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LABOR MOBILITY AND SPATIAL DENSITY

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Labor Mobility and Spatial Density

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Abstract

This paper focuses on a much cited but seldom measured micro-foundation for agglomerations: inter-firm labor mobility. Labor mobility has been advanced as a vehicle for knowledge flows and labor market efficiency, and is often maintained to be an important source of agglomeration economies. Based on matched employer-employee data, we estimate the influence that spatial employment density has on the probability of inter-firm job-switching, while controlling for ample attributes of each worker and employer. The rate of inter-firm labor mobility varies substantially across regions and we document a systematic and robust positive influence of density on the probability of job switching. The likelihood that such switching is intra-regional is significantly higher if the employees operate in denser regions, verifying that labor mobility (and thus the effects mediated by it) is indeed localized. Higher rates of inter-firm labor mobility appear as a likely mechanism behind the empirically verified productivity advantage of dense regions.

JEL: J61, J62, R12, R11

Keywords: job-switching, inter-firm labor mobility, agglomeration economies, external economies, micro-foundations, density

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1. INTRODUCTION

There is ample evidence on agglomeration economies in the form of robust effects of density on productivity.[1] Evidence on the nature and sources of agglomeration economies are however still rare (Rosenthal and Strange 2004). This paper focuses on inter-firm labor mobility as a source of agglomeration economies.

Mobility of labor between firms and its coupling to regional contexts is a relevant line of inquiry. This is a phenomenon that is facilitated by density of people and firms, and is often cited as a likely mechanism behind estimated productivity advantages of dense regions. A major reason for the latter is that labor mobility is linked to two types of micro-foundations for agglomeration economies; learning and matching (cf. Duranton and Puga 2004). The link to learning is evident by that labor mobility is a vehicle for knowledge flows (Almeida and Kogut 1999, Agrawal et al. 2006). Knowledge, experiences and competencies are embodied in people, and movements of employees between firms bring about knowledge diffusion and learning (cf. Feldman 1999). Labor mobility is also a means to an efficient matching between employers and employees. Models of labor markets typically emphasize that the quality of such matches are uncertain ex ante and must be experienced to be evaluated (Farber 1994). Labor mobility is a mechanism through which learning and matching effects materialize.

Despite the arguments pointing to labor mobility as a pertinent source of the density-productivity relationship, there are few systematic analyses of how density and mobility of labor are related. The aim of this paper is to fill this gap. It does so by empirically assessing the relationship between regional density and rates of inter-firm labor mobility. If labor mobility is an important source of the density-productivity linkage, then we should observe that high levels of inter-firm mobility are a characteristic feature of dense regions.

Previous studies are few in numbers, but point to an effect of density on mobility. Most of these focus on mobility as a vehicle for matching efficiency. Finney and Kohlhase (2008) study job switching among a sample of young men in US urban areas. Job switching is measured as the appearance of a new job start, and they find that the probability of changing job is higher in denser regions. Bleakley and Lin (2007) analyze the rate at which workers change occupation or industry using data from US cities and investigate the effect of population density. Occupation and industry switching is on average lower in denser regions. Yet, higher rates of occupational and industrial switching are

[1]The empirical literature on the productivity advantage of agglomerations comprises studies at different levels (regional, sectoral, firm-level and individual level). Examples include Ciccone and Hall (1996), Ciccone (2002), Rice et al. (2006), Brülhart and Mathys (2008), Ottaviano and Pinelli (2006), Glaeser and Maré (2001), Wheeler (2006), Yankow (2006), Andersson and Lööf (2011).

observed for a subsample of younger workers. The authors argue that the observed pattern is consistent with the impact density has on search costs. It is cheaper and takes less time to find a quality match in denser areas with thicker labor markets. Workers are thus more likely to search for new jobs and they do so early in their careers to maximize their work life income.

This study differs from the previous ones in several respects. Based on longitudinal matched employer-employee data comprising all employees in the private sector in Sweden over two decades, it analyzes the influence of density on rates of inter-firm labor mobility. We focus on job switching among employed individuals, where a change of job is measured as a change of employer.[2] In most previous studies the observed job change may or may not be associated with that the worker switches employer. Yet, from a knowledge flow perspective inter-firm mobility is a more relevant phenomenon. A better match may also be expected to be associated with a move to a new employer. The perceived match quality depends not only on the job as such, but also on the characteristics of the employer.

The paper provides a general picture of the rate of job switching in Sweden as a whole and in different regions of the country. Differences in the rates of intra-regional inter-firm labor mobility across regions are substantial, and amount to factor four. Selectivity issues are however central. Regions differ in terms of the composition of their workers and sectors, and there are large differences in mobility rates between employees of different age, in different sectors and with different levels of educational attainment. In order to isolate the effect of density on job switching, we estimate the influence density has on the probability that a worker switch employer while controlling for an ample set of worker and employer characteristics, such as age, education, tenure, sector affiliation, productivity and firm size. Two measures of density are employed. The first is a standard measure of employment per square kilometer (cf. Ciccone and Hall 1996). The second is a more refined measure of density, which accounts for the quality of transportation infrastructure through an accessibility measure with travel-time distance decay. Such a measure is directly related to choice contexts for spatial interaction (Weibull 1976, 1980).

Our main finding is that density indeed spurs the rate of inter-firm mobility of labor. Both measures of density – i.e. employment per km^2 and accessibility – have positive and significant influence on the probability of switching job. These results are robust and hold for both young and old workers, as well as for workers with different levels of educational attainment. We also show that in denser regions, intra-regional job switching as a fraction of total job switching (intra- plus interregional) is significantly higher. About 80 percent of all inter-firm job switching is intra-regional. Hence, the

[2]Entry and exit on the labor market is not considered.

likelihood that job-switching is intra-regional is significantly higher if employees operate in denser regions. We conclude that higher rates of inter-firm labor mobility are a likely mechanism behind the empirically verified productivity advantages of dense regions. It is a phenomenon linked to inter-firm knowledge flows as well as labor market efficiency.

The paper proceeds as follows: Section 2 discusses how dense environments spur mobility by reducing transaction costs, and how mobility is related to matching and learning. Section 3 presents the data and give a brief description of the basic patterns of inter-firm labor mobility in Sweden as a whole and in different regions. The effect of density on mobility is assessed in Section 4 which presents our methodology as well as the results. Section 5 concludes.

2. LABOR MOBILITY, DENSITY AND AGGLOMERATION ECONOMIES

Mobility on the labor market in the form inter-firm worker flows has many sources. Employees may for instance be pushed to switch job due to plant closure or notice of termination. They may also be pulled because of information about a better match between their skill sets and a job at another employer. Models of labor markets generally build on the presumption that the quality of the match between employer and employee is uncertain and can only be evaluated ex post. Match quality is thus an 'experience good' (Farber 1994). Topel and Ward (1992) show for example that the path to a stable employer-employee relation is characterized by frequent job switching, and suggest that this can be understood as a consequence of a search process for a match of high quality.

But the rate of labor mobility may differ across regions, and dense regions offer several mobility advantages. First, in large and dense regions workers have high accessibility to a large set of potential employers, and vice versa. This reduces costs associated with labor market transactions, both for employers and employees. A central aspect is that residents of large and dense regions have a larger choice set of potential employers within commuting time distance. This means that the potential to change job without change of residence is greater. Changing job and place of residence is a slower process and is associated with larger transaction costs compared to change of job without changing residence. Second, density may improve accessibility to information about potential jobs and employers. Granovetter (1995) analyses how information about job opportunities is secured and disseminated, and shows that personal networks are an important source of information about jobs. Such networks may be assumed to be wider and grow faster in regions with higher density of people (Finney and Kohlhase 2008).

A main reason why these mobility advantages are interesting is that mobility is linked to both learning and matching, i.e. two general micro-foundations for agglomeration economies (cf. Duranton and

Puga 2004). We discuss the respective links between labor mobility, learning and match efficiency below. These links are the main motivation for our analysis of density and inter-firm labor mobility.

Learning involves social interaction that often is of a face-to-face nature. Such interaction is generally assumed to stimulate learning through knowledge flows and human capital accumulation (Lucas 1988, Jovanovic and Rob 1989, Glaeser 1999). There is plenty of evidence that knowledge flows are localized (e.g. Jaffe et al. 1993) and inter-firm labor mobility is often suggested as a reasonable cause of this. Indeed, knowledge is embodied in people and mobility between firms implies interaction between new constellations of people which may be assumed to generate extended social relationships and networks. A number of studies explicitly study the relationship between mobility of labor and knowledge flows. Almeida and Kogut (1999) investigate inter-firm mobility of engineers as a source of knowledge flows by analyzing the degree of knowledge localization in the semiconductor industry across regions in the US. Knowledge localization is measured by the rate at which patents from the same regions cite each other. They find that the inter-firm mobility of engineers within the regions is a significant explanation for the degree of knowledge localization. Regions with high inter-firm mobility of engineers have higher knowledge localization, all else equal.[3] Based on this the authors conclude that knowledge flows are embedded in regional labor markets. Another study in this vein is Agrawal et al. (2006). They study the correspondence between mobility of inventors and subsequent citation patterns between regions. They find that knowledge flows (as evidenced by patent citation patterns) are linked to mobility of inventors. An interesting finding is that knowledge flows to an inventor's prior location (source region) is 50 percent greater than if they had never lived there, which the authors interpret as evidence of that enduring social relationships play role. Oettl and Agrawal (2008) find similar results in a study of international inter-firm mobility of inventors.

In terms of matching, dense regions have an advantage in matching workers' skill sets to different employers. The quality of the match between an employee and employer is an experience good which can only be evaluated ex post (Farber 1994). Since employers and employees are heterogeneous, dense environments provide better opportunities for workers to try out a greater variety of jobs in search of a good match. Topel and Ward (1992) shows that the path to a more stable employer-employee relation among young workers is characterized by frequent job switching, which can be understood as a consequence of an uncertain search process. In view of this, one may expect that more efficient matching processes are associated with higher mobility rates. However, matching models developed by Hesley and Strange (1990) and Kim (1990) emphasize that the expected average quality of a match between employer and employee is higher in dense and thick markets. When more employees are attracted to an agglomeration, the expected match quality increases for all actors in the

[3] They also find that Silicon Valley have the highest inter-firm mobility of engineers.

agglomeration. This would mean that mobility rates are lower in dense regions. If the average quality of matches is higher in denser regions, there could be lower mobility rates simply because workers have fewer incentives to switch job (Bleakley and Lin 2007). Recent analyses on individual data yet find that wage growth is indeed associated with job changes (e.g. Wheeler 2006), which suggests that matching efficiency is associated with higher mobility rates (cf. Finney and Kohlhase 2008). Another argument in favor of this is that the perceived quality of a match may change over time because of changes in job composition, colleagues or management, as well as the appearance of new job opportunities through new firm formation or retirement. High quality today does in other words not necessarily mean high quality in the future, which means that it does not need to impede (future) mobility.

We conclude that inter-firm labor mobility is associated with both learning and labor market efficiency. The analysis in the current paper does not focus on any specific set of workers, but we estimate the relationship between density and inter-firm job switching for workers with different levels of educational attainments and of different age. Workers with long university education or PhDs may be assumed to be more relevant for knowledge flows, and job switching may be a particular feature of young workers who shop around for quality matches early in their career.

3. DATA AND BASIC PATTERNS OF INTER-FIRM LABOR MOBILITY IN SWEDEN

3.1 Data and measurement of inter-firm mobility of labor

The data are audited register data maintained by Statistics Sweden and constitute a matched employer-employee dataset for the period 1987–2005. The dataset comprises all firms, plants and employed individuals (16–64 years) in the private sector (NACE 15–74) of the Swedish economy, which makes it possible to follow individuals over time between firms, plants and regions. In total we observe about 1.9 million employees per year.[4]

Labor mobility can be measured in many different ways. The definition of labor mobility in this paper is based on observed changes in employees' workplace (or firm) between two consecutive years. Each employee's workplace a given year is by construction of the data determined by her place of work in the month of November. The mobility measures are thus based on observations of the workplace in November year t and year $t + 1$.[5] Individuals that switch employer between two years are referred to as job switchers. If the new employer is located in the same region as the previous, we refer to this as

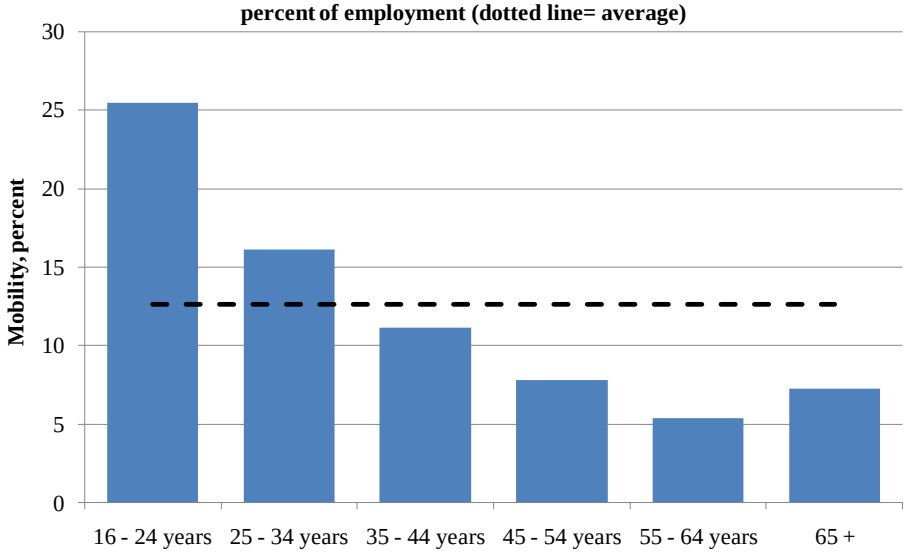
[4] More details of these data can be found in Andersson and Thulin (2008).
[5] More than one change of employer during a year is not registered, which means that mobility measure based on these data is likely to understate the rate of mobility.

intra-regional job switching and inter-regional otherwise. A region is defined as a functional region (FA-region). These regions have been defined by the Swedish Agency for Economic and Regional Growth (NUTEK) as geographical areas in which people can live and work without having to spend too long time commuting. They thus comprise local labor markets and are delineated based on commuting intensities. According to this definition, there are 72 FA-regions in Sweden.

3.2 Inter-firm labor mobility in Sweden – a basic description

What is the general pattern of inter-firm mobility? Figure 1 shows the total average labor mobility among employees in the private sector during the period 1987–2005 in Sweden, distributed on six age categories. Labor mobility is measured as the number of employed individuals that has switched employer, normalized by the total number of employees in each category. The dotted line shows Sweden's average labor mobility.

Figure 1. Labor mobility distributed on age groups 1987–2005, percent of employment (dotted line= average)



The average rate of inter-firm labor mobility in Sweden is 12.5 percent, i.e. about 12.5 percent of all employed in the private sector switch jobs between any given two years. It is also clear from the figure that labor mobility decreases with age. This pattern is in accordance with previous studies and can partially be explained by the fact that people with shorter work experience search for a job until they find a good match (Topel and Ward 1992), and mobility is expected to decline as the match quality increases.

Figures 2 and 3 show how labor mobility, both total and distributed on age cohorts, has varied during 1987–2005. We include the growth rate of GDP in the figures such that the variation in labor mobility

can be compared with the business cycle. The curves for labor mobility represent the ratio between the actual value for a given year and the average value over the whole time period 1987–2005, hence a value above one indicates that the variable is above average that year.

Figure 2. Labor mobility and GDP growth rate 1987–2005, normalized with respective average

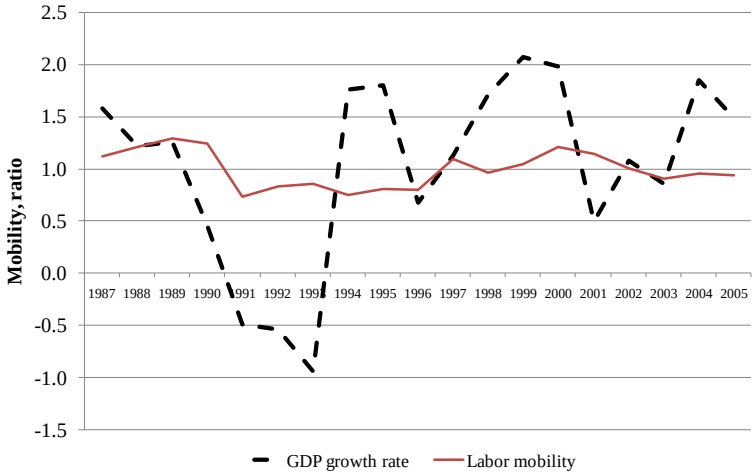
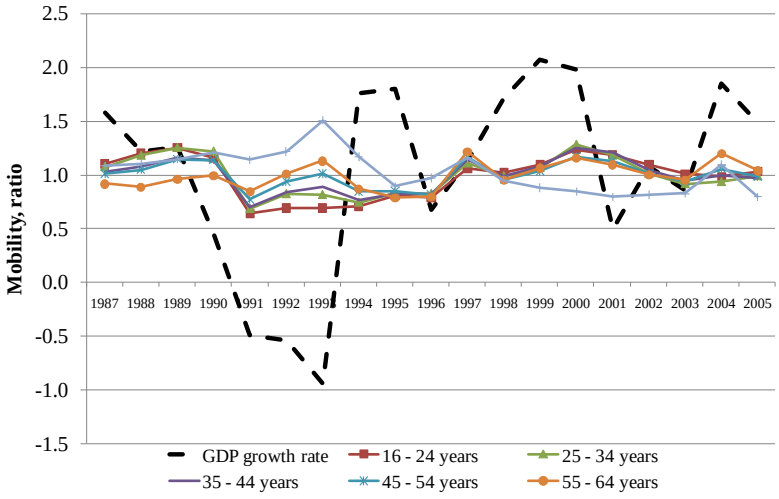


Figure 3. Labor mobility within different age cohorts and GDP growth rate 1987–2005, normalized with respective average

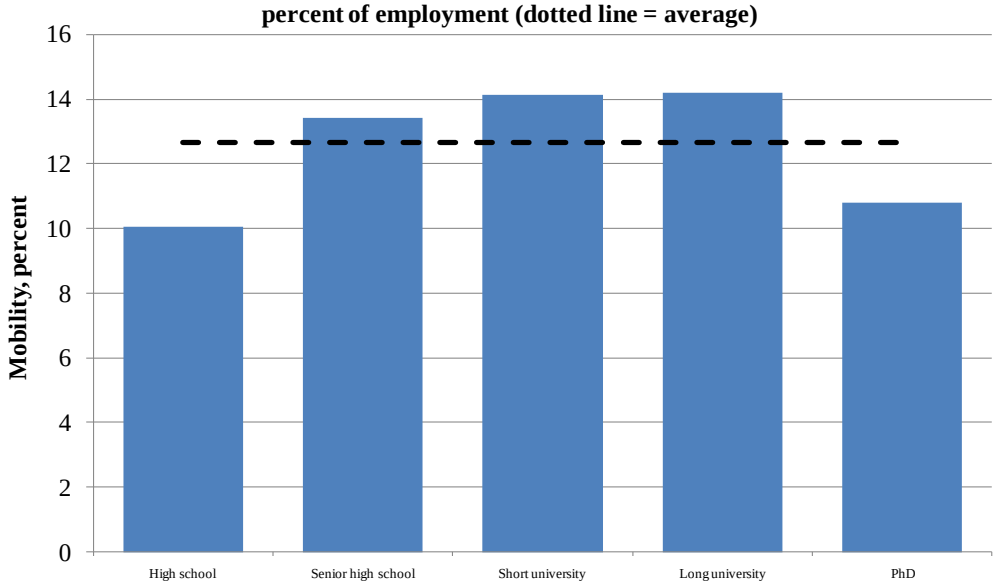


The growth rate of GDP varies to a much higher degree than labor mobility over time, and the rate of inter-firm job switching follows the business cycle; it is higher in economic upturns and lower in downturns. This is in accordance with earlier studies of labor mobility (Israelsson et al. 2003, Gartell et al. 2007). Another observation from Figure 3 is that labor mobility for different age groups display a similar evolution over time.

Figure 4 presents the rate of inter-firm labor mobility among workers with different education levels. Previous research shows that education levels and mobility are related, where longer education is normally associated with higher mobility (Machin et al. 2008). In a Swedish context, Johansson et al.

(2002) show that individuals' time-distance sensitivity falls with the level of educational attainment. In the figure, short university education refers to a university education shorter than three years. Long university education refers to a university education three years or longer, but excludes PhDs. Again, the dotted line shows average labor mobility for the total labor force. Labor mobility tends to increase with educational level, with the exception of those who has finished PhD studies. Job switching among individuals with only a high school education is far less frequent than among those with higher education.

Figure 4. Labor mobility distributed on educational levels 1987–2005, percent of employment (dotted line = average)



Mobility rates among individuals with a short or long university education are relatively similar**,** and slightly higher as compared to individuals with a senior high school education. The mobility rate for those with a PhD is only somewhat higher than for those with only high school education. The lower mobility rate among PhDs may be explained by that this category of workers have highly specialized skills, and that firms with high R&D outlays value their employed and wants to keep them within the firm. Moen (2005) study R&D workers and one conclusion is that such workers could be expected to have lower mobility in their early career because they accumulate knowledge on the job.

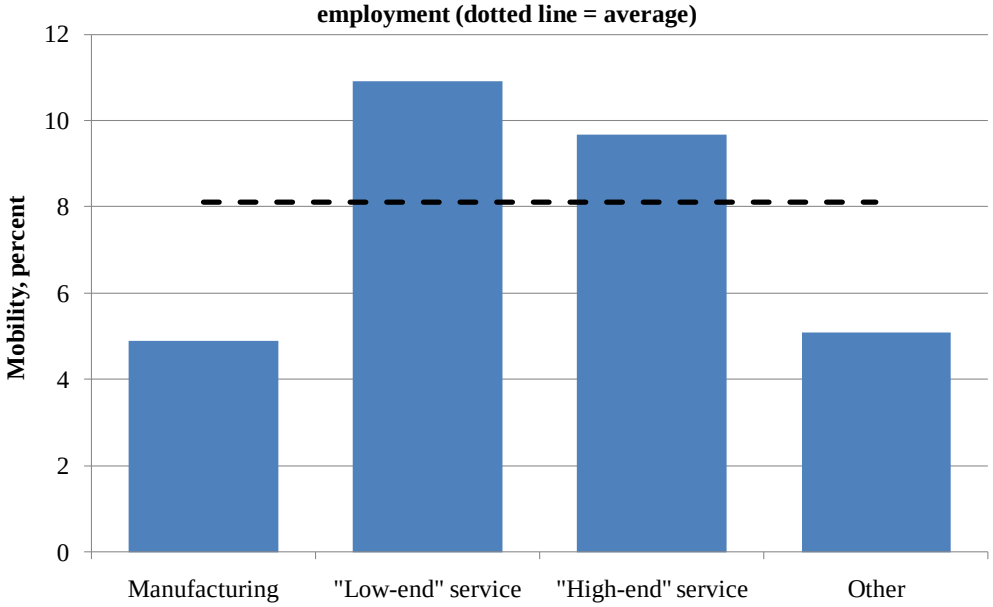
The rate of inter-firm mobility of labor may also be expected to differ across sectors. Job-switching tends for example to be higher in service sectors compared to manufacturing. To get a broad picture of such differences we divide the private sector in Sweden into three sector aggregates: (i) manufacturing (NACE 15–36), (ii) low-end services (NACE 37–64) and (iii) high-end services (NACE 65–74).[6] The first comprises all manufacturing sectors, whereas the second consists of simpler services such as retail and wholesale services as well as transportation. The third consists of

[6] The remaining industries (others) comprise a marginal share of total employment in the private sector.

more knowledge-intensive services and comprises those sectors that have contributed most to creating jobs in Sweden during the 1990s, such as financial services, consulting services and R&D.

Figure 5 presents the average labor mobility within the industries during the period 1987–2005. Mobility is here measured as the number of employed that switch employer within the same industry divided by the number of employed in the industry. The dotted line indicates the average within mobility across industries.[7]

Figure 5. Labor mobility within industries 1987-2005, percent of employment (dotted line = average)



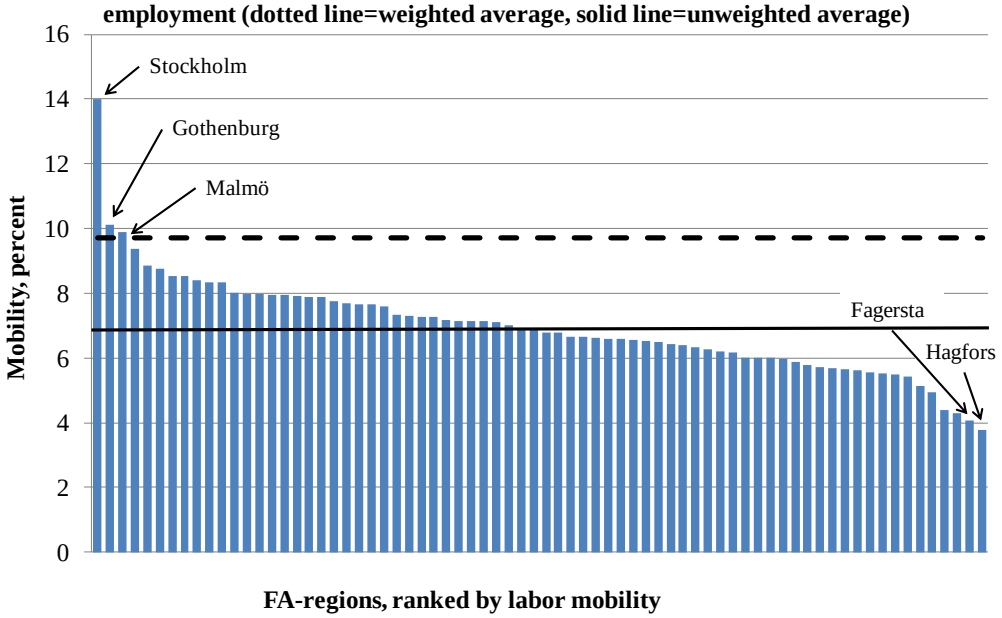
The figure shows that labor mobility differ substantially between the industries. Labor mobility is much higher in service industries than in the manufacturing industry; low-end services stand for the highest mobility rate. The share of employed that switched jobs in the manufacturing industry between any given two years during the period 1987–2005 is on average around 5 percent. The corresponding shares in the low- and high-end service industries are about twice as high.

The main aim of this paper is to assess the relationship between density and inter-firm mobility. About 80 % of all job-switching is intra-regional which is consistent with that this type of mobility involves lower transaction costs than inter-regional. Figure 6 provide a first indication of the magnitude of order of the differences between the rate of inter-firm labor mobility across region. The figure is based on data on the number of employees that change job between firms located in the same region (intra-regional inter-firm mobility) normalized by the total number of employees in the

[7] The average mobility rate in Figure 5 is lower than in Figures 1 and 4. The reason is that Figure 5 excludes inter-industry mobility and only focus on mobility within the different industries.

regions. All the 72 FA-regions are ordered according to level of intra-regional mobility. The dotted line shows the weighted average and the solid line the unweighed average.

Figure 6. Labor mobility within FA-regions 1987-2005, percent of employment (dotted line=weighted average, solid line=unweighted average)



It is evident that there are substantial differences in the rate of intra-regional labor mobility between regions. Average labor mobility in the FA-region with the highest mobility rate (Stockholm) is about four times higher than the one with the lowest mobility rate (Hagfors). In the metropolitan region Stockholm, about 14 percent of the employees switch to a new employer in the same region between any given two years. The corresponding figure for the unweighed average is 7 percent. The pattern of labor mobility indeed suggests that the potential for inter-firm knowledge flows and efficient matching is greater in the metropolitan regions with higher density of people and firms.

In order to assess if the differences illustrated by the figure can be attributed to differences in density, we need to acknowledge selectivity issues arising from the fact that regions differ substantially in terms of their composition of workers, sectors and firms. And as has been illustrated, mobility depends on the type of workers and sectors. The next section presents our empirical strategy to isolate the effect of density on inter-firm labor mobility as well as the results from this undertaking.

4. DOES DENSITY SPUR INTER-FIRM MOBILITY OF LABOR?

4.1 Empirical Strategy

We estimate the influence that spatial employment density has on the probability that an employed individual switches employer between two years, while controlling for an extensive set of worker and firm characteristics.[8] By including extensive control variables, we aim to account for selectivity issues associated with that workers and firms in denser areas may in general have higher mobility due to factors such as age, education and sector. A Probit specification is used in which employees are followed on a yearly basis. The model is given by:

(1a) $$\Pr\left(Mob_{i,t}=1\middle|\mathbf{x}_{i,t}\right)=\Phi\left(\mathbf{x}'_{i,t}\boldsymbol{\Gamma}\right)$$

(1b) $$\mathbf{x}'_{i,t}\boldsymbol{\Gamma}=\alpha+\mathbf{r}'\boldsymbol{\beta}+\mathbf{z}'_{i,t}\boldsymbol{\gamma}+\mathbf{w}'_{f,t}\theta+\varepsilon_{i,t}$$

where $Mob_{i,t}$ takes on the value 1 if individual *i* has changed employer between years *t* and *t* + 1. **r** is a vector of regional variables, where density is the key variable. Vector **z** consists of characteristics of individual *i* and **w** is a vector of attributes of the employer in period *t*.

As a complement to the empirical model, we present the relationship between intra-regional job-switching as a fraction of total job switching and density in the Appendix. If the estimated influence of density on mobility is positive at the same time as the likelihood that the job switch is intra-regional is higher in denser regions, we can conclude that density spurs localized inter-firm mobility. Intra-regional switching accounts for about 80 % of all switching

In order to assess if density matters more for younger workers who may shop around more intensively for a good match (cf. Bleakley and Lin 2007, Topel and Ward 1992), we estimate the model described by (1a) and (1b) not only for all employees, but also for young (30 years or younger) and older workers (+30 years) separately. We also conduct separate estimations for employees with different levels of educational attainment as a robustness procedure.

[8] Our strategy is similar to that of Finney and Kohlhase (2008) who examines the relationship between density and the job mobility of young men in urban areas in the US.

4.2 Variables and descriptives

Table 1 presents descriptive statistics for all the variables in the empirical model. The estimations are based on data for the period 1997-2005, which is a decade shorter than data presented in the previous section. The reason for this is that information about firms is absent from the data 1987-1996.

We include four worker characteristics; age, tenure, gender and education. Mobility is assumed to decline with age (Topel and Ward 1992). We also include a squared age variable to account for possible non-linearity. Tenure is defined as the length the employee has remained with the same employer. The longer tenure, the greater the likelihood that it is a good match and we thus expect tenure to have a negative influence on mobility (cf. Farber 1994). Gender is a dummy variable for men, and from established findings we expect males to be more mobile than females (Johansson et al 2002, Faggian et al 2007).

We control for the educational attainment of each employee with dummy variables for six different education levels. These are (i) high school (9 years), (ii) short senior high school ($\leq$ 2 years), (iii) long senior high school (> 2 years), (iv) university education shorter than 3 years, (v) university education longer than 3 years and (vi) PhD. For all these variables, they are 1 if the employee has the specific education as the highest attained level and 0 otherwise.[9] From the description of the basic patterns in the previous section, we expect that education is positively associated with mobility. That more highly educated individuals are more mobile is also verified in earlier research (Machin et al. 2008, Johansson et al. 2002), though PhDs appear as special case.

The model also includes characteristics of the employer. We include a dummy variable taking on the value one for firms with declining employment between year (t-1) and t, i.e. the period before actual job-switching. Being employed in a firm that decreases its employment between year (t-1) and t can affect change of employer in two ways. The worker may lose her job between year t and (t+1) due to continued downsizing of the firm and is therefore forced to find a new job elsewhere. Or, she chooses to look for a new job because the future within the firm looks less prosperous. Both stories suggest a positive effect of declining employment on the probability of job switching. In addition, we include firm size by means of dummy variables for different size classes, where we expect that employment in a small firm increase the probability of job-switching (Baltzopoulos and Braunerhjelm 2010). A further employer characteristic is value-added per employee, and workers are expected to be less likely to leave firms with higher labor productivity.

[9]This means that an individual with a PhD has 1 on the PhD dummy and 0 on all other education dummy variables.

Table 1. Descriptive statistics for variables in the empirical model (average values for the period 1997-2005).

	Variable	Mean	Std. dev.	Min	Max
Mobility Variables	Total labor mobility, share of total employment	0.1197	0.3246	0	1
	Intra-regional labor mobility, share of total employment	0.0953	0.2936	0	1
	Interregional labor mobility, share of total employment	0.0244	0.1543	0	1
Regional variables	Density, number of employed per square kilometer	21.69	15.51	0.04	44.15
	Density, squared	711	715	0.002	1,949
	Internal accessibility to employment	17,174	17,552	0.12	47,340
	External accessibility to employment	269	386	2.35E-07	2,729
	Stockholm, 1= the firm is located in Stockholm	0.2647	0.4412	0	1
Worker characteristics	Age	40.1	11.8	16	64
	Male, 1= the individual is a male	0.6729	0.4692	0	1
	Tenure, number of consecutive years with the same employer	5.334	5.251	0	18
	High school, 9 (10) years	0.1424	0.3494	0	1
	Senior high school, 2 years or shorter	0.3240	04680	0	1
	Senior high school, longer than 2 years and max 3 years	0.2306	0.4212	0	1
	University educ., shorter than 3 years (incl. 4-years senior high school)	0.1189	0.3237	0	1
	University educ., 3 years or longer (excl. PhD)	0.0999	0.2999	0	1
	PhD	0.0042	0.0649	0	1
Employer (firm) characteristics	Declining firm employment, 1=the firm reduced its employment between year *t*-1 and *t*	0.3306	0.4704	0	1
	Firm productivity, value added per worker, SEK, logarithm	5.974	0.6938	-2.967	15.284
	Firm size: 11-50 employed	0.2855	0.4517	0	1
	Firm size: 51-100 employed	0.1088	0.3114	0	1
	Firm size: 101-250 employed	0.1193	0.3242	0	1
	Firm size: 251-500 employed	0.0683	0.2522	0	1
	Firm size: 501- employed	0.1141	0.3179	0	1

Note: The accessibility variables are defined in Equations (1) and (2). All data originate from Statistics Sweden and are based on average values for the period 1997-2005.

Turning to regional characteristic our main variable of interest is density. We include two measures of density. The first is a standard measure of employment per square kilometer, which has been used in several analyses of the relationship between density and productivity (Ciccone and Hall 1996). For employment density per km^2, we also include a squared variable to account for non-lineraity. The second measure is an accessibility measure based on travel time-distance by car and exponential distance decay. Such a measure accounts for the quality of transportation infrastructure (at least by car) and is directly related to choice contexts for spatial interaction (Weibull 1976, 1980). The model includes both internal and external accessibility to employment as two different variables. Internal

accessibility is employment in the region weighed by average travel time-distance between zones in the region. External accessibility is total accessibility to employment outside the region. The measures are calculated as follows:

(2) $$A_{r,t}^{in} = E_{r,t} \exp\{-\lambda t_{rr}\}$$

(3) $$A_{r,t}^{ex} = \sum_{s \in R\_r} E_{s,t} \exp\{-\lambda t_{rs}\}$$

where $A_{r,t}^{in}$ and $A_{r,t}^{ex}$ denote internal and external employment accessibility, respectively. $E_{r,t}$ is employment in region r in year t. t_{rr} denotes the average travel time-distance by car between zones in region r and t_{rs} denotes the same distance between region r and region s. Data on travel time distances come from the Swedish Transport Administration. λ is a time-distance sensitivity parameter and we employ estimated values of this parameter from Johansson et al (2003). They estimated values for λ based on data on Swedish intra- and interregional commuting. These values represent the best available information for our empirical context.

In line with our main hypothesis, we expect that both employment density and internal accessibility have a positive influence on the probability of inter-firm job-switching. These are variables that describe the density in terms of both employees and employers inside the region an employee is operating in. The expected sign of the external accessibility is not clear-cut, but high accessibility to opportunities outside the region could stimulate inter-regional job-switching implying a positive influence on total job-switching. In general, the likelihood of intra-regional job-switching should be reduced by high accessibility to resources outside the region.

The model also includes year and sector dummies (2-digit NACE). The inclusion of year dummies is motivated by the cyclical behavior of mobility patterns (see Figures 2 and 3), and sector dummies are intended to control for differences in the level of overall labor mobility across sectors (see Figure 5).

4.3 Results

The estimated influence of the variables in Table 1 on the probability of inter-firm job-switching is presented in Table 2 and 3. Table 2 presents results for all individuals as well as for young (30 years old or younger) and old (older than 30 years) workers. In Table 3, results are presented for three groups of workers with different levels of education attainment, i.e. (i) less than three years of university education, (ii) three years or longer university education and (iii) PhD.

Table 2. Estimated effects on the probability of inter-firm job-switching, Probit model.

Dependent variable: Overall labor mobility	(1) Whole population	(2) 30 years old or younger	(3) Older than 30 years
Density	7.73E-03*** (2.30E-04)	6.71E-03*** (3.86E-04)	7.90E-03*** (2.83E-04)
Density squared	-1.85E-04*** (6.45E-06)	-1.67E-04*** (1.10E-05)	-1.81E-04*** (8.07E-06)
Internal access	1.55E-06*** (1.45E-07)	2.05E-06*** (2.43E-07)	1.11E-06*** (1.78E-07)
External access	-9.61E-06*** (1.52E-06)	-1.43E-05*** (2.53E-06)	-3.74E-06** (1.87E-06)
Stockholm	0.104*** (3.22E-03)	0.105*** (5.29E-03)	0.102*** (4.00E-03)
Age	-4.32E-02*** (3.14E-04)	-5.39E-02*** (3.28E-03)	-1.88E-02*** (7.59E-04)
Age squared	3.50E-04*** (3.92E-06)	6.52E-04*** (6.70E-05)	7.21E-05*** (8.43E-06)
Male	4.98E-02*** (1.14E-03)	3.14E-02*** (1.86E-03)	6.83E-02*** (1.42E-03)
Tenure	-5.36E-02*** (1.39E-04)	-9.33E-02*** (4.60E-04)	-5.31E-02*** (1.44E-04)
High school, 9 (10) years	9.72E-02*** (2.88E-03)	0.244*** (1.60E-02)	6.61E-02*** (3.02E-03)
Senior high school, 2 years or shorter	9.88E-02*** (2.67E-03)	0.261*** (1.59E-02)	8.59E-02*** (2.73E-03)
Senior high school, longer than 2 years and max 3 years	0.102*** (2.75E-03)	0.257*** (1.59E-02)	9.17E-02*** (2.94E-03)
University educ., shorter than 3 years (incl. 4-years senior high school)	0.149*** (2.91E-03)	0.321*** (1.60E-02)	0.121*** (3.09E-03)*
University educ., 3 years or longer (excl. PhD)	0.154*** (3.01E-03)	0.315*** (1.61E-02)	0.137*** (3.19E-03)
PhD	0.103*** (7.97E-03)	0.227*** (3.50E-02)	6.74E-02*** (8.22E-03)
Declining firm employment	0.141*** (1.02E-03)	0.103*** (1.77E-03)	0.164*** (1.24E-03)
Firm productivity, value added per worker, SEK	-0.101*** (7.47E-04)	-0.138*** (1.36E-03)	-8.44E-02*** (9.02E-04)
Firm size: 11-50 employed	4.31E-02*** (1.25E-03)	-1.22E-02*** (2.09E-03)	6.27E-02*** (1.54E-03)
Firm size: 51-100 employed	2.55E-02*** (1.70E-03)	-3.02E-02*** (2.84E-03)	4.67E-02*** (2.11E-03)
Firm size: 101-250 employed	-2.52E-02*** (1.75E-03)	-7.48E-02*** (2.97E-03)	-7.25E-03*** (2.14E-03)
Firm size: 251-500 employed	-7.22E-02*** (2.29E-03)	-0.107*** (3.94E-03)	-6.14E-02*** (2.79E-03)
Firm size: 501- employed	-9.00E-02*** (2.28E-03)	-0.164*** (3.86E-03)	-5.53E-02*** (2.77E-03)
Time dummies	YES	YES	YES
Industry dummies (2-Digit NACE Rev. 1)	YES	YES	YES
Number of observations	14,094,653	3,540,160	10,554,493
Number of individuals	2,906,668	1,093,223	2,166,170
Pseudo R^2	0.0976	0.0618	0.0764

Note: Robust standard errors, adjusted for clustering at the individual level are reported in parentheses; ***, ** and * represent statistical significance at the 1, 5 and 10 percentage level, respectively.

Table 3. Estimated effects on the probability of inter-firm job-switching by levels of educational attainment , Probit model.

Dependent variable: Overall labor mobility	(4) < 3 years univ. ed.	(5) ≥ 3 years univ. ed. incl. PhD	(6) PhD
Density	7.38E-03*** (2.42E-04)	8.53E-03*** (7.97E-04)	7.91E-03* (4.75E-03)
Density squared	-1.78E-04*** (6.89E-06)	-1.58E-04*** (2.24E-05)	-1.87E-04 (1.33E-04)
Internal access	1.63E-06*** (1.55E-07)	3.88E-07 (4.28E-07)	3.57E-06 (2.36E-06)
External access	-1.30E-05*** (1.58E-06)	2.91E-05*** (5.88E-06)	9.67E-05** (4.04E-05)
Stockholm	0.101*** (3.48E-03)*	0.115*** (8.80E-03)	3.15E-02 (4.77E-02)
Age	-4.10E-02*** (3.08E-04)*	-3.28E-02*** (1.20E-03)	-2.72E-02*** (8.06E-03)
Age squared	3.12E-04*** (3.86E-06*)	2.31E-04*** (1.44E-05)	1.73E-04* (8.95E-05)
Male	5.33E-02*** (1.23E-03)	2.87E-02*** (3.08E-03)	5.71E-02*** (1.87E-02)
Tenure	-5.71E-02*** (1.46E-04)	-4.75E-02*** (4.53E-04)	-2.60E-02*** (2.21E-03)
High school, 9 (10) years	-	-	-
Senior high school, 2 years or shorter	-	-	-
Senior high school, longer than 2 years and max 3 years	-	-	-
University educ., shorter than 3 years (incl. 4-years senior high school)	-	-	-
University educ., 3 years or longer (excl. PhD)	-	-	-
PhD	-	-	-
Declining firm employment	0.136*** (1.09E-03)	0.177*** (2.92E-03)	0.294*** (1.58E-02)
Firm productivity, value added per worker, SEK	-0.101*** (8.18E-04)	-8.89E-02*** (1.86E-03)	-8.75E-02*** (9.95E-03)
Firm size: 11-50 employed	3.66E-02*** (1.31E-03)	0.105*** (4.08E-03)	0.148*** (2.53E-02)
Firm size: 51-100 employed	1.55E-02*** (1.81E-03)	0.106*** (5.12E-03)	8.72E-02*** (2.98E-02)
Firm size: 101-250 employed	-3.70E-02*** (1.88E-03)	5.40E-02*** (4.94E-03)	9.37E-02*** (2.83E-02)
Firm size: 251-500 employed	-8.87E-02*** (2.50E-03)	2.88E-02*** (5.94E-03)	7.35E-02** (3.46E-02)
Firm size: 501- employed	-0.104*** (2.50E-03)	-2.70E-02*** (5.89E-03)	1.88E-02 (3.02E-02)
Time dummies	YES	YES	YES
Industry dummies (2-Digit NACE Rev. 1)	YES	YES	YES
Number of observations	12,626,386	1,468,267	59,497
Number of individuals	2,609,742	350,414	14,734
Pseudo R^2	0.1023	0.0598	0.0580

Note: Robust standard errors, adjusted for clustering at the individual level are reported in parentheses; ***, ** and * represent statistical significance at the 1, 5 and 10 percentage level, respectively.

Overall, the results are in line with our hypothesis. The density variables (employment density per km^2 and internal employment accessibility) are significant and positive. Employees operating in denser regions are more likely to switch employer, all else equal. The only exception to this is that internal employment accessibility is insignificant for employees with at least three years of university education and PhDs (Table 3). This may be explained by that people with higher education are less sensitive to commuting time-distances (Johansson et al. 2002), which means that the geographical scope of their labor markets is larger. Such an interpretation is supported by that the external employment accessibility variable (i.e. outside the region) is positive and significant for PhDs and employees with an university education of at least three years. In all other specifications, this variable is negative and significant.[10] Moreover, we do not find any difference as regard the influence of density on the probability of inter-firm job-switching between old and young workers (Table 2). The regional density variables are positive and significant for both categories of employees.

As regards other variables, the Stockholm dummy is positive and significant in all specifications but for PhDs, illustrating the special position of Stockholm in the Swedish hierarchy of regions. According to expectations, older employees are less mobile even though the effect falls of as age increase (age squared is positive). Tenure is also negative meaning that longer relationships between employer and employee may be interpreted as a sign of a quality match. For the education dummy variables, high school education is reference. That all the education dummy variables are positive thus means that more educated employees are more likely to switch employer, which is the expected result. Men are also found to on average be more likely to switch employer than women. Moreover, employees are more likely to switch employer if their current one has declining employment, and they are less likely to leave a firm with higher labor productivity (as indicated by average value-added per employee). Finally, the results also suggest that employees are more likely to switch employer if they work in smaller firms in terms of employees. The reference for the firm size dummy variables is firms with 1-10 employees.

The results in Tables 2 and 3 support the hypothesis that spatial employment density spurs inter-firm labor mobility. But is it mobility between firms inside the region that is stimulated, i.e. to what extent is this a localized phenomenon? The results in the tables are for general mobility which may or may not be intra-regional. We certainly expect mobility to be localized as transactions costs and information associated with switching employer is likely to be lower in denser region. About 80 % of all observed job-switching over the period 1997-2005 is indeed intra-regional.

[10]Moreover, when studying only intra-regional mobility, the internal accessibility variable is positive and significant also for PhDs and employees with an university education of at least three years.

To confirm the localized nature of inter-firm labor mobility we do two things. First, in Appendix we present the results for intra-regional mobility. As is evident these show the same patterns as in Tables 2 and 3.[11] Second, we study the relationship between spatial employment density and intra-regional mobility as a fraction of total mobility (intra- plus inter-regional). If this relationship is positive, we can confirm that density spurs in particular localized inter-firm mobility of labor. The relationship between regional density and the fraction of intra-regional mobility is presented in Figure 7.

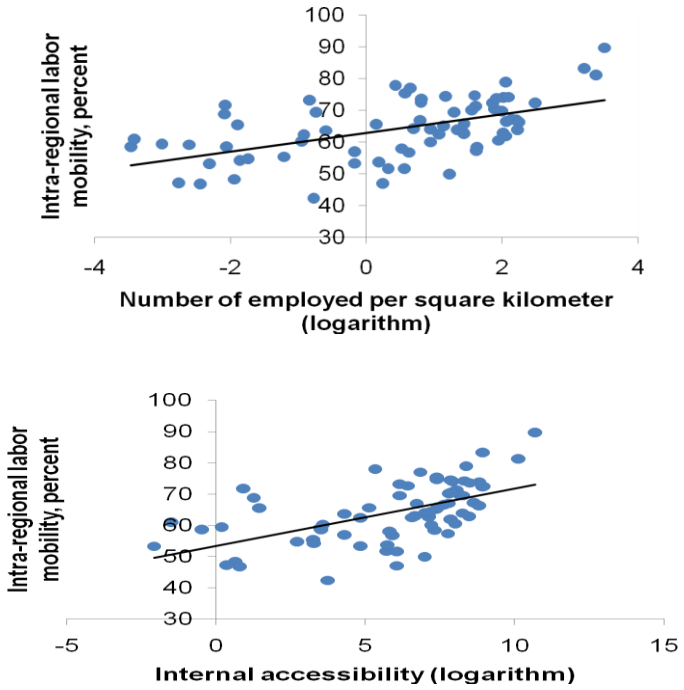


Figure 7. *The relationship between log employment density per square kilometer (upper panel), internal employment accessibility (lower panel) and intra-regional inter-firm job switching as a fraction of total job-switching.*

The upper panel shows the relationship between the fraction of intra-regional mobility and the log of employment density per square kilometer. The lower one shows the relationship between the same mobility variable and internal employment accessibility. Both panels verify that the fraction of intra-regional inter-firm mobility of labor is indeed higher in denser regions. We conclude that density spurs in particular localized inter-firm mobility.

[11]It can also be added that when estimating the model of inter-regional inter-firm job switching, the density variables are as expected negative and significant.

5. CONCLUSION AND DISCUSSION

The productivity advantages of dense regions are established in the literature but the sources of such agglomeration economies are often not observed. This paper analyzes the relationship between inter-firm mobility of labor and spatial employment density. Labor mobility is a much cited but seldom measured source, and is connected to two sources of agglomeration economies: learning and matching. It has been advanced as a vehicle for both knowledge flows and labor market efficiency.

The analysis asks if spatial employment density spurs inter-firm mobility of labor. Based on an extensive matched employer-employee dataset for Sweden 1997-2005, we find that spatial density has a positive and significant effect on the probability of inter-firm mobility of labor. This result is robust to the inclusion of several control variables and holds for workers of different age and levels of educational attainment. We also verify that inter-firm mobility of labor is indeed a spatially localized phenomenon. The likelihood that inter-firm mobility is intra-regional is significantly higher if the employees operate in denser regions. This means that phenomena mediated by labor mobility, such as knowledge flows and match efficiency, also are expected to be localized. We conclude that higher rates of inter-firm mobility of labor in denser regions appear as a likely reason for the empirically verified productivity advantage of dense regions. Labor mobility is a mechanism through which learning and matching effects materialize.

If inter-firm flow of labor is an accepted source of the productivity advantages of spatial density of people and firms, it gives some interpretational meaning to estimated distance-decay effects and also emphasizes a role played by investments in transport infrastructure. As an example, Rice et al. (2006) find that doubling the population in areas within short time distances to a region is associated with 3.5 percent higher productivity in the region. But this positive effect ceases to be important when travel time distances increase to over 80 minutes. Such a distance decay effect may be interpreted in a labor mobility context. Findings from commuting data in Sweden show for instance that around 60 minutes is a critical time-interval, and the willingness to commute falls sharply as time-distances increase over 60 minutes. If labor mobility is an important source of productivity advantages, then we could expect that estimated distance decays for productivity effects are linked to peoples' willingness to commute and travel over time distances. Changing job and place of residence is a slower process and is associated with larger transaction costs compared to change of job without changing residence.

Labor mobility as a source of productivity effects of density also suggests that investments in transportation infrastructure which reduce time distance, may be beneficial to productivity. Lower time distances increase the choice set of employees in terms of potential employers for a given place

of residence. The geographical scope of a labor market region can increase, which increase actual density in terms of tie distances and stimulate to improved matching efficiency and knowledge flows.

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APPENDIX - results for intra-regional mobility

Dependent variable: Intra-regional labor mobility	(1) Whole population	(2) 30 years old or younger	(3) Older than 30 years
Density	1.62E-02*** (2.51E-04)	1.99E-02*** (4.21E-04)	1.38E-02*** (3.09E-04)
Density squared	-3.34E-04*** (7.14E-06)	-4.07E-04*** (1.20E-05)	-2.79E-04*** (8.81E-06)
Internal access	2.63E-06*** (1.57E-07)	3.75E-06*** (2.62E-07)	1.82E-06*** (1.93E-07)
External access	-7.62E-05*** (1.82E-06)	-8.92E-05*** (3.01E-06)	-6.64E-05*** (2.24E-06)
Stockholm	0.135*** (3.46E-03)	0.148*** (5.65E-03)	0.127*** (4.32E-03)
Age	-3.83E-02*** (3.34E-04)	-0.107*** (3.46E-03)	-1.77E-02*** (8.09E-04)
Age squared	2.98E-04*** (4.18E-06)	1.64E-03*** (7.06E-05)	6.11E-05*** (8.99E-06)
Male	1.61E-02*** (1.20E-03)	1.57E-02*** (1.97E-03)	2.23E-02*** (1.50E-03)
Tenure	-4.83E-02*** (1.46E-04)	-7.79E-02*** (4.82E-04)	-4.58E-02*** (1.51E-04)
High school, 9 (10) years	9.09E-02*** (3.01E-03)	0.188*** (1.66E-02)	5.46E-02*** (3.21E-03)
Senior high school, 2 years or shorter	8.24E-02*** (2.85E-03)	0.196*** (1.65E-02)	6.78E-02*** (2.91E-03)
Senior high school, longer than 2 years and max 3 years	7.34E-02*** (2.93E-03)	0.179*** (1.64E-02)	6.66E-02*** (3.14E-03)
University educ., shorter than 3 years (incl. 4-years senior high school)	9.18E-02*** (3.11E-03)	0.188*** (1.66E-02)	7.91E-02*** (3.30E-03)
University educ., 3 years or longer (excl. PhD)	8.98E-02*** (3.21E-03)	0.168*** (1.66E-02)	9.04E-02*** (3.39E-03)
PhD	3.95E-02*** (8.56E-03)	0.105*** (3.77E-02)	1.26E-02 (8.80E-03)
Declining firm employment	0.139*** (1.08E-03)	0.103*** (1.87E-03)	0.161*** (1.32E-03)
Firm productivity, value added per worker, SEK	-9.36E-02*** (7.82E-04)	-0.123*** (1.40E-03)	-8.03E-02*** (9.48E-04)
Firm size: 11-50 employed	1.69E-02*** (1.31E-03)	-3.07E-02*** (2.20E-03)	3.41E-02*** (1.64E-03)
Firm size: 51-100 employed	-1.84E-03 (1.80E-03)	-5.26E-02*** (2.99E-03)	1.86E-02*** (2.24E-03)
Firm size: 101-250 employed	-4.69E-02*** (1.84E-03)	-9.14E-02*** (3.13E-03)	-2.96E-02*** (2.27E-03)
Firm size: 251-500 employed	-9.45E-02*** (2.42E-03)	-0.127*** (4.17E-03)	-8.27E-02*** (2.96E-03)
Firm size: 501- employed	-9.78E-02*** (2.41E-03)	-0.185*** (4.11E-03)	-5.61E-02*** (2.93E-03)
Time dummies	YES	YES	YES
Industry dummies (2-Digit NACE Rev. 1)	YES	YES	YES
Number of observations	14,094,653	3,540,160	10,554,493
Pseudo R^2	0.0905	0.0620	0.0722

Note: Robust standard errors, adjusted for clustering at the individual level are reported in parentheses; ***, ** and * represent statistical significance at the 1, 5 and 10 percentage level, respectively.

Dependent variable:	(4)	(5)	(6)

Intra-regional labor mobility	< 3 years univ. ed.	≥ 3 years univ. ed. incl. PhD	PhD
Density	1.61E-02*** (2.63E-04)	2.08E-02*** (9.22E-04)	1.93E-02*** (5.57E-03)
Density squared	-3.38E-04*** (7.50E-06)	-3.66E-04*** (2.58E-05)	-2.97E-04* (1.53E-04)
Internal access	2.47E-06*** (1.67E-07)	3.99E-06*** (4.77E-07)	4.71E-06* (2.62E-06)
External access	-7.68E-05*** (1.87E-06)	-9.66E-05*** (7.69E-06)	8.28E-07 (5.25E-05)
Stockholm	0.141*** (3.73E-03)	8.09E-02*** (9.71E-03)	-4.33E-03 (5.41E-02)
Age	-3.71E-02*** (3.27E-04)	-1.37E-02*** (1.29E-03)	-1.62E-02* (8.74E-03)
Age squared	2.75E-04*** (4.10E-06)	2.65E-05* (1.56E-05)	4.64E-05 (9.69E-05)
Male	1.80E-02*** (1.30E-03)	-3.94E-03 (3.29E-03)	4.06E-02** (2.00E-02)
Tenure	-4.90E-02*** (1.53E-04)	-3.99E-02*** (4.78E-04)	-2.05E-02*** (2.35E-03)
High school, 9 (10) years	-	-	-
Senior high school, 2 years or shorter	-	-	-
Senior high school, longer than 2 years and max 3 years	-	-	-
University educ., shorter than 3 years (incl. 4-years senior high school)	-	-	-
University educ., 3 years or longer (excl. PhD)	-	-	-
PhD	-	-	-
Declining firm employment	0.135*** (1.15E-03)	0.173*** (3.11E-03)	0.310*** (1.67E-02)
Firm productivity, value added per worker, SEK	-9.58E-02*** (8.55E-04)	-8.26E-02*** (1.97E-03)	-9.03E-02*** (1.05E-02)
Firm size: 11-50 employed	9.48E-03*** (1.38E-03)	9.19E-02*** (4.33E-03)	0.151*** (2.74E-02)
Firm size: 51-100 employed	-1.39E-02*** (1.91E-03)	9.84E-02*** (5.43E-03)	9.40E-02*** (3.26E-02)
Firm size: 101-250 employed	-5.99E-02*** (1.98E-03)	4.37E-02*** (5.25E-03)	8.87E-02*** (3.07E-02)
Firm size: 251-500 employed	-0.111*** (2.64E-03)	1.28E-02** (6.34E-03)	8.30E-02** (3.73E-02)
Firm size: 501- employed	-0.112*** (2.64E-03)	-1.90E-02*** (6.29E-03)	3.97E-02 (3.29E-02)
Time dummies	YES	YES	YES
Industry dummies (2-Digit NACE Rev. 1)	YES	YES	YES
Number of observations	12,626,386	1,468,267	59,452
Pseudo R^2	0.0943	0.0625	0.0653

Note: Robust standard errors, adjusted for clustering at the individual level are reported in parentheses; ***, ** and * represent statistical significance at the 1, 5 and 10 percentage level, respectively.