive hours worked as being crucial in determining which associates will be accepted as partners. As with Landers et al., we consider the different situations faced by younger and older workers. In contrast to Landers et al., we look across all occupations and cities rather than analyzing a single occupation in a single firm or city. In addition, we examine actual hours worked rather than relying on survey evidence on worker satisfaction and attitudes.

The remainder of the paper is organized as follows. Section II discusses our data and variable construction and documents the relationship between agglomeration and hours worked. Section III looks at several explanations of the observed relationship, including productivity, selection, and rivalry. Section IV concludes.

[6] This pattern may explain the estimated reduction in work hours on average noted by Robinson and Bostrom (1994).
[7] Whether this would occur in equilibrium depends on the tradeoff between the fixed costs of hiring and training new workers versus the cost of employing existing workers for longer hours.

II. Documenting the Agglomeration–Hours Worked Relationship

A. Data and Variables

This section documents the relationship between agglomeration and labor supply using the IPUMs data described above. At this point, we focus only on male workers. Female workers are considered in detail later (beginning in section IIIE). As before, we include only full-time workers, defined throughout the paper as those who reported that their usual hours worked were 35 or more per week. We also experimented with a sample based on individuals working 40 hours per week or more. Results for this latter group are nearly identical to those from the 35 hours-plus sample and are not reported.[8]

As in table 1, we divide workers into two occupational groups. Professional workers are defined to be individuals in Census occupations categorized as "professional" or "technical" who also have a master's or more for educational attainment.[9] Nonprofessional workers are defined to be those who belong to all other occupational categories except farmers and managers and have less than a bachelor's degree.[10] Individuals not belonging to one of these two groups are excluded from the sample. This ensures a sharp division of workers into professional and nonprofessional categories.[11] Throughout the paper, person sampling weights from IPUMs (perwt) are used to ensure that the estimates in table 1 are representative.

In all of the estimated models, each group of workers is further subdivided into young and middle-aged workers, where the young are between ages 30 through 39, and middle-aged workers are between 40 and 49. We focus on these age groups for two reasons. First, the decision to work is more exogenous for individuals in their thirties and forties than in their twenties and fifties. Individuals in their twenties may still be in school, while individuals in their fifties may behave differently as they approach retirement. Second, among professionals, most workers establish their reputations in their thirties. In law, for example, young associates compete for partnerships, with a reputation for diligence being an important part of their competition (Landers et al., 1996).

In addition to stratifying the models by age and occupation type, we also control for a standard set of demographic attributes. These include the worker's level of education, the presence of children, marital status, age, race, years of residency in the United States, and commute times. These measures help to control for differences in taste for long hours of work. Wage rates are not included directly in the model because of concerns about endogeneity: wage affects an individual's willingness to supply labor, but wage rates themselves are sensitive to the individual's skills and attributes.[12] This issue arises in nearly all hours worked studies. For that reason, we adopt a reduced-form approach to controlling for wage rates.[13] Specifically, we use the same demographic attributes just noted to proxy for the individual's unobserved skill level and, therefore, market wage. In addition, in all of our models we control for occupation fixed effects in order to capture unobserved differences across occupations: there are 70 such fixed effects for the professional models and 135 fixed effects for the nonprofessional models.[14] Moreover, in our most robust model, we interact the occupation fixed effects with MSA fixed effects, adding over 6,000 fixed effects to the specification. This controls for the possibility that individuals in the same occupation may have different skills and perform different tasks in different MSAs. It should be emphasized that these measures are provided separately for each age and occupation segment of the sample described above.

For all of the labor supply models, we use the log of usual hours worked per week as the dependent variable.[15] Finally, for all of the models to follow, *t*-ratios are calculated based on robust standard errors that are clustered based on the work PUMAs (Public Use Microdata Areas). This tends to lower the reported *t*-ratios, but allows for a more general pattern of residuals.

B. Urbanization and Hours Worked

We begin by regressing log hours on occupation fixed effects, worker attributes, and a measure of urbanization, the log population density of the work PUMA (*PopDen*).[16] work PUMAs have an average of roughly 210,000 people in residence and range from just over 100,000 people present

[8] We also ran the models setting the minimum hours worked to 1 hour or more per week. Results were little changed for men but did change substantially for women for whom part-time work is more prevalent.

[9] This includes individuals with a master's, professional, or PhD degree.

[10] The occupational categories were defined based on the OCC1950 variable in the IPUMs data file. In addition, occupations excluded from both professional-technical workers and nonprofessionals include farmers and farm managers (occ1950 $\geq$ 100 & occ1950 $\leq$ 123), managers, officials, and proprietors (occ1950 $\geq$ 200 & occ1950 $\leq$ 290), nonoccupational responses (occ1950 $\geq$ 980 & occ1950 $\leq$ 997), NA-blank (occ1950 = 999), and any observations with missing values for OCC1950.

[11] Many individuals indicate that they work in professional or technical occupations, but have less than a master's degree, or even less than a college degree. Regressions based on these workers suggest that as the level of education falls, their behavior becomes similar to that of the nonprofessionals. For this reason, we use education as a further filter when placing individuals in the professional/nonprofessional categories.

[12] This problem is compounded in PUMS data because wage is not directly reported. Instead, hourly wage rates are calculated by dividing annual wage earnings by the usual number of hours worked per year, creating a mechanical relationship between wage and hours worked.

[13] See Kahn and Lang (1991) for a discussion of this reduced-form approach.

[14] Few studies have instrumented directly for wage in labor supply equations. For a recent example see Black, Daniel, and Sanders (2002). In their work, Black et al. use temporal variation in the market value of coal in the ground as driven by world oil price shocks to instrument for variation in wage rates in the coal mining regions of the United States.

[15] In the IPUMS this is measured using UHRSWORK.

[16] It is important to emphasize that *PopDen* and the rest of our agglomeration variables include all full-time workers, both male and female.

to over three million.[17] We carry out the analysis at the PUMA level because it allows us to use MSA fixed effects and because of prior evidence that agglomeration economies attenuate rapidly (Rosenthal & Strange, 2003, 2005). The popular notion that urban life is busy and the preliminary summary measures in table 1 both suggest that individuals work longer hours in larger cities, leading one to expect a positive coefficient on *PopDen.* However, if there is a limited amount of work to be done, then having more workers of a particular type might tend to result in each working shorter hours, ceteris paribus. If this kind of work-spreading occurs, this would imply the opposite sign on *PopDen.* The possibility that workers might concentrate in this way in equilibrium is consistent with various models, including Harris-Todaro (1970) on urban unemployment and MacDonald (1988) on rising stars.[18]

Results are presented in table 2. The coefficients on the demographic controls agree with priors and are not discussed further given our focus on agglomeration. Among nonprofessionals, the elasticity of hours worked with respect to the population density of the individual's work PUMA is negative, significant, and identical in magnitude (and significance) for both age groups. This is consistent with work-spreading. In contrast, the elasticity among professional workers is also nearly identical in magnitude for both age groups, but is positive and significant. This difference between professional and nonprofessional workers echoes the summary measures in table 1 and will persist throughout the paper.

C. Localization and Hours Worked

Do the estimates from table 2 imply that population density per se is associated with longer hours worked by professional workers? Not necessarily. Perhaps instead a worker is motivated more by the presence of workers in the same occupation. After all, lawyers do not compete with doctors in the labor market. To consider this possibility, we add a control for the occupation-specific employment density of a work PUMA (*OccDen*). *OccDen* equals the number of full-time male and full-time female workers between the ages of 30 and 65 in each occupation for each work PUMA (weighted by the person weights in the IPUMS to ensure a representative sample) divided by the geographic area of the work PUMA. This variable was calculated separately for each of the occupations in the professional-technical group and each of the occupations in the nonprofessional group, a total of over two hundred occupations. Following Hoover (1948) and the large literature on agglomeration, we refer to this as a measure of localization.

Table 3 reports results with localization (*OccDen*) included in the model. To simplify presentation, only the coefficients on the agglomeration variables are provided (both here and in the remaining tables). The population density coefficients from the models in table 2 are included in table 3 to facilitate comparison. Beginning once more with the nonprofessionals (the last four columns of table 3), for both age groups, adding the localization variable causes the population density coefficient to change from negative and significant, to positive and clearly insignificant. In contrast, the elasticity of hours worked with respect to occupational density is roughly -0.14% and is significant for both age groups. This is consistent with work-spreading, but in this case the effect arises from proximity to workers in the same occupation and not from city size per se.

Among professional workers, localization effects also appear to dominate. For young workers the elasticity of hours worked with respect to *OccDen* is 0.47% and is highly significant. Among middle-aged workers the elasticity with respect to *OccDen* is smaller, just 0.13%, and is insignificant. In contrast, *PopDen* now has a negative impact on hours worked for both age groups, though significant only for the younger workers.

In sum, this section has presented evidence that labor supply varies systematically with agglomeration. The strongest pattern is for young professionals. They work longer hours when there is a high density of other workers in the same occupation. Nonprofessionals, in contrast, work fewer hours when there are many similar workers nearby.

III. Understanding the Agglomeration–Hours Worked Relationship

A. Productivity, Selection, and the Urban Rat Race

There are many factors that might lead to some sort of positive relationship between agglomeration and labor supply among professional workers. This section will emphasize three: productivity, selection, and rivalry among workers that produces a sort of rat race. As noted in the introduction, we believe that all of these effects are likely to be present. In the discussion to follow, we pay special attention to the rat race effect, not because it is necessarily more important than the others, but because empirical evidence of rat race effects is so scarce.

The productivity and selection channels are easy to understand. There is compelling evidence that agglomeration increases productivity per hour worked (see the literature

[17] Work PUMAs in 1990 correspond to regions identified by the first three digits of the five-digit residential PUMA code. Large metropolitan areas have numerous work PUMAs, but in rural areas a single work PUMA can cover a large geographic area. Information on the population and geographic area of each residential PUMA was obtained from the Census Mable geographic engine available on the Web (See http://mcdc2.missouri.edu/websas/geocorr2k.html). Residential PUMAs were then matched to their corresponding work PUMAs, enabling us to calculate the work PUMA population and land area. Dividing yields the population density of the work PUMA (*PopDen*).

[18] Harris and Todaro (1970) show that when the urban wage is fixed above the market-clearing level, there can be unemployment in equilibrium. Although the context of this paper is industrialization in a developing country, the result regarding non-market-clearing prices is much more general. In MacDonald (1988), the possibility of a rewarding career as a "star" leads a large number of young workers to participate in the contest determining who gets to be a star.

TABLE 2.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR

FULL-TIME MALE WORKERS,[a] PROFESSIONALS VERSUS NONPROFESSIONALS

Dependent variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Professional Workers[b]		Nonprofessional Workers[c]	
	Age 30–40	Age 41–50	Age 30–40	Age 41–50
Professional or PhD degree[d]	0.0390	0.0420		
	(16.16)	(17.76)		
Some college or associate degree[d]			0.0038	0.0028
			(4.88)	(3.10)
High school degree[d]			0.0159	0.0149
			(17.12)	(14.95)
Have children	0.0008	−0.0017	0.0086	0.0042
	(0.38)	(−0.86)	(11.87)	(5.18)
Married	0.0108	0.0167	0.0117	0.0079
	(4.83)	(6.28)	(15.55)	(9.10)
Age	−0.0005	0.0010	0.0047	0.0098
	(−0.08)	(0.11)	(2.44)	(2.65)
Age squared	−1.60E-05	−1.68E-05	−7.18E-05	−1.08E-04
	(−0.18)	(−0.16)	(−2.61)	(−2.66)
Black	−0.0234	−0.0267	−0.0349	−0.0334
	(−5.12)	(−5.81)	(−35.83)	(−28.05)
Asian	−0.0272	−0.0352	−0.0086	−0.0028
	(−7.36)	(−7.97)	(−1.91)	(−0.5)
Hispanic	−0.0180	−0.0150	−0.0263	−0.0260
	(−3.97)	(−2.83)	(−17.04)	(−15.6)
Other race	−0.0084	−0.0173	−0.0179	−0.0107
	(−0.56)	(−1.38)	(−4.56)	(−2.67)
Immigrated 6–10 years ago[e]	−0.0101	0.0044	−0.0029	−0.0117
	(−1.77)	(0.47)	(−0.98)	(−2.72)
Immigrated 11–15 years ago[e]	−0.0121	0.0169	−0.0070	−0.0081
	(−2.19)	(1.71)	(−2.19)	(−1.89)
Immigrated 16–20 years ago[e]	0.0123	0.0257	−0.0019	−0.0064
	(1.52)	(2.85)	(−0.57)	(−1.62)
Immigrated > 21 yrs or nat. U.S. citizen[d]	0.0090	0.0211	−0.0080	−0.0167
	(1.92)	(2.96)	(−2.62)	(−4.39)
Log commute time	−0.0094	−0.0115	−0.0065	−0.0084
	(−9.51)	(−11.22)	(−13.92)	(−16.78)
Log population density of work PUMA	0.0011	0.0012	−0.0009	−0.0009
	(1.94)	(2.21)	(−2.75)	(−2.75)
Constant	3.8500	3.7700	3.7000	3.5700
	(35.37)	(17.6)	(112.11)	(42.73)
No. of occupation fixed effects	70	70	135	133
No. observations	54,459	51,991	450,731	286,997
Adj R^2	0.2041	0.1472	0.0747	0.0769
Root MSE	0.1705	0.1702	0.1603	0.1592

[a]Full-time is defined as 35 or more hours per week.
[b]Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]Nonprofessional workers belong to nonprofessional and nontechnical occupations and have less than a BA degree.
[d]Omitted categories for salaried and hourly workers are master's degree and less than high school degree, respectively.
[e]Omitted category is immigrated in the last five years.

review in Rosenthal & Strange, 2004). If workers are paid for extra hours, either through an explicit wage or some sort of implicit contract, then agglomeration and related productivity gains will encourage workers to choose longer hours.[19] Selection can also lead to a positive relationship between agglomeration and labor supply. As above, if workers are more productive when agglomerated, then those with a taste for long hours can earn greater incomes by choosing cities.[20] Selection can also occur if hard-working professionals have a taste for theater, restaurants, and other consumption amenities that are more readily found in large cities. Both the wage- and consumption-selection mechanisms have the potential to draw industrious workers to cities, contributing to a positive relationship between agglomeration and hours worked.

[19] There is mixed evidence regarding whether high-ability workers benefit more from agglomeration than do low-ability workers. Rosenthal and Strange (2005) find that both types benefit roughly equally. Lee (2005) finds low-ability workers benefit more, while Wheeler (2001) finds the opposite.

[20] This is related to Leamer (1999), who argues that employers seek to match expensive capital with workers who will take best advantage of it. Agglomeration is like an expensive piece of capital: urbanization enhances productivity but urban land rents are high. Urban entrepreneurs, therefore, will seek out industrious workers, while industrious workers will be lured to urban areas by the promise of higher wages.

TABLE 3.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR BY PROFESSIONAL STATUS[a,b,c]

FULL-TIME MALE WORKERS, ALTERNATIVE SPECIFICATIONS OF OCCUPATION DENSITY EFFECTS

Dependent variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Professionals[b]				Nonprofessionals[c]			
	Model 1		Model 2		Model 1		Model 2	
	Age 30–40	Age 41–50	Age 30–40	Age 41–50	Age 30–40	Age 41–50	Age 30–40	Age 41–50
Log population density of work PUMA (PopDen)	0.0011	0.0012	−0.0035	−0.0001	−0.0009	−0.0009	0.0006	0.0005
	(1.94)	(2.21)	(−2.36)	(−0.10)	(−2.75)	(−2.75)	(0.71)	(0.63)
Log employment density of worker's occupation in work PUMA (OccDen)			0.0047	0.0013			−0.0015	−0.0014
			(3.36)	(0.99)			(−1.95)	(−2.00)
No. of occupation fixed effects	70	70	70	70	135	133	135	133
No. observations	54,459	51,991	54,459	51,990	450,731	286,997	450,731	286,996
Adj R^2	0.2041	0.1472	0.2045	0.1472	0.0747	0.0769	0.0748	0.0770
Root MSE	0.1705	0.1702	0.1705	0.1702	0.1603	0.1592	0.1603	0.1592

[a]All other variables listed in table 2 are also included in the model but their coefficients are suppressed to conserve space.
[b]Full-time is defined as 35 or more hours per week. Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]Nonprofessional workers belong to nonprofessional and nontechnical occupations and have less than a bachelor's degree.

The effect of rivalry on labor supply in cities is more complicated. Here we appeal to Akerlof's (1976) classic signaling model. He supposes that workers are heterogeneous in type, with higher-type workers being both more productive and more willing to work long hours. The latter is obviously related to the Spence (1973) condition. Under some circumstances, a rat race equilibrium exists, with all workers except those of the lowest type working harder than they would like in order to avoid being mistaken for lower-type workers and paid accordingly. This result requires that it is costly for a high-type agent to be misidentified as a low-type. In other words, it requires that there be rewards to career advancement. The result also depends on local labor markets being relatively "thick." Unless there is a worker of slightly lower type, a high-type worker need not buy into the rat race and work long hours in order to signal. Urban markets are thick, of course. This means that a worker in a large city may choose to work harder in order to be distinguished from rivals. The greater the number of rivals and the larger are the rewards to advancement, the greater will be the tendency for a worker to engage in rat race signaling.

This rat race discussion is quite particular. The idea that rivalry is keener in larger markets is much more general. For instance, in a patent race, a larger number of competitors results in a larger equilibrium level of research and development (Lee & Wilde, 1980). In independent values first-price auctions, a larger number of rivals leads each individual to bid an amount closer to his or her actual valuation (McAfee & McMillan, 1987). Similarly, in tournaments, an increase in the number of participants can encourage effort (Nalebuff & Stiglitz, 1983). Thus, there are many situations where a larger market leads to more vigorous competition.

B. Predictions of the Explanations

Productivity, selection, and rivalry can all explain some sort of positive relationship between agglomeration and hours worked. However, the three forces have very different implications for the form that the relationship will take. One difference concerns the sorts of occupations that are likely to exhibit a positive relationship between market size and work hours. In the presence of productivity effects, workers put in long hours because they are compensated for doing so. Because of selection-wage effects, industrious workers are drawn to agglomerated areas anticipating this compensation. These patterns should apply to workers in all occupations.

On the other hand, in the rivalry explanation, workers put in long hours in order to signal ability. These effects are likely to be stronger in occupations where productivity cannot be easily monitored, and thus where reputation building is important. Such conditions are often characteristic of professional occupations, where output is somewhat intangible. This is in contrast to nonprofessional occupations, where output is more readily identified. In addition, professionals typically work for a salary, while most nonprofessionals work for an hourly wage. This weakens the link between output and compensation for professionals relative to nonprofessionals. Furthermore, salaried workers typically have some choice in hours worked, while wage workers' hours are usually fixed by employers. Taken together, these differences suggest that rivalry effects will lead to a stronger agglomeration–market size relationship in professional occupations than in nonprofessionals occupations.

Another difference between the productivity, selection, and rivalry explanations concerns work hours over an individual's lifetime. Returning to the rivalry explanation, it is likely that after a worker has been active in the labor market for many years, then firms will no longer be uncertain about the worker's type. This would be consistent with models of job ladders (for example, MacLeod & Malcomson, 1988). In this situation, later in their careers, workers would no longer need to work longer hours to distinguish themselves from their less-able coworkers. This implies that the effect of agglomeration on work hours should be lower for older workers.

The life cycle predictions of the rivalry explanation are not shared by the productivity or selection-wage explanations. As long as productivity is higher for workers of all ages—there is no evidence otherwise in the agglomeration literature—then workers would continue to take advantage of high urban productivity and work long hours. Similarly, industrious workers will be drawn to agglomerated areas in order to take advantage of higher wages. It seems likely that these effects would not erode by age forty. Consequently, in both the productivity and selection-wage explanations, the effect of agglomeration on work hours is likely to persist.

One final difference depends on the nature of agglomeration itself, specifically city size versus the spatial concentration of a given occupation. Urban consumer amenities (such as theater) are likely associated more with the size and density of the entire city rather than with the density of a given occupation. For that reason, selection-consumption effects are likely captured by the *PopDen* variable in model 2 of table 3 and are unlikely to account for the positive relationship between localization (*OccDen*) and hours worked among professionals.

In addition to the factors discussed thus far, it is also possible that a kind of work-spreading may occur, as suggested earlier. For a given level of product demand, the presence of more workers of a particular type will tend to result in each working shorter hours, ceteris paribus. Equivalently, in the absence of suitable workers, work stretching may occur, where workers put in long hours. In equilibrium, of course, whether employers will respond to higher levels of product demand by hiring additional workers or by increasing hours worked is ambiguous. On the one hand, the fixed cost of training new workers and of existing workers' benefits encourage employers to expand hours worked among existing employees. On the other hand, if employers must pay higher wages to induce their employees to work longer hours, this would encourage employers to hire new workers. We do not formally model these tradeoffs here. Instead, for our purposes, it is sufficient to note that agglomeration likely reduces hiring and training costs to the extent that employers have a large pool of skilled labor to draw upon (Marshall, 1920; Krugman, 1990). For that reason, it is likely that employers will respond to the availability of substitute workers in part by hiring additional workers and, possibly, reducing the extent of overtime work. This seems especially likely for the nonprofessional sector of the workforce for whom training is presumably easy and where employers are obliged to pay higher wages for overtime hours.[21]

Summarizing, the rivalry, productivity, and selection explanations all imply a positive relationship between hours worked and localization, at least in some circumstances. These explanations never imply a negative relationship. A work-spreading effect instead implies a negative effect of agglomeration on hours worked. The various explanations predict different patterns of labor supply for different types of occupations and age groups.

C. *Urbanization and Localization Revisited*

The discussion above suggests that differencing across worker ages and occupations can shed light on the agglomeration–hours worked relationship. We return, therefore, to the patterns in model 2 of Table 3. In this model the coefficients on urbanization (*PopDen*) for young and middle-aged nonprofessionals are both nearly equal to 0, while the coefficients on localization (*OccDen*) are negative, significant, and nearly identical in magnitude. This pattern is consistent with work-spreading, but offers little evidence of selection, productivity, or rivalry.

Among professional workers, the most important patterns concern occupation density. The coefficient on *OccDen,* although positive for both young and middle-aged professionals, is much larger for the younger workers and significant only for that age group. The positive influence of *OccDen* on hours worked among professionals is consistent with the presence of selection and/or productivity effects.[22] The much larger influence of *OccDen* on young versus middle-aged professionals is consistent with a rat race. The next section focuses more tightly on the rat race. For that reason, the emphasis will be on professional workers.[23]

D. *Rivalry and Inequality among Professional Workers*

To consider labor market rivalry, we begin by constructing an additional variable whose function is to identify the intensity of competition in a worker's local labor market (*Rival*). We take two approaches. Initially, we define a worker's rivals as those individuals in the same occupation who work nearby, are close in age, and earn similar wages. An alternate definition that does not require similarity in wage is discussed later in the paper. Mechanically, to create the initial *Rival* variable, we begin by calculating the national

[21] The Fair Labor Act of 1938 requires that employers pay one and a half times the regular wage for hours worked beyond a "standard" work week (Pencavel, 1986). The law was modified in 1940 to set the standard week at 40 hours for a wide range of nonprofessional occupations.

[22] Kahn and Lang (1991) find that about half of the workforce would prefer to work a different number of hours relative to their actual experience, holding the hourly wage constant, and that the majority of these individuals would prefer to worker longer hours. Our results are at least broadly consistent with this finding. There are fewer professionals than nonprofessionals, and we find behavior consistent with work-spreading for the latter but not for the former. Work-spreading is consistent with wanting to work more and not being able to.

[23] We also estimated a model in which *PopDen* and *OccDen* were replaced with the log ratio employment density in the worker's occupation relative to population density (*OccDen - PopDen*). This tests for whether the degree of specialization in the workforce affects wages. Consistent with the patterns in model 2 of table 3, for young professionals the corresponding coefficient was positive and significant, but for middle-aged professionals and nonprofessionals the coefficients were small and insignificant. This specification, of course, is less flexible than model 2 in table 3, since it constrains the coefficients on *PopDen* and *OccDen* to be of equal magnitude and opposite sign. For that reason, results from the specialization model are not presented.

TABLE 4.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR[a,b]

FULL-TIME PROFESSIONAL MALE WORKERS, ALTERNATIVE SPECIFICATIONS OF OCCUPATION DENSITY EFFECTS

Dependent variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Age 30–40				Age 41–50			
	Model 3	Model 4	Model 5	Model 6	Model 3	Model 4	Model 5	Model 6
Log population density of work PUMA (PopDen)	−0.0025	−0.0021	−0.0024	−0.0007	0.0001	0.0004	0.0005	0.0003
	(−1.69)	(−1.45)	(−1.80)	(−0.41)	(0.07)	(0.25)	(0.37)	(0.18)
Log employment density of worker's occupation in work PUMA (OccDen)	0.0033	0.0026	0.0028	0.0005	0.0016	0.0012	0.0010	0.0007
	(2.28)	(1.82)	(2.05)	(0.29)	(1.12)	(0.84)	(0.70)	(0.40)
Log number of workers in the individual's age group, occupation, and work PUMA within 5 percentage points in the occupation-age national wage distribution (Rival)[c]	0.0048	0.0048	−0.0056	−0.0096	−0.0033	−0.0033	−0.0075	−0.0070
	(3.13)	(3.12)	(−3.09)	(−4.12)	(−2.27)	(−2.27)	(−3.83)	(−2.84)
Interquartile range of log wages in worker's occupation in the worker's work PUMA (WageIQR)		0.0129	−0.0414	−0.0606		0.0068	−0.0187	−0.0178
		(5.86)	(−4.75)	(−5.43)		(3.23)	(−1.88)	(−1.50)
Interactive term: Rival × WageIQR			0.0176	0.0232			0.0084	0.0073
			(6.41)	(6.46)			(2.59)	(1.92)
No. of occupation fixed effects	70	70	70		70	70	70	
No. of occupation and MSA fixed effects				6,345				5,973
No. observations	49,120	49,120	49,120	49,120	46,845	46,845	46,845	46,845
Adj R^2	0.2093	0.2101	0.2111	0.2090	0.1487	0.1489	0.1491	0.1519
Root MSE	0.1687	0.1686	0.1685	0.1687	0.1680	0.1680	0.1680	0.1677

[a]All other variables listed in table 2 are also included in the model but their coefficients are suppressed to conserve space.
[b]Full-time is defined as 35 or more hours per week. Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]*Rival* is calculated by counting the number of workers in the individual's work PUMA in the same occupation and age category (young versus middle-aged) within 5 percentage points in the national wage distribution pertinent to the individual. For these purposes, national wage distribution is measured using all (male and female) full-time workers for the same occupation and age category (young versus middle-aged) as the individual.

hourly wage distribution for all full-time workers in the individual's age cohort and occupation (including both men and women). We then add up the number of full-time workers in the individual's work PUMA. occupation, and age group that earn a wage in the same 5-percentile bracket as the individual worker. This bracket is identified based on the age- and occupation-specific national wage distribution corresponding to the individual worker's age and occupation.[24] The resulting measure identifies the number of individuals who are close substitutes for the individual worker in the local labor market. If rivalry effects are present for young professionals but not for older professionals or nonprofessionals, then *Rival* should have a positive influence on hours worked among young professionals but not for others.

Table 4 presents results from several different models that provide increasingly stringent tests for whether rivalry contributes to hours worked. Beginning with the simplest specification. model 3 controls for the influence of *PopDen, OccDen,* and *Rival.* In this model, the effect of *PopDen* is negative and weakly significant for young workers, and small and insignificant for middle-aged workers. The effect of *OccDen* is positive and significant for young workers. It is positive but insignificant and roughly half the size for middle-aged workers.

Consider next the coefficient on *Rival.* The estimated elasticity of hours worked with respect to *Rival* equals 0.48% for young workers (with a *t*-ratio of 3.13) but *minus* 0.33% (with a *t*-ratio of −2.27) for middle-aged workers. The negative effect of *Rival* on middle-aged professionals is consistent with work-spreading. The positive effect of *Rival* on young professional work hours controlling for occupational density lends further support to the idea that signaling and rivalry contribute to an urban rat race among young professionals.

The theory governing rivalrous behavior allows for even more stringent tests. The rat race requires that two conditions be met: there must be rivals with whom a worker must compete and there must also be a reward to competing successfully. Without the second condition, the reward to getting ahead, the incentive to compete with rivals goes away, or at least is diminished. This idea is consistent with the argument that an unequal wage distribution creates incentives for workers to seek advancement and so encourages hard work (for example, Bell & Freeman, 2000). Accordingly, we specify a variable that captures the degree of wage inequality in professional occupations (*WageIQR*). This measure equals the interquartile range of log wage rates for full-time workers (35 hours or more per week) in the individual's occupation and age category (young versus middle-aged) in the individual's work PUMA.[25]

When *WageIQR* is large, there are large rewards to getting ahead in the individual's occupation and local labor

[24] For example, for a thirty-year-old doctor at the 32nd percentile of the national wage distribution for all doctors in their thirtys (including men and women), we add up the number of doctors in the individual's work PUMA whose wages are in the 30th through 34th percentiles of the national wage distribution. Had the doctor's wage been at the 36th percentile, we would have added up individuals in the 35th through 39th percentiles of the distribution. As before, person sampling weights are used to ensure that the number of rivals present is calculated from a representative sample.

[25] The interquartile wage variable is calculated using the person weights in the IPUMS to ensure a representative measure as with the *OccDen* and *Rival* variables.

market. In this case, we expect young professionals to work longer hours. When *WageIQR* is small, rivalry effects should also be small, young professionals should behave more like middle-aged professionals, and *Rival* should have a negative effect on hours worked as the workload allocated to a group of potential rivals is spread over more individuals. These latter ideas are tested by including interactions between the *Rival* and *WageIQR* variables in the model.

Returning to table 4, model 4 adds the wage inequality measure (*WageIQR*). The corresponding coefficients are positive and highly significant for both age groups. This is consistent with the Bell and Freeman (2000) conclusion that wage inequality increases hours worked. That the coefficient is roughly twice as large for the young workers is consistent with the previously reported differences between young and middle-aged professionals. Also, the remaining agglomeration coefficients are little changed from the previous model.[26]

Model 5 provides a complete specification of the *Rival* and *WageIQR* variables, with direct measures of each along with the interactive term. Two striking results emerge. First, the coefficient on *Rival* is now negative and highly significant for young professionals and similar in magnitude to the corresponding coefficient among middle-aged professionals. Second, the interactive term is positive, highly significant for both groups, but twice as large for the younger workers. These results are consistent with priors, and they suggest that when the financial reward to getting ahead (*WageIQR*) is small, the presence of rivals (*Rival*) has nearly the same effect on the hours worked of young professionals as for middle-aged professionals. The negative coefficient on *Rival* is suggestive of work-spreading, since work-spreading should be most pronounced among workers who are close substitutes. In contrast, as the financial rewards to getting ahead increase (*WageIQR* becomes large), young professionals work longer hours relative to middle-aged professionals.[27]

It is possible that for some occupations the activities performed may differ across cities. To allow for that possibility, model 6 interacts the occupation fixed effects with MSA fixed effects. This controls for additional unobserved occupation/MSA attributes that might affect hours worked, including occupation/MSA-specific differences in productivity levels, the local cost of living, and the activities carried out by a Census-defined occupation. This approach also increases the number of fixed effects from 70 in the previous models to roughly 6,000. The inclusion of so many fixed effects controls for a vast array of unobserved effects, but also has the effect of reducing variation in the data, making identification more difficult.

Not surprisingly, in model 6 the significance of the coefficients on population density and occupation density is substantially reduced. This occurs because *PopDen* and *OccDen* do not vary within work PUMAs for a given occupation, which limits their variation within MSAs. On the other hand, the rival and wage inequality variables do vary within work PUMAs for each occupation. Estimates of the coefficients on these variables and their interaction are little changed from those in model 5. This is an important result because it suggests that the various agglomeration variables already included in the model largely capture the influence of metropolitan area attributes relevant to hours worked among professionals.[28]

E. Robustness

This section examines the degree to which estimates from model 6, our preferred specification, are robust to alternative specifications and samples. Panel A of table 5 presents estimates from model 6 for male and female professionals and nonprofessionals using the same measure of *Rival* as before. Panel B of table 5 repeats the exercise, but uses an alternate measure of *Rival* that defines rivals as individuals in the same occupation who work nearby and are close in age, but without taking account of the individual worker's wage. In all cases, only the coefficients on *Rival, WageIQR,* and their interaction are presented. We focus first on panel A in which *Rival* is defined as before.

In Panel A, the first two columns report the values for young and middle-aged professionals from model 6 of table 4. The next two columns present parallel estimates for female professionals. The pattern of results is quite similar to the pattern for male professionals. This supports a conclusion that labor market rivalry affects women in much the same way that it affects men. There is certainly no evidence here that women are less competitive.[29]

The remaining columns of panel A display results for nonprofessional workers. As might be expected. *Rival* ×

[26] We also estimated a model in which *PopDen* and *WageIQR* were included as regressors but *OccDen* and *Rival* were not. The coefficients on *WageIQR* were always positive and highly significant but the coefficients on *PopDen* were little changed from model 1 in table 3.

[27] The discussion above suggests that the estimated coefficients on *Rival* provide evidence that workers signal their worth through long hours worked. An alternative possibility is that workers seek to develop new skills by working long hours. However, because we restrict our sample to full-time workers, for this to explain our results, working beyond full time must have a substantial effect on the worker's ability to acquire new skills. While we cannot rule this out, overtime work is not essential for skill acquisition, but it is essential for signaling. Thus, we believe that signaling is likely to be the dominant mechanism, at least with respect to the influence of *Rival.*

[28] It is interesting to note the marginal effects of *Rival* and *WageIQR.* Evaluating at the sample means and using the coefficients in model 6, the marginal effects for *Rival* and *WageIQR* are (i) for young professional males, 0.0026 and 0.0203, respectively, and (ii) for middle-aged professional males. −0.0035 and 0.0072, respectively. Analogous measures for *Rival* for a select set of large and small cities are discussed in more detail later in the paper.

[29] We estimated the rest of the paper's models for females as well. Results are in the appendix. The key patterns are the same as for male workers: *OccDen* has a negative and significant impact on hours worked for young professionals and an insignificant effect on both middle-aged professionals and nonprofessionals; when *Rival* is included in the young professionals model, it has a positive and significant effect, and the effect of *OccDen* is reduced.

TABLE 5.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR[a,b] BY GENDER AND PROFESSIONAL STATUS—FULL-TIME WORKERS

ALTERNATIVE SPECIFICATIONS OF "RIVAL" CONTROLLING FOR OCCUPATION/MSA FIXED EFFECTS (MODEL 7)

Dependent variable: Log of hours worked (*t*-ratios in parentheses: robust standard errors with clustering on work PUMAs)

	Panel A: *Rival* controlling for the occupation-age national wage distribution							
	Professional Workers				Nonprofessional Workers			
	Men Aged 30–40	Men Aged 41–50	Women Aged 30–40	Women Aged 41–50	Men Aged 30–40	Men Aged 41–50	Women Aged 30–40	Women Aged 41–50
Rival	−0.0096	−0.0070	−0.0119	−0.0132	−0.0050	−0.0056	−0.0066	−0.0059
	(−4.12)	(−2.84)	(−4.87)	(−4.88)	(−5.91)	(−5.96)	(−7.20)	(−5.65)
WageIQR	−0.0606	−0.0178	−0.0634	−0.0195	−0.0013	−0.0066	−0.0080	−0.0103
	(−5.43)	(−1.50)	(−4.25)	(−1.05)	(−0.31)	(−1.46)	(−1.62)	(−1.91)
Rival × *WageIQR*	0.0232	0.0073	0.0268	0.0117	0.0049	0.0060	0.0069	0.0076
	(6.46)	(1.92)	(5.54)	(1.97)	(3.43)	(4.14)	(4.45)	(4.43)
No. of occupation and MSA fixed effects	6,345	5,973	4,145	3,563	19,065	16,336	11,784	11,087
No. observations	49,120	46,845	32,567	30,042	426,626	268,639	236,225	185,310
Adj R^2	0.2090	0.1519	0.1631	0.0676	0.0875	0.0864	0.0422	0.0454
Root MSE	0.1687	0.1677	0.1398	0.1413	0.1552	0.1530	0.1165	0.1204
	Panel B: *Rival* without controlling for the occupation-age national wage distribution							
	Professional Workers				Nonprofessional Workers			
	Men Aged 30–40	Men Aged 41–50	Women Aged 30–40	Women Aged 41–50	Men Aged 30–40	Men Aged 41–50	Women Aged 30–40	Women Aged 41–50
Rival	−0.0017	−0.0013	−0.0045	−0.0063	−0.0025	−0.0036	−0.0002	−0.0014
	(−1.01)	(−0.69)	(−2.38)	(−2.86)	(−3.08)	(−4.27)	(−0.33)	(−1.70)
WageIQR	−0.0337	−0.0208	−0.0248	−0.0276	0.0064	0.0054	0.0112	0.0004
	(−3.44)	(−1.81)	(−1.73)	(−1.52)	(1.30)	(1.05)	(2.01)	(0.07)
Rival × *WageIQR*	0.0100	0.0060	0.0099	0.0106	0.0017	0.0015	0.0004	0.0028
	(4.48)	(2.22)	(3.08)	(2.60)	(1.51)	(1.33)	(0.38)	(2.43)
No. of occupation and MSA fixed effects	6,345	5,973	4,145	3,563	19,065	16,336	11,784	11,087
No. observations	49,120	46,845	32,567	30,042	426,626	268,639	236,225	185,310
Adj R^2	0.2081	0.1518	0.1618	0.0663	0.0874	0.0863	0.0417	0.0452
Root MSE	0.1688	0.1677	0.1399	0.1414	0.1552	0.1530	0.1165	0.1204

[a] All other variables listed in table 2 are also included in the model but their coefficients are suppressed to conserve space.
[b] Full-time is defined as 35 or more hours per week. Professional workers belong to "professional and technical" occupations and have a master's or higher degree.

IQR has a very different effect than on professionals. For young workers, both male and female, the nonprofessional coefficients are roughly 75% smaller than for professionals of similar age. For middle-aged workers, the nonprofessional coefficients are also lower in magnitude than for middle-aged professionals, but by a smaller amount. These patterns are consistent with arguments offered earlier that rilvalrous behavior should be less prevalent among nonprofessional workers.[30]

Panel B of table 5 presents results based on the alternate definition of rivals that ignores information about a worker's standing in the national wage distribution. The pattern is generally similar to that in panel A. The effect of *Rival* × *IQR* is greater on professional than on nonprofessional workers for young workers of either gender. The effect of *Rival* × *IQR* is greater for young male professionals than for middle-aged male professionals. The primary departure from panel A is that for female workers the coefficient on *Rival*×*IQR* is quite similar for young and middle-aged professionals. The rest of the female results exhibit the same patterns as before. Taken as a whole, table 5 suggests that our key results are largely robust.

F. Magnitudes

The discussion thus far has emphasized the qualitative nature of the estimated effects of agglomeration on hours worked. A clear pattern has emerged, the key features of which are the differences between the effects of agglomeration on professionals versus nonprofessionals and young versus middle-aged workers. This section will further characterize the economic importance of these differences.

In model 2 of table 3, the estimated elasticities with respect to employment concentration within the worker's own occupation (*OccDen*) are 0.47% for young male professionals, less than one-third that size for middle-aged professionals, and roughly −0.15% for nonprofessionals of all ages. These estimates imply that a doubling of occupation employment density would serve to widen the differ-

[30] Taking table 4 and table 5 together, the coefficients on *WageIQR* are sometimes negative and significant, but are also often insignificant. They are even sometimes positive and significant. Thus, when controlling for the interaction between the presence of rivals and wage inequality, there is no consistent pattern of results for wage inequality itself.

TABLE 6.—PERCENTAGE IMPACT OF RIVALS ON HOURS WORKED IN LARGE AND MODERATE-SIZED CITIES[a]

	Panel A: *Rival* controlling for the occupation-age national wage distribution							
	Men Aged 30–40		Men Aged 41–50		Women Aged 30–40		Women Aged 41–50	
	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento
All professionals[b]	2.55	1.35	−1.05	−1.28	1.85	0.44	−3.07	−3.26
Lawyers and judges	3.29	1.83	1.27	0.06	5.86	3.52	−9.01	−7.64
Nonprofessionals	−0.90	−1.06	−0.87	−1.03	−1.31	−1.42	−0.60	−0.82
	Panel B: *Rival* without controlling for the occupation-age national wage distribution							
	Men Aged 30–40		Men Aged 41–50		Women Aged 30–40		Women Aged 41–50	
	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento	New York, Chicago, Los Angeles	Hartford, Milwaukee, Sacramento
All professionals[b]	3.43	2.34	1.55	0.85	1.00	0.28	−0.50	−1.22
Lawyers and judges	8.63	6.23	2.92	2.21	7.72	5.16	2.62	5.74
Nonprofessionals	−1.05	−1.05	−1.91	−1.72	0.03	0.00	0.24	0.02

[a]Estimates were obtained by forming θ_1 *Rival* + θ_2 *Rival* × *WageIQR* for each individual observation in the sample and then averaging across individuals while applying the sampling weights ("perwt") in the IPUMs to ensure a representative result. Estimates of θ_1 and θ_2 for the "all professionals" results were obtained from model 7. For the "lawyers and judges" results. model 7 was estimated using only lawyers in the sample and estimates from those regressions used to compute the influence of rivals.

[b]Professional workers are in occupations categorized as professional-technical in the OCC1950 variable of the IPUMS *and* who have a master's degree or more. Nonprofessionals include all other workers except managers and agricultural workers *and* who have less than a bachelor's degree. Lawyers and judges belong to occupation category (OCC1950) 55 and have a master's degree or more.

ence in hours worked between young professionals and nonprofessionals by 0.62%, and between young versus middle-aged professionals by 0.27%.

In table 6, we further examine the degree to which the presence of rivals contributes to hours worked among young and middle-aged professionals for the same two groups of cities examined in table 1 (New York, Chicago, and Los Angeles in comparison with Hartford, Milwaukee, and Sacramento). This is done by applying the *Rival* and *Rival* × *WageIQR* coefficients from table 5 to the individual-level data and then averaging across observations.[31] Separate calculations are performed for each segment of the workforce considered in table 5 (male and female professionals and nonprofessionals), and also for the two different measures of *Rival.*

Several patterns stand out. First, rivals have a substantial impact on hours worked for young professionals, as shown by the first row of panel A. The presence of rivals increases the hours worked among younger males by 2.6% in the larger cities. This translates into over one additional hour worked per week or the equivalent of about one extra week of work per year—a large effect. Female hours increase by 1.85%, which translates into slightly less than one additional hour per week. In the smaller cities, this effect is only half as large for males, and is less than one-quarter as large for females. In addition, the presence of rivals *reduces* hours worked among middle-aged male professionals by over 1% in both groups of cities: for middle-aged women professionals, the corresponding effect is also negative and more than 3%. It is clear, therefore, that the presence of rivals substantially elevates hours worked among young professionals relative to middle-aged professionals, and this effect is most pronounced in the largest cities. In contrast, the influence of rivals on hours worked among nonprofessionals is always negative and similar in magnitude for young versus middle-aged workers. These patterns are largely the same in panel B, which uses the alternative measure of *Rivals.*

As a final exercise, we estimated the wage regressions once more including only lawyers and judges in the sample, a profession famous for its long hours and also the focus of recent work by Landers et al. (1996). The magnitude of the rivalry effects for this group is provided in the second row for each panel in table 6. Estimates in that row are calculated as before, with the important difference that the underlying model coefficients were drawn from the models that included *only* the lawyers and judges in the sample.

In the second row of panel A, it is immediately apparent that the influence of rivals on hours worked for lawyers is qualitatively the same as for all professionals. It is also clear that the presence of rivals has a substantially larger impact on the hours worked of young lawyers relative to all young professionals. Specifically, proximity to rivals elevates hours worked among young male lawyers by 1.8% in the three moderate-sized cities and by 3.3% in the larger cities. For females, these effects are even greater, 3.5% in the smaller cities and 5.9% in the larger ones. Once again, the key qualitative patterns are similar in panel B, although the magnitudes are somewhat larger. Lawyers, it would seem, deserve some of their reputation for rivalrous behavior, at least among younger individuals.

IV. Conclusion

This paper is the first to systematically document a relationship between hours worked and agglomeration. The

[31] As above, sampling weights were used when averaging to ensure a representative result.

paper presents evidence that among nonprofessional workers, agglomeration tends to spread out workloads over a larger number of individuals, resulting in diminished individual hours worked. Among professional workers, the pattern is different, with agglomeration increasing hours worked. Using differencing methods, the paper finds evidence consistent with the presence of both selection and productivity effects and also of the rat race effect. The paper is, therefore, one of very few to have provided empirical evidence in support of Akerlof's (1976) theory of the rat race. Moreover, consistent with recent empirical work by Landers et al. (1996), we also find evidence of especially rivalrous behavior among lawyers.

This paper also contributes to the literature on agglomeration. Over eighty years ago Marshall (1920) argued that cities are productive places because they allow for pooling of labor, sharing of intermediate inputs, and knowledge spillovers. More recently, it has been established that these effects are manifested in worker wages. This paper provides evidence that agglomeration also encourages hard work, a kind of magnification of the effect of agglomeration on wage.[32] In addition, the paper's evidence of an urban rat race, where agglomeration encourages professionals to work harder, is an entirely new explanation for why cities are productive.

[32] In addition, human capital effects may also be magnified. See Moretti (2004) and Rosenthal and Strange (2005) for evidence of the existence of human capital externalities. See Acemoglu and Angrist (2000) and Ciccone and Peri (2005) for contrary evidence.

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APPENDIX

Supplemental Tables on Hours Worked among Women

TABLE A1.—AVERAGE HOURS WORKED AMONG FULL-TIME WORKERS IN SELECT METROPOLITAN AREAS[a]

Occupation Category	Metropolitan Area	Young Females	Middle-Aged Females
Nonprofessional workers[b]	New York, Chicago, Los Angeles	42.42	42.88
	Hartford, Milwaukee, Sacramento	42.05	42.54
Professional workers (including lawyers & judges)[b]	New York, Chicago, Los Angeles	45.82	44.93
	Hartford, Milwaukee, Sacramento	44.41	43.84
Lawyers and judges	New York, Chicago, Los Angeles	48.41	48.73
	Hartford, Milwaukee, Sacramento	48.25	45.80

[a]All data are weighted to be representative using the perwt variable in the IPUMs. Hours worked are based on the "usual hours worked per week." Full-time is defined as 35 or more hours per week.
[b]Professional workers are individuals in occupations categorized as professional-technical in the OCC1950 variable of the IPUMS *and* who have a master's degree or more. Nonprofessionals include all other workers except managers and agricultural workers *and* who have less than a bachelor's degree.

TABLE A2.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR

FULL-TIME FEMALE WORKERS,[a] PROFESSIONALS VERSUS NONPROFESSIONALS

Dependent variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Professional Workers[b]		Nonprofessional Workers[c]	
	Age 30–40	Age 41–50	Age 30–40	Age 41–50
Professional or PhD degree[d]	0.0285	0.0294		
	(9.87)	(10.19)		
Some college or associate degree[d]			−0.0016	−0.0013
			(−1.86)	(−1.42)
High school degree[d]			0.0069	0.0090
			(7.17)	(8.06)
Have children	−0.0323	−0.0171	−0.0038	−0.0023
	(−17.28)	(−9.46)	(−6.60)	(−3.77)
Married	−0.0075	−0.0089	−0.0061	−0.0095
	(−3.97)	(−4.87)	(−11.41)	(−13.57)
Age	−0.0051	0.0266	0.0035	0.0112
	(−0.83)	(2.56)	(1.91)	(3.01)
Age squared	7.93E-05	−2.81E-04	−4.25E-05	−1.24E-04
	(0.90)	(−2.43)	(−1.61)	(−3.03)
Black	−0.0185	−0.0224	−0.0088	−0.0113
	(−5.85)	(−6.32)	(−10.36)	(−10.62)
Asian	−0.0290	−0.0201	0.0113	0.0205
	(−5.55)	(−3.91)	(3.47)	(4.14)
Hispanic	−0.0055	−0.0063	−0.0067	−0.0061
	(−1.01)	(−1.06)	(−4.85)	(−4.02)
Other race	0.0103	−0.0054	−0.0021	−0.0047
	(0.77)	(−0.40)	(−0.48)	(−1.44)
Immigrated 6–10 years ago[e]	−0.0058	0.0185	−0.0061	−0.0038
	(−0.59)	(1.04)	(−2.02)	(−0.81)
Immigrated 11–15 years ago[e]	−0.0164	0.0186	−0.0015	−0.0073
	(−1.79)	(1.17)	(−0.42)	(−1.60)
Immigrated 16–20 years ago[e]	0.0100	0.0149	−0.0066	−0.0067
	(0.98)	(0.98)	(−2.11)	(−1.46)
Immigrated > 21 yrs or nat. U.S. citizen[e]	0.0018	0.0245	−0.0093	−0.0128
	(0.24)	(1.87)	(−2.84)	(−2.73)
Log commute time	−0.0013	−0.0014	−0.0014	−0.0037
	(−1.18)	(−1.31)	(−3.12)	(−7.37)
Log population density of work PUMA	0.0011	0.0007	−0.0002	0.0001
	(2.14)	(1.28)	(−0.87)	(0.22)
Constant	3.8700	3.1300	3.6800	3.5000
	(36.16)	(13.30)	(114.29)	(41.31)
No. of occupation fixed effects	71	69	132	130
No. observations	33,696	30,910	242,596	192,177
Adj R^2	0.1466	0.0561	0.0246	0.0337
Root MSE	0.1435	0.1444	0.1212	0.1268

[a]Full-time is defined as 35 or more hours per week.
[b]Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]Nonprofessional workers belong to nonprofessional and nontechnical occupations and have less than a BA degree.
[d]Omitted categories for salaried and hourly workers are master's degree and less than high school degree, respectively.
[e]Omitted category is immigrated in the last five years.

TABLE A3.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR BY PROFESSIONAL STATUS[a,b,c]

FULL-TIME FEMALE WORKERS, ALTERNATIVE SPECIFICATIONS OF OCCUPATION DENSITY EFFECTS

Dependent Variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Professionals[b]				Nonprofessionals[c]			
	Model 1		Model 2		Model 1		Model 2	
	Age 30–40	Age 41–50	Age 30–40	Age 41–50	Age 30–40	Age 41–50	Age 30–40	Age 41–50
Log population density of work PUMA (PopDen)	0.0011	0.0007	−0.0049	0.0002	−0.0002	0.0001	0.0008	0.0006
	(2.14)	(1.28)	(−3.03)	(0.15)	(−0.87)	(0.22)	(1.04)	(0.72)
Log employment density of worker's occupation in work PUMA (OccDen)			0.0060	0.0005			−0.0010	−0.0005
			(3.93)	(0.30)			(−1.30)	(−0.63)
No. of occupation fixed effects	71	69	71	69	132	130	132	130
No. observations	33,696	30,910	33,696	30,910	242,596	192,177	242,596	192,177
Adj R^2	0.1466	0.0561	0.1473	0.0561	0.0246	0.0337	0.0246	0.0337
Root MSE	0.1435	0.1444	0.1434	0.1444	0.1212	0.1268	0.1212	0.1268

[a]All other variables listed in table 2 are also included in the model but their coefficients are suppressed to conserve space.
[b]Full-time is defined as 35 or more hours per week. Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]Nonprofessional workers belong to nonprofessional and nontechnical occupations and have less than a bachelor's degree.

TABLE A4.—USUAL HOURS WORKED PER WEEK IN THE LAST YEAR[a,b]

FULL-TIME PROFESSIONAL FEMALE WORKERS, ALTERNATIVE SPECIFICATIONS OF OCCUPATION DENSITY EFFECTS

Dependent Variable: Log of hours worked (*t*-ratios in parentheses; robust standard errors with clustering on work PUMAs)

	Age 30–40				Age 41–50			
	Model 3	Model 4	Model 5	Model 6	Model 3	Model 4	Model 5	Model 6
Log population density of work PUMA (PopDen)	−0.0045	−0.0040	−0.0041	−0.0019	−0.0009	0.0005	0.0006	−0.0041
	(−2.74)	(−2.46)	(−2.66)	(−0.95)	(−0.58)	(0.32)	(0.40)	(−1.85)
Log employment density of worker's occupation in work PUMA (OccDen)	0.0054	0.0046	0.0044	0.0017	0.0022	0.0004	0.0003	0.0040
	(3.39)	(2.90)	(2.96)	(0.86)	(1.37)	(0.26)	(0.17)	(1.83)
Log number of workers in the individual's age group, occupation, and work PUMA within 5 percentage points in the occupation-age national wage distribution (Rival)[c]	0.0021	0.0021	−0.0077	−0.0119	−0.0040	−0.0040	−0.0104	−0.0132
	(1.67)	(1.63)	(−3.59)	(−4.87)	(−3.06)	(−3.12)	(−4.70)	(−4.88)
Interquartile range of log wages in worker's occupation in the worker's work PUMA (WageIQR)		0.0150	−0.0457	−0.0634		0.0239	−0.0236	−0.0195
		(5.00)	(−3.62)	(−4.25)		(6.96)	(−1.68)	(−1.05)
Interactive Term: Rival × WageIQR			0.0197	0.0268			0.0154	0.0117
			(4.79)	(5.54)			(3.42)	(1.97)
No. of occupation fixed effects	71	71	71		69	69	69	
No. of occupation and MSA fixed effects				4,145				3,563
No. observations	32,567	32,567	32,567	32,567	30,042	30,042	30,042	30,042
Adj R^2	0.1471	0.1481	0.1493	0.1631	0.0504	0.0527	0.0532	0.0676
Root MSE	0.1411	0.1410	0.1409	0.1398	0.1426	0.1424	0.1424	0.1413

[a]All other variables listed in table 2 are also included in the model but their coefficients are suppressed to conserve space.
[b]Full-time is defined as 35 or more hours per week. Professional workers belong to "professional and technical" occupations and have a master's or higher degree.
[c]*Rival* is calculated by counting the number of workers in the individual's work PUMA in the same occupation and age category (young versus middle-aged) within 5 percentage points in the national wage distribution pertinent to the individual. For these purposes, national wage distribution is measured using all (male and female) full-time workers for the same occupation and age category (young versus middle-aged) as the individual.