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Local multipliers and human capital in the United States and Sweden

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We show that every time a local economy generates a new job by attracting a new business in the traded sector, a significant number of additional jobs are created in the non-traded sector. This multiplier effect is particularly large for jobs with high levels of human capital and for high-technology industries. These findings are important for local development policies, as they suggest that to increase local employment levels, municipalities should target high-technology employers with high levels of human capital.

JEL classification: J23, R11, R12, R23.

1. Introduction

The economy of a metropolitan area is a highly interconnected system. Every time a local economy generates a new job by attracting a new business in the traded sector, additional jobs are created in the local service sector. This multiplier effect stems from increases in the demand for local services generated by the increase in total earnings in the traded sector. As the number and wages of, say, manufacturing workers increases in a city, their demand for services like haircuts, restaurant meals, and medical care increases, thus raising the demand for hair stylists, waiters, and doctors in the city. Although this multiplier effect is partially offset by general equilibrium effects induced by changes in local prices, its magnitude can be sizable. In the United States and Sweden, approximately two-thirds of total employment is in the local service sector, and a third is in the traded sector. While the traded sector

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employs only a minority of workers, its effects on local employment are much larger. In essence, a productive traded sector means more local jobs in the non-traded sector.

From the point of view of local governments seeking to promote employment and economic growth in their jurisdictions, the multiplier effect has important implications, as it means that attracting employers in the traded sector ultimately results in an additional effect on local employment. Crucially, the magnitude of this local multiplier effect varies enormously across industries and type of jobs. Existing evidence for the United States indicates that the multiplier effect of high-technology employment is three times larger than the multiplier effect of employment in traditional manufacturing industries. In other words, the impact on a local labor market of attracting a high-technology employer to a city is three times larger than the impact of attracting a low-technology employer of similar size. The magnitude of the multiplier effect also varies depending on the type of workers involved and their level of human capital. The effect of increasing the number of workers with high human capital employed in the local traded sector is significantly larger than the effect of increasing the number of workers with low human capital in the local traded sector. Obviously, these considerations matter to local governments that are involved in local economic development strategies because they can help them better target their efforts.

In this article, we estimate the employment multiplier at the local level in Sweden, and we compare it with estimates for the United States. In particular, we quantify the long-term change in the number of jobs in a city's non-tradable sectors generated by an exogenous increase in the number of jobs in the tradable sector, allowing for the endogenous reallocation of factors and adjustment of prices. We first regress the growth of local employment in the non-tradable sector (defined as services that are locally produced and consumed) on the growth of local employment in the tradable sector (defined as manufacturing and part of the service sector that are exported outside the local economy). We also show how these average estimates vary by human capital levels and by technology class. Finally, we compare our estimates with estimates in the United States.

We use local labor market regions as our spatial unit of observation. Sweden is divided into 290 municipalities, which in turn are aggregated into 72 local labor market regions, so-called Funktionella Analysregioner (FA)-regions. Of course, local economies differ enormously in terms of productivity determinants and factors that determine the local labor supply. The longitudinal nature of the data allows us to account for all *permanent* differences between metropolitan areas that may affect local labor demand and labor supply both in the traded and non-traded sector. However, it is still possible that there are unobserved shocks to local labor supply that may confound our ordinary least squares (OLS) estimates. To account for time-varying labor supply shocks, we use an instrumental variable technique that isolates arguably exogenous shocks to the labor demand in the traded sector.

Governments, both in Europe and the United States, devote significant effort and financial resources in trying to attract new businesses to their jurisdictions or retain existing businesses that threaten to move. In the United States, for example, the commitment of taxpayers' resources can be sizable. Greenstone and Moretti (2004) report that Mercedes received a $250 million ($165,000 per job) incentive package for locating in Vance, Alabama; the Toyota plant in Georgetown, Kentucky was awarded $200 million ($80,000 per job) and Boeing was given $50 million ($100,000 per job) in tax abatements to locate its corporate headquarters in Chicago (Mitol, 2001; Trogen, 2002). The European Union provides significant funding for place-based policies aimed at increasing job creation in low-income regions. The benefits of these policies are not fully understood, as the empirical evidence is scarce (Bartik, 1991; Glaeser and Gottlieb, 2008, provide in depth discussions of the economic rationales behind these policies; Bartik, 2012).

Given that local and national governments routinely engage in these types of policies, it is important to know what the effect on local communities is, to better understand whether these policies can be justified on economic grounds and where subsidies should be directed. The magnitude of local multipliers is important for this type of regional economic development policy. Should local government target firms that employ highly skilled workers or less-skilled workers? Should they target high-technology industries or more traditional industries?

The analysis for Sweden and its comparison with the United States is interesting for several reasons. First, the data available for Sweden are significantly more detailed than those available for the United States. In particular, we use a matched employer–employee data set provided by Statistics Sweden for 1994–2008. These data include all employed individuals in Sweden as well as information about the firm and establishment where individuals work. We focus the analysis on workers who are 20–64 years old. The number of individuals in our data set range from 3.4 million in 1995 to 3.9 million individuals in 2007.

Second, and most importantly, local labor markets in Sweden tend to have features that make them different from local labor markets in the United States. Specifically, some of the factors that determine the magnitude of multiplier effects are likely to differ in the two countries. For example, labor mobility is lower in Sweden than in the United States, and public subsidies for the unemployed are more generous. As we will see, the magnitude of the local multiplier crucially depends on the elasticity of labor supply at the local level, which in turn is determined by labor mobility and labor market institutions, such as unemployment insurance. This suggests that in principle, the local employment effect of a labor demand increase in the traded sector is more likely to differ in Sweden than in the United States.[1]

[1]The entrepreneurial environment may also affect the magnitude of the employment multiplier. For instance, better access to venture capital may simplify the start-up process, and hence, help to

Moreover, the wage distribution in Sweden is more compressed than that in the United States. This means that the difference in average earnings between highly skilled workers and less-skilled workers is smaller. As we will see, the difference in the multiplier effect between jobs that require high skills and jobs that require low skills, and between high-technology industries and low-technology industries, largely depends on the difference in wages. This indicates that the skill and industry differences documented for the multiplier effect in the United States might not necessarily manifest themselves in Sweden.

Our empirical findings point to the existence of sizable multiplier effects in Swedish local labor markets. The average effect is smaller than that estimated for the United States. Consistent with US evidence, the multiplier effect in Sweden is particularly large for employers with many well-educated workers and for employers in the high-technology sector. These findings are informative for local development policies intended to raise employment levels in metropolitan areas with high levels of unemployment. Our estimates indicate that municipalities that seek to attract employers to their jurisdictions to increase local employment levels should target employers with high level of human capital in the high-technology sector.

2. Conceptual framework

This section builds on the framework discussed in Moretti (2010) and Moretti (2011) to clarify the economic meaning of the multiplier effect and the underlying structural parameters that determine its magnitude. Assume that each metropolitan area is a competitive economy that uses labor to produce a vector of nationally traded goods and a vector of non-traded goods. The price of traded goods is assumed to be set on the national market, and therefore does not reflect local economic conditions, whereas the price of non-traded goods is determined locally.

Assume also that labor is perfectly mobile across sectors within a city. This assumption, which is likely to hold in the long run, ensures that marginal product and wages are equalized within a city. Workers' utility in each city depends on local wages net of local living costs, and idiosyncratic preferences for location. This assumption implies that while workers are free to move across cities, local labor supply is upward sloping. Weaker idiosyncratic preferences for location imply higher geographical mobility, and therefore a higher elasticity of labor supply. In the extreme, when idiosyncratic preferences for location are assumed away, and worker utility in each city depends only on local wages net of local living costs, mobility is perfect and

channel increased local demand into additional employment. See Lerner and Tåg (2013) for a comparison of the venture capital markets in Sweden and the United States, and Goldfarb and Henrekson (2003) for a broader institutional comparison of Sweden and the United States.

local labor supply is infinitely elastic. In this case, wages net of housing costs and utility are equalized across all locations for all workers. In the more realistic case where workers do have some idiosyncratic preferences for location, utility is equalized only for marginal workers, but not necessarily for inframarginal workers.

Local housing supply is assumed to be upward sloping, with an elasticity that depends on geography and land use regulations.[2] For simplicity, we assume that amenities are identical in all cities.

We are interested in determining the effect of a permanent increase in local labor demand in a tradable industry. For example, this could occur if a city successfully attracts a new firm in the tradable sector or if existing firms enjoy an exogenous labor productivity shock. The direct effect is obvious: the attraction of the new firm or the labor productivity increase results in an increase in employment in the traded sector.

The more interesting effect is the indirect effect. Specifically, in this article, we are concerned with the effects that the labor demand shift in the traded sector induces in the rest of the local economy. This indirect effect includes changes both in local employment in the rest of the tradable sector and in the non-tradable sector. It also includes general equilibrium effects on local prices: the wage of *all* workers in the city increases (unless local labor supply is infinitely elastic), and the cost of housing also increases (unless housing supply is infinitely elastic).

The effect on the local non-tradable sector is unambiguously positive. Because the city aggregate income increases, there will be an increase in the local demand for non-tradables. For example, employment in industries like restaurants, real estate, cleaning services, legal services, construction, medical services, retail, personal services, and so forth, grows because the city has more workers and wages are higher. These new jobs are split between existing residents and new residents, depending on the degree of geographical mobility.

The magnitude of this multiplier depends on several factors.

1. First, it depends on consumer preferences for non-tradables. Stronger preferences for non-tradable goods mean that a larger share of the increase in the city aggregate income is spent on local goods and services, and therefore a large multiplier.
2. Second, the magnitude of the multiplier depends on the technology in the non-tradable sector. More labor intensive technologies result in a larger multiplier for the same increase in traded sector employment, everything else being equal.
3. Third, the magnitude of the multiplier also depends on the type of new jobs created in the tradable sector. High-technology jobs and jobs that require high levels of human capital should have a larger multiplier than low-technology jobs

[2]See Moretti (2011).

and jobs that require low levels of human capital. The reason is that high-technology jobs and jobs that require high level of human capital have higher productivity, and therefore command higher earnings. This in turn implies a larger increase in the aggregate income level in the area, and therefore a larger increase in the demand for local services. Additionally, higher-income households tend to spend a larger fraction of their income on personal services, which are largely non-traded.

4. Fourth, the magnitude of the local multiplier depends on the offsetting general equilibrium effects on wages and price. This ultimately depends on the elasticities of local labor and housing supply. More specifically:

   (a) Cities where supply of housing is more constrained will experience larger increases in local costs of living for a given increase in labor demand in the traded sector.

   (b) Higher labor mobility means smaller wage increases, and therefore a larger multiplier.

The citywide increase in labor costs generated by the shock causes a decline in the supply of local services. This decline *partially* undoes the effect of the increase in demand for local services. Effectively, the addition of jobs in the traded sector partially crowds out jobs in other industries. If labor and housing supply are locally very elastic, this crowding out is more limited and the increase in labor costs is small, making the multiplier larger.

It is also important to highlight that the general equilibrium effects also affect employment in the tradable sector. On the one hand, the citywide increase in labor costs hurts employment in parts of the traded sector that are not directly affected by the increase in demand. Because these are tradable industries, the increase in production costs lowers their competitiveness. On the other hand, it is also possible that the increase in employment in the part of the traded sector that receives the shock may increase the local demand for intermediate goods and services. This effect depends on the geography of the industry supply chain (local vs. national) and on the strength of agglomeration economies.[3] Therefore, the employment effect on the tradable sector should be quantitatively smaller than the effect on the non-tradable sector, and possibly even negative, unless agglomeration spillovers are large or the supply of intermediate inputs is highly localized.

The multiplier for the non-tradable sector measured locally is an upper bound for the national multiplier. Owing to geographical mobility, labor supply is arguably more elastic at the local level than at the national level. Higher elasticity implies that less crowding out takes place at the local level than at the national level. The multiplier for the tradable sector measured locally is a lower bound for the national

[3]See Duranton *et al.* (2010), Glaeser (1999, 2001), and Greenstone *et al.* (2010).

multiplier. By definition, the market for tradables is national, and much of the additional local demand is likely to benefit other cities.

3. Econometric Framework

3.1 Tradable vs. non-tradable sectors

The relationship between labor demand shocks and the long-run effect on local employment is assessed using a panel estimator, with fixed regional effects. Specifically, we undertake two types of regressions. First, we regress growth of local employment in the non-tradable sector on growth of local employment in the tradable sector, controlling for unobserved region-specific fixed effects.

Separate regressions are performed for different skill levels. As discussed earlier in the text, we expect local employment multipliers to be larger for more skilled workers because high-skilled jobs pay higher salaries, which should generate a higher local demand. We also distinguish between the effects of adding new jobs in high- and low-technology manufacturing firms operating in the tradable sector.

Second, we regress employment changes in a specific industry in the tradable sector on employment changes in other tradable industries. We expect that the effect in the latter type of regression should be smaller than in the former owing to the geographical extent of the markets. As discussed in the previous section, increased local labor demand puts an upward pressure on local wages and rents. Firms producing for the local economy can partly compensate for this by raising prices, whereas firms competing on the national/global market are much more constrained to do so. Prices for tradable products are, to a large extent, set outside the local economy, and raising prices locally would decrease the competitive strength for these firms. Although agglomeration economies may partially compensate for higher labor costs, we expect the multiplier to be larger for firms in the non-tradable sector.

The theoretical definition of tradable and non-tradable industries is based on the geographical range of their markets. We use the so-called assumption method and include agriculture, fishing, manufacturing, and extracting activities (NACE rev. 1.1 01–37) in the tradable sector and services (NACE rev. 1.1 40–99) in the non-tradable sector.[4] This division is based on the fact that many services are produced for the local economy as they demand face-to-face interactions, whereas manufactured products typically do not have this restriction.

3.2 Econometric specification

The empirical regression equation used to estimate the relationship between changes in tradable employment and non-tradable employment is given by

[4]NACE stands for Statistical classification of economic activities in the European community.

$$\begin{aligned} E_{c,t}^{NT} - E_{c,t-s}^{NT} &= \beta_0 + \beta_1 \left(E_{c,t}^{T} - E_{c,t-s}^{T} \right) + \beta_2 TDUM + \varepsilon_{c,t} \\ \varepsilon_{c,t} &= \mu_c + \nu_{c,t}, \end{aligned} \tag{1}$$

where $E_{c,t}^{NT}$ and $E_{c,t}^{T}$ denote employment in the non-tradable and tradable sector, respectively, in region c at time t. TDUM is a time dummy included to control for national shocks to employment in the non-tradable sector. The error term ε is assumed to consist of unobservable region-specific fixed effects, represented by μ, and a truly random component, ν. The specification in (1) implies that the employment multiplier is given by β_1.

The effect of tradables on other tradables is estimated by

$$\begin{aligned} E_{c,t}^{T1} - E_{c,t-s}^{T1} &= \beta_0' + \beta_1' \left(E_{c,t}^{T2} - E_{c,t-s}^{T2} \right) + \beta_2' TDUM + \varepsilon_{c,t}' \\ \varepsilon_{c,t}' &= \mu_c' + \nu_{c,t}' \end{aligned} \tag{2}$$

where $E_{c,t}^{T1}$ denotes employment in a randomly selected part of the tradable sector in region c at time t, and $E_{c,t}^{T2}$ denotes employment in the rest of the tradable sector in the same region at time t.

All regressions will be undertaken using employment data expressed in 3-year moving averages to avoid having the results being skewed by the employment level in a single year.

OLS estimates of model (1) are likely to be inconsistent if there are unobserved shocks to the size of the non-traded sector in the local economy that also affect the number of traded jobs. Specifically, unobserved time-varying shocks to the labor supply of a city (changes in amenities, crime, school quality, local public services, local taxes) may induce bias. The bias can, in principle, be either positive or negative, depending on whether the correlation between the shocks (the residual epsilon) and changes in the traded sector employment are positive or negative.

To address this problem, we isolate arguably exogenous shifts in the demand for labor in the tradable sector using a shift-share instrumental variable. More specifically, we use 23 tradable industries (j) based on two-digit NACE and 74 tradable industries based on three-digit NACE to calculate the instrument for tradable employment growth in region c at time t as

$$\sum_j E_{c,j,t-s}^{T} \left(\ln\left(E_{j,t}^{T} - E_{c,j,t}^{T} \right) - \ln\left(E_{j,t-s}^{T} - E_{c,j,t-s}^{T} \right) \right). \tag{3}$$

The calculation thus includes the national share and the industry mix components, but excludes the regional shift. In effect, of all the variations in employment in subindustry j in region c, the instrument isolates the variation that comes from nationwide changes in industry j (where nationwide changes are computed excluding region c). These nationwide changes affect different cities differently because of their industry composition in the base year. Intuitively, the instrument captures exogenous changes in local labor demand because these nationwide changes do not reflect local economic conditions. When we estimate the multipliers for tradables in model (2), we use a group-specific version of the shift-share instrument.

In some models, we estimate skill-specific multipliers. In these cases, we calculate the instrument using skill-specific employment. In other cases, we present separate estimates for the high- and low-technology manufacturing sectors and then base the instrument on employment in those types of industries only.

4. Estimates for the United States

Using data from the 1980, 1990, and 2000 United States Census of Population and Housing, Moretti (2010) finds that for each additional job in the tradable sector in a given city, 1.6 jobs are created in the non-tradable sector in the same city. This is shown in Table 1. The geographical unit of analysis is the metropolitan area, which includes an economically self-contained urban region where most residents both live and work. Entries in the table show estimates of β_1 in models similar to the one in equation (1). The implied OLS and instrumental variables (IV) elasticities are 0.55 and 0.33, respectively. The latter indicates that a 10% increase in the number of manufacturing jobs in a city is associated with a 3.3% increase in employment in local goods and services. Because there are almost 5 non-tradable jobs for each tradable job, the IV estimate implies that for each additional job in manufacturing in a given city, 1.59 jobs are created in the non-tradable sector in the same city.

Table 2 suggests that this effect is significantly larger for skilled jobs (2.5), presumably because they command higher earnings. The corresponding figure for unskilled jobs is 1 (skilled workers are those with some college education or more, and unskilled workers are those with high school education or less). Crucially, the multiplier also varies across industries. Estimates by industry indicate that the average multiplier in manufacturing is 1.6, while the multiplier for high-technology is 4.9. This reflects higher wages in high-technology and stronger agglomeration economies.

The local multiplier for the tradable sector should be smaller than the one for the non-tradable sector, and possibly even negative. Empirically, Moretti (2010) finds that adding 1 additional job in one part of the tradable sector has no significant effect on employment in other parts of the tradable sector. In other words, it seems to be the case that the increase in labor costs generated by the initial labor demand shock hurts local producers of tradables. Adding a skilled job in the tradable sector generates 2 skilled jobs and no unskilled jobs in the non-tradable sector, whereas adding an unskilled job in the tradable sector generates 3.3 unskilled jobs and no skilled jobs in the non-tradable sector. In interpreting these estimates, one should keep in mind the general equilibrium effect on relative wages.

Table 1 Local multipliers for tradables and non-tradables in the United States

Model	Additional jobs for each new job	
	OLS	IV
1: Effect of tradable on non-tradable	1.99*** (0.39)	1.59*** (0.26)
2: Effect of tradable on other tradable	0.48*** (0.13)	0.26 (0.23)

Standard errors clustered by city in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percentage level, respectively.

Table 2 Local multipliers, by skill level in the United States

Independent variable	Non-tradable		Non-tradable—Skilled		Non-tradable—Unskilled	
	Additional jobs		Additional jobs		Additional jobs	
	OLS (1)	IV (2)	OLS (1)	IV (2)	OLS (1)	IV (2)
Tradable—Skilled	0.28*** (0.04)	2.52* (1.54)	0.40** (0.18)	2.03 (1.72)	0.63** (0.27)	0.30 (1.68)
Tradable—Unskilled	2.79*** (0.11)	1.04 (0.99)	−1.10*** (0.14)	−0.09 (1.21)	4.02*** (0.82)	3.34*** (1.06)

Standard errors clustered by city in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percentage level, respectively.

5. Estimates for Sweden

5.1 Data

The empirical analysis is based on a matched employer–employee data set provided by Statistics Sweden. We collected data for 1994–1996, 2000–2002, and 2006–2008 and base the econometric analysis on changes in employment over two periods: 1995–2001 and 2001–2007.

Data comprise detailed information on all employed individuals in Sweden, including age, sex, highest attained level of education, and location of workplace, along with several other variables. We focus the analysis on employment for the age cohort 20–64 years, which implies that we restrict our sample to individuals who mainly “work for a living” as compared with other age cohorts, who are more likely to get their main support from other sources. The number of individuals in our data set range from 3.4 million in 1995 to 3.9 million individuals in 2007.

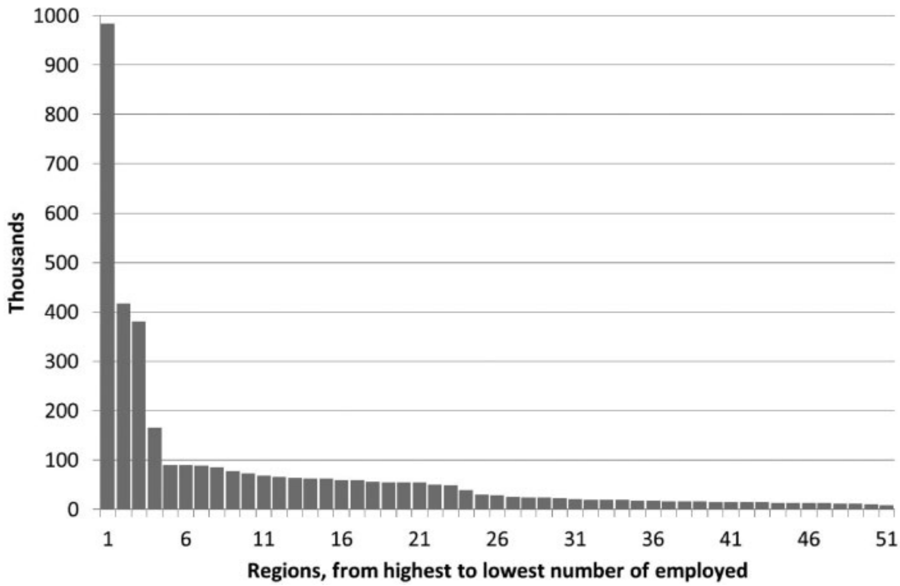

Figure 1 Average employment (1995, 2001, and 2007) in 51 regions, thousands.

Sweden is divided into 290 municipalities, which are aggregated into 72 local labor market regions, so-called FA-regions.[5] Similarly to metropolitan areas in the United States, the FA-regions are delineated using average commuting times and are basically defined as regions where individuals can live and work without having to commute too long. The regions vary considerably in size, with Stockholm, Gothenburg, and Malmoe, the three largest FA-regions, accounting for ~50% of overall employment throughout the studied period. We base our spatial unit of observation on FA-regions, but have aggregated smaller neighboring regions to end up with 51 regions with at least 5000 employed individuals per region and year.

As can be seen in Figure 1, the average size distribution is skewed even after aggregating the smallest regions. Moreover, the trend is toward an even more skewed size distribution—the Gini coefficient has increased all years except one in the sample, from 0.610 in 1995 to 0.641 in 2007 (see Figure 2). This mirrors a long ongoing trend in Sweden where workers tend to move to larger regions, predominately to Stockholm, Malmoe, and Gothenburg.

Stockholm is by far the largest region, with approximately the same number of employed workers as in the next four largest regions combined. Owing to its size,

[5]This classification was conducted by NUTEK in 2005 to facilitate regional analysis. The classification is partly based on commuting time statistics from 2003 and partly on other factors that might affect commuting patterns.

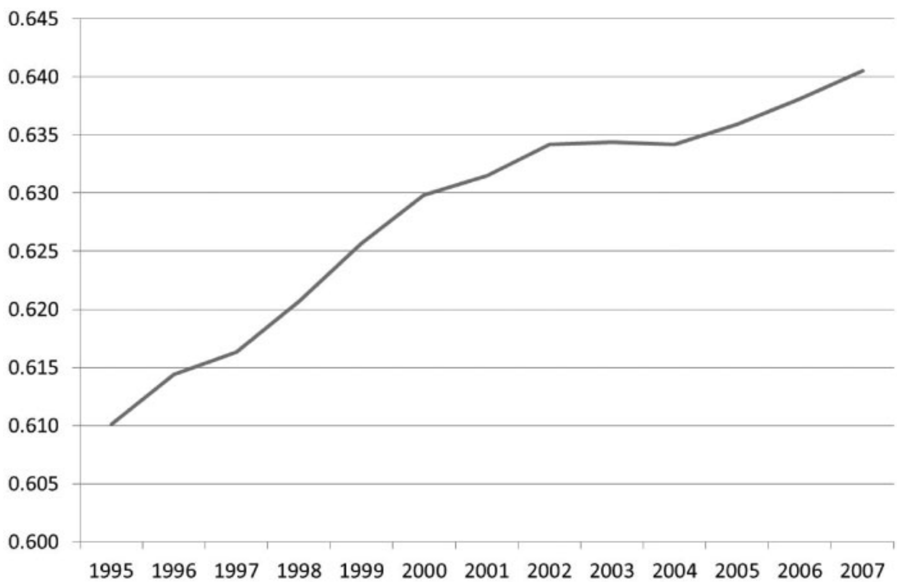

Figure 2 Gini coefficient based on employment in 51 regions, 1995–2007.

Stockholm does not lend itself well to our instrumental variable strategy. Recall that our instrumental variable isolates the variation in local tradable employment that comes from nationwide changes in a given industry. The instrument works best when there are many regions in a country, and each of them is too small to affect aggregate changes. Because Stockholm is so much larger relative to the rest of the country, it is difficult to find nationwide changes that do not reflect what happens in Stockholm. For this reason, our baseline models are based on a sample that excludes Stockholm. We separately report estimates including Stockholm in the Appendix.

5.2 *Descriptive statistics*

Table A1 in the Appendix provides detailed statistics for employment in the tradable and non-tradable sectors of the economy as well as for high- and low-skilled workers and high- and low-technology firms. A first noteworthy feature of the table is that employment in the non-tradable sector increases by 22% (583,000 jobs) between 1995 and 2007, while the same figure for the tradable sector is a decrease in employment of 8% (63,000 jobs). This shift in the sectoral distribution is highlighted in panel A of Table 3, where we report the relative magnitude of employment in the tradable and non-tradable sectors for 1995, 2001, and 2007. Tradable industries accounted for almost 25% of overall employment in 1995, but only some 20% in 2007.

Table 3 Distribution of the labor force, by year—Sweden

Employment	1995	2001	2007
Panel A: Sectoral distribution			
Tradable	23.5	21.4	18.8
Non-tradable	76.5	78.6	81.2
Panel B: Education distribution			
Lower secondary education	21.6	16.1	12.3
Upper secondary education	49.7	51.0	49.8
Tertiary education	28.7	32.9	37.9
Panel C: Percent of skilled workers			
Tradable sector	15.9	19.8	24.6
Non-tradable sector	32.6	36.4	41.0
High-technology manufacturing firms	36.6	43.7	51.4

Tradable include NACE 1–37, and Non-tradable NACE 40–99. High-skilled refers to a completed tertiary education. High-technology manufacturing firms include pharmaceuticals (NACE 244); office machinery and computers (NACE 30); radio, television, and communication equipment (NACE 32); medical, precision, and optical instruments, watches and clocks (NACE 33); and aircraft and spacecraft (NACE 353).

Another important trend in Table A1 is a marked increase in human capital intensity since the early 1990s. In the traded sector, the number of low-skilled workers (lower secondary education) decreased by 46% (119,000 workers) between 1995 and 2007, whereas the number of workers with a completed tertiary education increased by 42% (54,000 workers) over the same time period. A similar evolution can be seen among workers in the non-tradable sector. The shift from lower secondary education toward tertiary education is remarkable, and is much more pronounced than the change observed in the United States in the same period. Panel B of Table 3 indicates that in 1995, ~1 of 4.6 workers had a lower secondary education and ~1 of 3.5 had a tertiary education. In 2007, these figures had changed to ~1 of 8.1 and 1 of 2.6 workers having lower secondary education and tertiary education, respectively.

The bottom panel in Table 3 provides more details on the increase in the share of highly skilled workers, defined as workers who have completed a post-secondary education. In 1995, 15.9% of the workers in the tradable sector and 32.6% of the workers in the non-tradable sector had completed a post-secondary education. By 2007, these numbers had increased to 24.6% and 41.0% for tradable and non-tradable workers, respectively. The difference between high-skilled workers in the tradable and non-tradable sectors has been fairly constant at ~16 percentage points for the 3 years included in the sample. The last row of Table 3 indicates that

Table 4 Average wages—Sweden (Swedish Krona)

Employment	1995	2001	2007
Panel A: By sector and education level			
Non-tradable			
Lower secondary education	157,847	187,716	205,896
Upper secondary education	168,806	204,218	225,717
Tertiary education	233,317	287,084	300,513
Tradable			
Lower secondary education	176,752	211,163	236,710
Upper secondary education	195,088	233,760	261,565
Tertiary education	278,239	350,114	385,082
Panel B: By high-technology status—manufacturing only			
Overall manufacturing	204,439	249,562	284,539
Low-technology manufacturing	201,214	242,593	273,548
High-technology manufacturing	239,461	319,689	384,774

Wages expressed in 2005 year's prices. High-technology firms include pharmaceuticals (NACE 244); office machinery and computers (NACE 30); radio, television and communication equipment (NACE 32); medical, precision, and optical instruments, watches and clocks (NACE 33); and aircraft and spacecraft (NACE 353). Low-technology firms include food products, beverages, and tobacco (NACE 15, 16); textiles and textile products (NACE 17, 18); leather and leather products (NACE 19); wood and wood products (NACE 20); pulp, paper, and paper products, publishing and printing (NACE 21, 22); manufacturing not elsewhere classified (NACE 36, 37).

high-technology firms tend to become more reliant on high-skilled workers over time. More than 50% of the workers in high-technology firms had completed a tertiary education in 2007, while the corresponding figure for 1995 was ~37%.

Table 4 shows average wage levels. Panel A reports wage level by education for the tradable and non-tradable sectors. Not surprisingly, wages increase with the level of education, although the differences across education groups are less pronounced than the differences observed in the United States. Workers with tertiary education earn, on average, ~50% more than workers with lower secondary education in the non-tradable sector and ~60% more in the tradable sector. The corresponding differences for the United States are twice as large. This matters because we expect the magnitude of the multiplier to depend on the increase in purchasing power generated by an increase in labor demand in the tradable sector. Better paid jobs lead to higher local income, and hence, in principle, should generate a larger multiplier, all else being equal.

Table 5 Local multipliers—Average effects—Sweden

Multiplier for:	OLS (1)	IV (2) Instrument based on two-digit NACE	IV (3) Instrument based on three-digit NACE
Overall tradable employment	0.22 (0.25)	0.48* (0.28)	0.49* (0.29)
Private sector only	0.13 (0.14)	0.35*** (0.12)	0.35*** (0.12)
Private employment only	0.40** (0.17)	0.77*** (0.09)	0.75*** (0.08)
Number of observations	100	100	100

Robust standard errors clustered by region in parentheses.

*, **, and *** denote significance at the 10, 5, and 1 percentage level, respectively. Private sector includes NACE 1–74.

Table 4 also indicates that, just as in the United States, average wages are generally lower in the non-tradable sector and that wages tend to grow faster in the tradable sector as compared with the non-tradable sector, probably because productivity in services tends not to increase significantly over time. Wages also differ between types of industry. The bottom panel in Table 4 indicates that firms operating in high-technology manufacturing industries pay considerably higher wages than firms in low-technology industries. In 1995, high-technology firms paid on average 19% higher wages as compared with low-technology firms; in 2007, this difference had risen to more than 40%. This growing difference in wage levels paid by high- and low-technology firms probably reflects the fact that high-technology firms increasingly employ better educated workers.

Table A2 in the Appendix provides a correlation matrix and Table A3 shows descriptive statistics for the variables and instruments used to identify the exogenous part of the variation in tradable employment growth in the regression analysis.

5.3 Estimates

Our main empirical estimates are reported in Tables 5–8. Table 5 reports estimates of the average multiplier effect across all sectors and skill groups. The instrumental variable estimates in the first row of Table 5 suggest that the average multiplier for Sweden is smaller than the multiplier for the United States. For example, the entry in column 2, estimated using an instrumental variable based on two-digit industries, indicates that increasing employment in the tradable sector by 1 unit in a metropolitan area results in an increase in 0.48 additional units of employment in the non-tradable sector in the same metropolitan area in the long run. This multiplier

Table 6 Local multipliers, by schooling level—Sweden

Multiplier for:	OLS (1)	IV (2) Instrument based on two-digit NACE	IV (3) Instrument based on three-digit NACE
Lower secondary education	0.42 (0.72)	−0.15 (1.43)	−0.27 (1.25)
Upper secondary education	0.25 (0.32)	0.50 (0.40)	0.51 (0.42)
Tertiary education	1.42 (1.20)	2.97*** (0.61)	2.79*** (0.72)
Number of observations	100	100	100

Robust standard errors clustered by region in parentheses.

*, **, and *** denote significance at the 10, 5, and 1 percentage level, respectively.

Table 7 Local multipliers, by technology level—Sweden

Multiplier for:	OLS (1)	IV (2) Instrument based on two-digit NACE	IV (3) Instrument based on three-digit NACE
Overall manufacturing	0.21 (0.25)	0.45 (0.29)	0.45 (0.29)
Low-technology manufacturing	0.72 (0.75)	0.64 (0.82)	0.48 (0.81)
High-technology manufacturing	1.16*** (0.43)	1.10** (0.44)	1.11** (0.43)
Number of observations	100	100	100

Robust standard errors clustered by region in parentheses.

*, **, and *** denote significance at the 10, 5, and 1 percentage level, respectively.

Table 8 Local multipliers—Tradable sector—Sweden

Multiplier for:	OLS (1)	IV (2) Instrument based on two-digit NACE	IV (3) Instrument based on three-digit NACE
Tradables on other tradables	0.17* (0.09)	0.33*** (0.10)	0.41*** (0.15)

Robust standard errors clustered by region in parentheses.

*, **, and *** denote significance at the 10, 5, and 1 percentage level, respectively.

effect is only approximately one-third of the multiplier uncovered in the United States (cf. Table 1). The entry in column 3, estimated using an instrumental variable based on three-digit industries, is similar. It indicates that increasing employment in the tradable sector by 1 unit in a metropolitan area results in an increase in 0.49 additional units of employment in the non-tradable sector in the same metropolitan area.[6]

The second and third rows of Table 5 show estimates for two alternative specifications. The first row presents results based only on employment in the private sector (NACE 1–74), and the second row presents results based on only private employment. The results indicate that the multiplier for the private sector is slightly lower than for the overall sample—0.35 as compared with 0.48. When focusing the analysis on private employment, we get a somewhat larger multiplier effect—adding 1 worker in the tradable sector yields 0.77 additional jobs in the non-tradable sector.

While the average multiplier effect is interesting, the heterogeneity in the magnitude of the effect is even more important. Table 6 shows estimates by education level. The table indicates that the effect is larger for high-skilled workers than for low-skilled workers. One additional worker with lower or upper secondary education in the tradable sector causes employment in the local non-tradable sector to increase by an amount that is not statistically different from 0. In contrast, the multiplier effect on the local non-traded employment of 1 additional worker with tertiary education in the tradable sector is approximately 3. Hence, adding 1 high-skilled worker in the tradable sector generates 3 new jobs in the non-tradable sector. Thus, while the average multiplier effect is smaller for Sweden than the United States, the magnitude of the multiplier for high-skilled workers seems to be approximately the same in the two countries.[7]

Table 7 shows the magnitude of the multiplier effect when distinguishing between high- and low-technology firms operating in the tradable sector. We have experimented with different definitions of high-technology industries. Here we report results based on the classification made by EUROSTAT, which include pharmaceuticals; office machinery and computers; radio, television, and communication equipment; medical, precision, and optical instruments, watches and clocks; and aircraft and spacecraft. We note that this definition only applies to the

[6]As mentioned earlier in the text, estimates that include Stockholm are reported in Table A4 in the Appendix.

[7]The fact that wage differences between skilled and unskilled workers in Sweden appear more contained than differences in the United States may suggest that the difference in the multiplier effect between skilled jobs and unskilled jobs should be smaller. But at the same time, differences between the United States and Sweden in the relative mobility of skilled and unskilled workers, in institutions that affect labor supply (like the generosity of the welfare and unemployment insurance system), in consumer tastes, and in the elasticity of housing supply may explain the empirical results.

manufacturing sector, and therefore Table 7 is based on the subset of tradable sector workers employed in manufacturing.

Adding 1 additional worker in a high-technology firm yields 1 additional job in the non-tradable sector. The corresponding figure for low-technology firms is not statistically different from zero, although the precision of the estimate is low. Taken at face value, these findings suggest that the estimated multiplier is larger for high-technology firms than for firms operating in the low-technology sector. This result, which is in line with the estimates uncovered in the United States, is what we expected because we have seen that high-technology firms tend to employ more high-skilled workers, and therefore pay higher salaries than low-technology firms. This implies that the local demand for non-tradable goods increases relatively more when a metropolitan attracts a high-technology employer than an equally sized low-technology employer.

To investigate the effect of adding new jobs in a tradable industry on other tradable industries, we first randomly divide all 74 tradable industries into two groups, and then estimate the effect using a group-specific shift-share instrument. The results are reported in Table 8. The multiplier is slightly smaller than the one for non-tradable sector—1 additional worker in a tradable industry yields ~0.33 new jobs in other tradable industries. This effect is statistically significant and stronger than the one detected in the United States.

For completeness, we report the regression results for the full sample that includes Stockholm in Table 4 in the Appendix (as we argue earlier in the text, we are less confident of the validity of our instrumental variable strategy in this sample). The pattern is similar to the one in our baseline regressions in Tables 5–7, although the magnitude of the multiplier is significantly larger. The multiplier for high-skilled workers and high-technology manufacturing firms is larger than for low-skilled workers and low-technology firms, respectively.

6. Conclusions

Employment changes in the tradable sector in a city are expected to generate changes in the employment in the non-tradable sector in that city. The main channel is increasing demand for local services. The magnitude of the local multiplier effect depends on a number of factors, including consumer preferences for tradable and non-tradable goods, the non-tradable sector production function, the type of new jobs created in the tradable sector and their salary levels, and the elasticities of local labor and housing supply. Although the non-tradable sector production function is unlikely to differ substantially between the United States and Sweden, all the other factors are likely to be quite different. In particular, the lower geographic mobility of labor in Sweden and the presence of a more generous welfare system and unemployment insurance system are likely to reduce the elasticity of local labor supply, thus potentially making smaller the multiplier effect. In contrast, smaller wage differences between workers with college education and workers without college education predict that the difference in multiplier effects between jobs with different level of human capital should be more limited in Sweden than in the United States.

Empirically, we find evidence of an economically sizable and statistically significant multiplier effect in Sweden. A 1-unit increase in the employment level in a metropolitan area in Sweden causes labor demand in the non-tradable sector to increase by ~0.4–0.8 jobs in the long run. The average multiplier in Sweden is smaller than the average multiplier in the United States. Notably, the multiplier effect is significantly larger for traded jobs with high level of human capital and for high-technology industries. Adding a tertiary education job to the traded sector of a local economy results in the creation of 3 additional jobs in the non-traded sector in the long run. These estimates are important for local development policies intended to raise employment levels in high-unemployment areas. They suggest that to increase employment levels, municipalities should target high-technology employers with high level of human capital.

We note, however, that the presence of large multipliers is not, in itself, a market failure, and therefore does not necessarily justify government intervention. More specifically, the multiplier effect largely operates through increases in the product demand for local goods and services, and therefore, it is mainly a pecuniary externality. In contrast, the presence of unemployment may be a rationale for government intervention. Moreover, the magnitude of the employment effect could, in principle, be magnified by the existence of agglomeration economies. Thus, a large multiplier is consistent with the existence of agglomeration economies, but it does not necessarily imply the existence of agglomeration economies.

Finally, we note that the magnitude of local multipliers is also relevant for the literature on nationwide multipliers. The exact magnitude of multipliers is a crucial element in formulating countercyclical stimulus policies. Estimates of local multipliers are useful because they provide bounds for national multipliers.

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Appendix

Table A1 Employment statistics for 51 regions, 1995, 2001, and 2007

Variable	Statistic	1995	2001	2007
Employment, non-tradable sector	Sum	2,604,410	2,936,126	3,187,491
	Mean	51,067	57,571	62,500
	Standard deviation	111,590	134,447	147,561
	Minimum	4811	5073	4767
	Maximum	738,036	893,179	973,210
Employment, tradable sector	Sum	800,316	797,770	737,394
	Mean	15,692	15,643	14,459
	Standard deviation	21,394	21,822	19,842
	Minimum	2372	2456	2257
	Maximum	117,446	119,617	108,009
Employment, tradable sector, tertiary education	Sum	127,588	158,234	181,260
	Mean	2502	3103	3554
	Standard deviation	5405	6724	7357
	Minimum	145	198	251
	Maximum	33,401	40,757	43,503
Employment, tradable sector, upper secondary education	Sum	414,173	444,900	416,723
	Mean	8121	8724	8171
	Standard deviation	10,371	10,847	9558
	Minimum	1386	1652	1530
	Maximum	56,083	57,128	48,958
Employment, tradable sector, lower secondary education	Sum	258,555	194,636	139,411
	Mean	5070	3816	2734
	Standard deviation	5918	4558	3205
	Minimum	841	606	454
	Maximum	27,962	21,732	15,548
Employment, tradable sector, overall manufacturing	Sum	715,753	720,447	661,041
	Mean	14,034	14,126	12,962
	Standard deviation	19,922	20,473	18,607
	Minimum	1442	1370	1323
	Maximum	110,434	112,786	101,227
Employment, tradable sector, high-technology manufacturing firms	Sum	90,620	97,282	77,448
	Mean	1777	1907	1519
	Standard deviation	5469	5911	4801
	Minimum	2	1	0
	Maximum	36,822	39,919	32,078
Employment, tradable sector, low-technology manufacturing Firms	Sum	246,007	231,664	200,696
	Mean	4824	4542	3935
	Standard deviation	6500	6281	5357
	Minimum	425	374	327
	Maximum	35,920	33,765	30,164

Table A2 Correlation matrix, 1995–2001 and 2001–2007

Id	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	Difference in employment, non-tradable sector	1												
(2)	Difference in employment, tradable sector	−0.21	1											
(3)	Difference in employment, tradable sector, tertiary education	0.88	0.05	1										
(4)	Difference in employment, tradable sector, upper secondary education	−0.20	0.93	0.08	1									
(5)	Difference in employment, tradable sector, lower secondary education	−0.79	0.44	−0.80	0.26	1								
(6)	Difference in employment, tradable sector, high-technology manufacturing firms	−0.02	0.73	0.20	0.73	0.15	1							
(7)	Difference in employment, tradable sector, low-technology manufacturing firms	−0.52	0.77	−0.41	0.69	0.72	0.40	1						
(8)	Instrument for difference in employment	−0.34	0.79	−0.20	0.80	0.47	0.79	0.72	1					
(9)	Instrument for difference in employment, tertiary education	0.93	−0.01	0.88	0.04	−0.74	0.23	−0.38	−0.03	1				
(10)	Instrument for difference in employment, upper secondary education	0.00	0.77	0.18	0.86	0.09	0.82	0.56	0.90	0.29	1			
(11)	Instrument for difference in employment, lower secondary education	−0.84	0.38	−0.85	0.22	0.98	0.15	0.68	0.49	−0.78	0.10	1		
(12)	Instrument for difference in employment, high-technology manufacturing firms	0.04	0.63	0.09	0.64	0.18	0.82	0.44	0.87	0.35	0.84	0.19	1	
(13)	Instrument for difference in employment, low-technology manufacturing firms	−0.80	0.60	−0.71	0.55	0.86	0.37	0.83	0.76	−0.63	0.47	0.89	0.42	1

The instruments in the table are based on two-digit NACE.

Table A3 Difference in employment and instruments for 51 regions, 1995–2001 and 2001–2007

Variable	Statistic	1995–2001	2001–2007
Difference in employment, non-tradable sector	Mean	6272	4886
	Standard deviation	22,319	13,136
	Minimum	−1224	−538
	Maximum	150,518	78,445
Difference in employment, tradable sector	Mean	82	−1226
	Standard deviation	1302	2252
	Minimum	−2214	−11,166
	Maximum	6319	408
Difference in employment, tradable sector, tertiary education	Mean	626	423
	Standard deviation	1362	711
	Minimum	−7	−156
	Maximum	7036	4274
Difference in employment, tradable sector, upper secondary education	Mean	710	−580
	Standard deviation	942	1438
	Minimum	−205	−7889
	Maximum	4606	433
Difference in employment, tradable sector, lower secondary education	Mean	−1254	−1069
	Standard deviation	1421	1339
	Minimum	−7190	−6148
	Maximum	−172	−109
Difference in employment, tradable sector, high-technology manufacturing firms	Mean	150	−409
	Standard deviation	769	1237
	Minimum	−1640	−7797
	Maximum	3930	165
Difference in employment, tradable sector, low-technology manufacturing firms	Mean	−275	−590
	Standard deviation	374	961
	Minimum	−1466	−4663
	Maximum	533	217
Instrument for difference in employment	Mean	27	−1411
	Standard deviation	520	2898
	Minimum	−1085	−18,736
	Maximum	2238	8
Instrument for difference in employment, tertiary education	Mean	597	353
	Standard deviation	1560	480
	Minimum	27	37
	Maximum	10,446	2400
Instrument for difference in employment, upper secondary education	Mean	661	−680
	Standard deviation	875	1351
	Minimum	−30	−8522

(continued)

Table A3 Continued

Variable	Statistic	1995–2001	2001–2007
	Maximum	4236	114
Instrument for difference in employment, lower secondary education	Mean	−1463	−1283
	Standard deviation	1727	1605
	Minimum	−8592	−8127
	Maximum	−242	−175
Instrument for difference in employment, high-technology manufacturing firms	Mean	146	−469
	Standard deviation	935	1480
	Minimum	−1261	−10,237
	Maximum	6402	0
Instrument for difference in employment, low-technology manufacturing firms	Mean	−312	−641
	Standard deviation	581	968
	Minimum	−3359	−5314
	Maximum	−2	−29

The instruments in the table are based on two-digit NACE.

Table A4 Estimated multipliers—Sweden, including Stockholm

Multiplier for:	OLS (1)	IV (2) Instrument based on two-digit NACE	IV (3) Instrument based on three-digit NACE
Overall tradable employment	2.33 (1.45)	3.85*** (1.50)	4.02*** (1.46)
Lower secondary education	−0.45 (1.49)	−11.4 (12.7)	−2.36 (2.56)
Upper secondary education	2.83 (1.99)	4.57* (2.37)	4.77** (2.41)
Tertiary education	11.2*** (4.22)	15.9*** (1.64)	16.7*** (0.89)
Overall manufacturing	2.33 (1.45)	3.81** (1.51)	3.97*** (1.48)
Low-technology manufacturing	4.23 (3.63)	8.24 (6.89)	9.12 (7.60)
High-technology manufacturing	5.64*** (1.27)	6.49*** (0.69)	6.55*** (0.64)
Number of observations	102	102	102

Robust standard errors clustered by region in parentheses.

*, **, and *** denote significance at the 10, 5, and 1 percentage level, respectively.