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LOCAL EMPLOYMENT MULTIPLIERS IN U.S. CITIES

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Local Employment Multipliers in U.S. cities

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Abstract

This paper shows that within a regional economy, employment in the nontradable sector benefits from attracting jobs in the tradable sector. I rework Moretti's study of U.S. cities (AER 2010) and find that one new job in a given city's tradable sector will result into 1.02 new jobs in the nontradable sector in the same city. I show that Moretti overestimated the size of this local multiplier by 0.57, because he made five perfunctory assumptions that had a major impact on his results. Subsequently I show that Moretti's assertion that skilled tradable jobs have a larger multiplier than unskilled tradable jobs is not supported by the data. The evidence provided by Moretti was only significant due to an endogeneity effect.

Keywords: Local labour market, multiplier, tradable, nontradable

1 Introduction

> "The motor of a city-region's economy is the tradable sector; it provides the jobs that come in and anchor labour as well as income to a place, on the basis of which the home market is built. However big the locally serving sector might appear at any given moment in time, it will always shrink if the tradable jobs go away, as cities such as Detroit know all too well."(Storper, 2013)

The regional interdependency described in the quote above have been studied extensively using regional input-output modelling and base theory (Mathur and Rosen, 1974; Isserman, 1975). Moretti (2010) breaks with this tradition by applying Bartik's Shift-Share approach (1991) to a reduced form analysis of the local employment multiplier of the tradable sector on the nontradable sector. Moretti estimates a significant multiplier of 1.6[1] for United States Metropolitan areas and an even higher multiplier of 2.5 when only considering skilled jobs.

Variations of Moretti's method have already been applied in subsequent studies of Sweden, Italy and the United Kingdom (Moretti and Thulin, 2013; de Blasio and Menon, 2011; Faggio and Overman, 2014) and studies of Brazil and Europe are on their way. These estimates of local multipliers give insight in the possible impact of regional policy and already influence politicians. For example Moretti and Thulin (2013) has been cited by the Swedish government.

The significant multipliers demonstrated by Moretti are very valuable, but because they are so influential it is important to make these estimates as accurate as possible. In this paper I show five ways[2] to improve the accuracy and robustness of Moretti's estimates and I compare my improved estimates to an exact replication of Moretti's original study.

I show that one new job in a given city's tradable sector will result into 1.02 new jobs in the nontradable sector in the same city. So I confirm there is a significant local multiplier effect, but I also show Moretti overestimates this effect by about one third. Subsequently I show that Moretti's assertion that skilled tradable jobs have a larger multiplier than unskilled tradable jobs is not supported by the data he uses, but is instead based on some mistakes and endogeneity of the instrument he uses.

2 Conceptual Framework

In this paper I use the exact same conceptual framework as Moretti (2010, 2011); Moretti and Thulin (2013). Because these papers already discuss this framework in detail, I will only provide a brief outline here.

[1] This would be considered a multiplier of 2.6 in the input-output literature. An influx of 100 jobs in the tradable sector induces an additional 160 jobs in the nontradable sector, so the total employment increase is 260.

[2] Some of which are also (partially) used in Faggio and Overman for their analysis of the U.K.

Each region is a competitive economy where tradable and nontradable goods are produced. Nontradable goods and services are only consumed within the region, therefore the prices of these goods are determined locally. Tradable goods and services can also be consumed in other regions, either nationally or internationally. Therefore the prices of these goods are considered fixed from the perspective of the regional economy. The production of tradable goods can move to another region when for example rent or wages become too high. Most manufacturing goods will be tradable and services such as barbers, restaurants and dry cleaners are nontradable. In practice I only include manufacturing sectors as tradable and almost all other sectors as nontradable.

Labour is mobile within each city and wages in all sectors are determined locally. The labour supply is upward sloping and labour mobility between regions depends on the housing supply.

When a local economy attracts a new manufacturing firm or an existing manufacturing firm expands this increases the number of jobs in the tradable sector. This is a direct increase in the number of jobs in the region. These extra workers will spend part of their income on local goods and services, or nontradable goods. The size of this spending increase depends on the workers' wages and preferences. The non-tradable sector may also supply intermediate goods and services to the tradable sector so that an increase in employment in the tradable sector directly increases demand. Depending on which specific non-traded goods are demanded and their respective technologies there will be an increase in labour demand in the nontradable sector. Assuming the elasticity of the local labour supply is neither zero nor infinite, the increased demand for labour in the nontradable sector will increase both wages and employment in the nontradable sector.The latter is the local employment multiplier effect of jobs in the tradable sector on jobs in the nontradable sector.

The increase in labour demand in some tradable sub-sector also has an effect on the rest of the tradable sector. Demand for labour (and land) increases, which will increase factor prices. Since tradable firms are price takers, when wages and other factor prices go up less efficient firms might close down and move to a cheaper region or hire fewer workers. Therefore the increase in jobs in a tradable sub-sector has a negative effect on the rest of the tradable sector.

When a new firm locates in a region there can also be agglomeration effects such as a positive spillover (Greenstone et al., 2008) to the incumbent firms in the region. Improved technologies can create efficiency benefits and therefore increase labour demand and wages. Depending on which effect is greater, the crowding out effect or the spillover effect, the multiplier of extra jobs in one tradable sub-sector on other jobs in the tradable sector could go either way, but it is expected to be smaller than the multiplier on the nontradable sector.

3 Empirical method

The goal of this paper is to determine the long run effect of labour demand shocks in the tradable sector on employment in the nontradable sector in the

same region. The point of departure for my empirical method is the method found in Moretti (2010). From here I make five improvements and the resulting method is described in detail in Section 3.1. I will compare this improved method to the method originally used by Moretti (2010) in Section 3.2 and demonstrate why the five changes I make are improvements. Finally I discuss an alternative method used in Moretti and Thulin (2013) in Section 3.3.

3.1 Improved analysis of local employment multipliers

I will determine the relationship between changes over time in the number of workers in the tradable sector in a region and the number of workers in the nontradable sector in a region by two-step weighted pooled least squares regression using panel data. I will use the change over time in the log of the number of workers in the tradable sector between period $t-s$ and period t in a region c, $\Delta N_{c,t}^{T}$, as the independent variable and the change over time in the log number of workers in the nontradable sector in a region, $\Delta N_{c,t}^{NT}$, as the dependent variable. Apart from this I will add an intercept α and dummy variables d_t for every time-period apart from the first. This results into

$$\Delta N_{c,t}^{NT} = \alpha + \beta \Delta N_{c,t}^{T} + \gamma' d_t + \Delta \varepsilon_{c,t}. \tag{1}$$

All unobservable region-specific fixed effects are cancelled out due to the differencing and only the truly random component $\Delta \varepsilon_{c,t}$ remains. Using least-squares regression, the intercept and the time dummy variables will capture any general booms and recessions that occur in a specific interval and all other co-movement between jobs in the tradable and the nontradable sector are captured by the elasticity β.

There will be three types of co-movement captured by β: the causal effect of extra jobs in the tradable sector on employment in the nontradable sector; the effect of employment in the nontradable sector on the tradable sector; and effects due to omitted variables, for example effective local government can increase employment in both sectors.

3.1.1 Instrumental Variable

Since I am only interested in the causal effect of a change in the number of jobs in the tradable sector on the number of jobs in the nontradable sector I need a way to filter out the other two unwanted co-movements captured by β when using weighted pooled LS. To achieve this I will use an instrumental variable derived from the well-established shift-share approach introduced by Bartik (1991) and I will use this instrument to do a weighted 2SLS analysis.

The instrument,

$$\Delta \tilde{N}_{c,t}^{T} = \sum_{j \in T} \left\{ \frac{N_{j,c,t-s}}{N_{c,t-s}^{T}} \left[\ln \left(\sum_{c' \in C \setminus c} N_{j,c',t} \right) \right. \right.$$

$$- \ln \left(\sum_{c' \in C \setminus c} N_{j,c',t-s} \right) \Bigg] \Bigg\}, \tag{2}$$

is based on the lagged size of each industry in the region and the combined growth of each industry in all other regions. In expression (2) $N_{j,c,t}$ is the number of workers in industry j of city c at time t. T is the set of all tradable industries, C is the set of all cities and $N^T_{c,t} = \sum_{j \in T} N_{j,c,t}$.

Consider for example the production of computer hardware. If there is a productivity shock in computer hardware in China, there will be more exports to the U.S. and the demand for computer hardware produced in the U.S. will decline. This decline will be measured by

$$\Delta N_{j,-c,t} = \ln \left(\sum_{c' \in C \setminus c} N_{j,c',t} \right) - \ln \left(\sum_{c' \in C \setminus c} N_{j,c',t-s} \right) \tag{3}$$

which approximates the average national percentage growth in industry j between period $t - s$ and period t.

It is likely that a region with a large share of employment in the production of computer hardware will be affected more by this shock than regions with a smaller share. Multiplying the share of tradable jobs in region c that are part of industry j at time $t-s$, $N_{j,c,t-s}/N^T_{c,t-s}$, with (3) and summing over all tradable industries results in the instrument described by (2).

Under the assumption that the national changes in employment are exogenous to a specific region, a weighted 2SLS regression with this instrument will identify the effect of an increase in jobs in the tradable sector on employment in the nontradable sector, avoiding the problems caused by endogeneity and omitted variables seen in the OLS regression.

3.1.2 Regression Weights

Since $\Delta N^T_{c,t}$ and $\Delta N^{NT}_{c,t}$ are both measures of relative change, regions with only a few workers would have the same effect on the regression as very large regions with many workers in an unweighted regression. To correct for this I use weighted LS, where the weight of each observation is given by the total number of workers employed in the tradable and nontradable sector at the start of the interval

$$w_{c,t} = N^T_{c,t-s} + N^{NT}_{c,t-s}. \tag{4}$$

3.1.3 Interpretation

The estimated value of β represents an elasticity between jobs in the tradable sector and jobs in the nontradable sector. For example when $\beta = 0.3$, a 10% increase in the number of jobs in the tradable sector will result into a 3% increase in the number of jobs in the nontradable sector. In order to express the multiplier in an absolute number of jobs I need the relative size of the nontradable sector to the tradable sector. I calculate this by adding up the number

of workers in the nontradable sector in each region at the start of each interval and dividing this by the number of workers in the tradable sector. The relative size is therefore given by

$$r = \frac{\sum_{S \setminus t_1} N_t^{NT}}{\sum_{S \setminus t_1} N_t^{T}}, \tag{5}$$

where S is the set of all periods, t_1 is the first period and N_t^{NT} is the total number of workers in the nontradable sector in period $t-s$ over all cities observed in both period $t-s$ and period t. N_t^T is defined in an analogous fashion. Equation (5) is consistent with the way the individual regression weights are defined as the sum of all weights used is equal to the sum of the numerator and the denominator

$$\sum_{S \setminus t_1} \sum_{C_t} w_{c,t} = \sum_{S \setminus t_1} N_t^T + \sum_{S \setminus t_1} N_t^{NT}, \tag{6}$$

where C_t is the set of all cities observed in both period $t-s$ and period t. One additional job in the tradable sector will result into $r\beta$ extra jobs in the nontradable sector.

3.2 Critiques on Moretti

Moretti was kind enough to provide me with the the Stata-files he used to estimate the local multiplier effect of the entire tradable sector on the entire nontradable sector. This allowed me to exactly reproduce his estimate of 1.59 and to reverse engineer all assumption he made to get this estimate. Some of these assumptions are not completely consistent with method described in Moretti (2010) in which he published this result. To prevent any confusion I will refer to method and assumptions necessary to get the exact estimate of 1.59 as "Moretti's method" and I will discuss any discrepancies with his paper in Section 5.1.

Using Moretti's method as a starting point I will discuss the changes I made to get a more accurate estimate of the local employment multiplier. I found five ways to make his estimation of the local multiplier more accurate and more robust:

- I remove industries from the analysis that are not observed in every period;
- I do not treat mining and agriculture as nontradable industries;
- I use a more exogenous shift-share instrument;
- I weigh both time intervals in the dataset equally;
- I provide a more accurate estimate for the relative size of the nontradable sector to the tradable sector.

In this section I will illustrate why every change improves the reliability of the estimation. The combination of these five changes results into the method described in the previous section and is the basis of my own analysis.

3.2.1 Exogenous shift-share instrument

Moretti (2010) uses the sum of all metropolitan areas, including the own city, to determine the shift-share instrument

$$\Delta\tilde{N}^T_{c,t} = \sum_{j\in T}\left\{\frac{N_{j,c,t-s}}{N^T_{c,t-s}}\left[\ln\left(\sum_{c'\in C}N_{j,c',t}\right)-\ln\left(\sum_{c'\in C}N_{j,c',t-s}\right)\right]\right\}. \quad (7)$$

An instrument is necessary, because there is an endogeneity problem when directly using $\Delta N^T_{c,t}$. The major drawback of this instrument is that $\Delta N^T_{c,t}$ itself is included in the construction of $\Delta\tilde{N}^T_{c,t}$. Because $\Delta N^T_{c,t}$ consists of the combination of the growth of all tradable sectors in region c, and $\Delta\tilde{N}^T_{c,t}$ includes the growth of each tradable sub-sector in all regions. So this instrument violates the assumed exogeneity. Therefore I use equation (2) instead. This excludes the change in the own city when calculating the overall growth out of concern that the changes in the region may drive the national changes.

3.2.2 Correct relative sector size

After $\hat{\beta}$ - the elasticity between jobs in the tradable and the nontradable sector - is estimated, the local multiplier can be calculated with the relative size between these two sectors. Moretti considers the average size of the tradable and nontradable sector in 1990 over all cities that were observed in the 1980-1990 interval, to find a relative size of

$$r = \frac{\sum_{C_{1990}} N^{NT}_{c,1990}}{\sum_{C_{1990}} N^{T}_{c,1990}} = 4.74. \quad (8)$$

Whilst this method might result in a reasonable estimate of the relative size between the tradable and the nontradable sector when considered over all three periods, we estimate the size of the multiplier based on the growth from 1980-1990 and from 1990-2000, but not from 2000 onwards. Since the relative size of the tradable (in this case manufacturing) sector has decreased over time as shown in Table 1, Moretti's method leads to an underestimation of the size of the tradable sector. Additionally this definition is inconsistent with his definition of the weights used for individual observations in the regression.

Therefore I use the size of the tradable and the nontradable sector at the start of each interval for all cities to determine the relative size of the sectors. Cities that are observed in both intervals will be included twice, once with their size in 1980 and once with their size in 1990. I define the relative size this way in (5) and find

$$r = \frac{\sum_{C_{1990}} N^{NT}_{c,1980} + \sum_{C_{2000}} N^{NT}_{c,1990}}{\sum_{C_{1990}} N^{T}_{c,1980} + \sum_{C_{2000}} N^{T}_{c,1990}} = 4.02. \quad (9)$$

3.2.3 Weigh time intervals equally

Moretti weights all observations, those over the interval 1980-1990 and those over the interval 1990-2000, by their size in 1990 in his regression analysis. This can be expressed as

$$w_{c,t} = N^{T}_{c,1990} + N^{NT}_{c,1990}, \tag{10}$$

but this is problematic for cities observed in 1980 as shown in the following example.

Consider a true local multiplier of 1 and a city in 1980 with 100 workers in the tradable sector and 500 workers in nontradable sector. If this cities attracts 10 tradable jobs between 1980 and 1990, the multiplier will create 10 additional jobs in the nontradable sector. Using (10) the weight of the city is 620, whilst if the same changes where observed from 1990 to 2000, the weight would be 600. This is inconsistent, because observations of the interval 1980-1990 are overweighted.

In both cases the estimation result is $\hat{\beta} = 0.2$. If we calculate the relative size of the nontradable sector to the tradable sector consistent to the defined weight, this results into $r = 4.6$ for this observation in 1980-1990 and $r = 5$ for the same observation in 1990-2000. It is clear that only the latter will result into a correct estimate of the true multiplier $\left(r\hat{\beta} = 1\right)$. Therefore I will use the combined size of the tradable and the nontradable sector in a city at the beginning of the interval to determine the regression weight as shown in (4).

3.2.4 Remove unbalanced industries

The industries of 1980 and 2000 are recoded to the three-digit industry codes of 1990. This results in some industries that are not observed at all in 1980 or 2000 according to the 1990 industry codes. Moretti includes all industries, but industries that weren't observed in 1980 would appear to have increased infinitely. To prevent this I choose to remove all industries that do not have at least one employed worker observed in each time period. This results in the removal of 8 tradable industries and 16 nontradable industries.

3.2.5 Exclude mining and agriculture

Moretti defines the tradable sector as all manufacturing industries and the nontradable sector as agriculture, forestry, and fisheries; mining; construction; transportation, communications, and other public utilities; wholesale trade; retail trade; finance, insurance, and real estate; business and repair services; personal services; entertainment and recreation services; and professional and related services. I change this by choosing not to treat agriculture and mining as nontradable industries. Mining is not a nontradable industry, because the product of this industry can be sold over the entire country and abroad. I also don't treat mining as a tradable industry, because firms cannot relocate to a region with lower wages as firms need to be near the resources found in the ground.

These arguments for treating mining as neither tradable nor nontradable also hold for agriculture, albeit less strict.

3.3 Alternative Method: Direct Difference

Instead of using the change in the log of the number of jobs and a regression weight, it is also possible to do the analysis directly with the change in the number of jobs in each sector, $\blacktriangle N_{c,t}^{T}$ and $\blacktriangle N_{c,t}^{NT}$. This exact method is used in the analysis of Sweden by Moretti and Thulin (2013). In this case the OLS regression is given by

$$\blacktriangle N_{c,t}^{NT} = \alpha + \beta \blacktriangle N_{c,t}^{T} + \gamma' d_t + \varepsilon_{c,t} \tag{11}$$

and no weights are necessary. The parameter β directly represents the effect of the local multiplier. One additional job in the tradable sector will result into β extra jobs in the nontradable sector. The instrument becomes

$$\blacktriangle \tilde{N}_{c,t}^{T} = \sum_{j \in T} (N_{j,c,t-s} \Delta N_{j,-c,t}) \tag{12}$$

because the lagged size of an industry is used instead of the lagged share. There is no literature on which method is preferable, so I will consider both for my analysis. This direct difference method does appear to be a cleaner approach.

4 Data

For my analysis of U.S. cities I use the exact same dataset as Moretti (2010). I use the United Status Census Data provided by IPUMS USA (Ruggles et al., 2010). This census data provides a 1-in-20 national random sample of the population for 1980, 1990 and 2000. The sample of 1980 is unweighted and the sample of 1990 and 2000 are weighted. For each individual it contains the metropolitan area his household lived in, his employment status, his wage and the industry he worked in.

It is important to note that the populations of many MSA's are only partially identified in the census data, and in many cases, the unidentified portion is considerably large. The reason for incomplete coverage is that the source data for these samples include no specific information about metro areas. The most detailed geographic information available is for 1980 county groups or for 1990 or 2000 PUMAs, areas which occasionally straddle official metro area boundaries. If any portion of a straddling areas population resided outside a single metro area, the METAREA variable uses a conservative assignment strategy and identifies no metro area for all residents of the straddling area.

The number of cities included in the dataset increases over time, therefore the panel dataset is unbalanced, but this should not have any averse effects on the analysis.

The industries of 1980 and 2000 are recoded to the three-digit industry codes of 1990. This results in some industries that are not observed at all in 1980 or

2000 according to the 1990 industry codes. This is a problem for my estimation as it is based on relative change, and this would sometimes imply an infinite change. To prevent this I choose to remove all industries that do not have at least one employed worker observed in each time period. This results in the removal of 8 tradable industries and 16 nontradable industries.

For my analysis I select all employed workers and aggregate those living in the same metropolitan area and working in the same industry. I aggregate them based on the weight attributed to each individual and for every observed year. The results of this aggregation is captured by N_{jct}, the number of workers in industry j of city c at time t. I consider 74 tradable industries and 119 nontradable industries. Overall I observe 245 cities, 226 of those I observe in the period 1980-1990 and 238 of those I observe in the period 1990-2000.

Tab. 1: Employment share in metropolitan areas by industry group

	Census Year		
Industry	1980	1990	2000
Tradables	**22.6%**	**17.1%**	**14.6%**
Manufacturing	22.6%	17.1%	14.6%
Nontradables	**75.5%**	**80.9%**	**83.7%**
Construction	5.9%	6.5%	6.9%
Transportation, communications, and other public utilities	8.0%	7.9%	7.9%
Wholesale trade	5.0%	4.9%	3.6%
Retail trade	17.3%	17.5%	17.5%
Finance, insurance, and real estate	7.4%	8.4%	7.7%
Business and repair services	4.3%	5.6%	7.0%
Personal services	3.3%	3.4%	3.4%
Entertainment and recreation services	1.2%	1.6%	1.6%
Professional and related services	22.9%	25.1%	28.1%
Other industries	**2.0%**	**2.0%**	**1.7%**
Agriculture, forestry, and fisheries	1.4%	1.6%	1.4%
Mining	0.6%	0.4%	0.2%
Total number of workers (x1000)	64,193	76,997	93,943
Relative size nontradable to tradable	3.340	4.717	5.742

5 Local Multiplier in U.S. Cities

This section discusses four estimates of local employment multiplier in U.S. cities. To start, all results labelled "Moretti" are cited directly from Moretti (2010). The number of observations and R-squared value are missing in this case, because Moretti did not report these.

In Section 5.1 I try to replicate these results as closely as possible using the Stata-files Moretti provided me with. Since these files only cover the estimation of the total effect of the tradable sector on the nontradable sector all other replications required additional assumptions from me. This is sometimes reflected in a replication result that differs somewhat from Moretti's own report. All replication results are labelled "Replication".

Section 5.2 is the main part of this paper. Here I show the results of my improved estimation technique and compare them to Moretti's estimates. My results follow from the method described in Section 3.1 and are labelled "Van Dijk".

In Section 5.3 I apply the method used in Moretti and Thulin (2013) to the data used in Moretti (2010). This yields some unlikely results, labelled as "Linear".

I extend my analysis to income effects in Section 5.4, where I try to find support for the framework used and consider the welfare effect of an expanding tradable sector. Finally I discuss the effect of the unemployment rate on the size of the local multiplier in a preview of future research in Section 5.5.

5.1 Replication

I was able to exactly reproduce Moretti's estimate that for each additional job in the tradable sector in a metropolitan statistical area, 1.59 jobs are created in the nontradable sector in the same area. I would like to thank Moretti for providing me with the Stata file he used for his analysis. Using this file I was able to reverse engineer the assumption he made, to come to this exact replication as shown in Table 6.

5.1.1 Discrepancies between the method used and the paper

I did discover three discrepancies between the method Moretti describes in his paper and the method he actually used.[3] First, he states "*the sample includes two observations per city, corresponding to the periods 1980–1990 and 1990–2000*", but he also includes cities observed in just one interval. Second, he states "$\Delta N_{c,t}^{T}$ *is measured using changes in manufacturing employment, while* $\Delta N_{c,t}^{NT}$ *includes all other industries excluding agriculture, mining, government and the military*", whilst he does include agriculture and mining as nontradable industries. Third, he states he uses "*the weighted average of nationwide employment growth by 77 narrowly defined industries within manufacturing*", but in fact he uses 82 industries within manufacturing in the 1980-1990 period and 74 industries within manufacturing in the 1990-2000 period.

[3] In this paper I will refer to Moretti's method as the method he used to come to the multiplier of 1.59 he reports, instead of the method he describes himself in his paper.

5.1.2 Durable and nondurable tradable goods

I do not have the original files for Moretti's other estimates, so I will modify the method used for the first estimate in accordance with the description in his paper. But before I do this, I will note a discrepancy in Moretti's analysis of durable manufacturing goods. The local multiplier expressed in "Additional jobs for each new job" is calculated by multiplying the estimated elasticity between two sectors with the relative size of both sectors as described in Section 3.

Moretti does not report the relative size he uses, but this can be calculated from the reported elasticity and multiplier. His estimate of the effect of employment in durable tradable goods on employment in nontradable goods implies the latter sector is $0.73/0.006 \approx 122$ times larger. This seems excessive. Alternatively the relative size used can be derived from the standard error reported for both the elasticity and the multiplier, which should have the same ratio. But in this case the standard errors imply the nontradable sector is $1.73/0.138 \approx 13$ times larger than the durable manufacturing sector. An estimate that seems more reasonable. If I apply this ratio to the estimated multiplier I find an elasticity of 0.058, so it seems reasonable the reported estimate of 0.006 is a decimal error.

When I replicate his analysis using the IPUMS definition of durable and nondurable goods I find similar OLS estimates and a nontradable sector that is about 13 times larger as the durable tradable sector. This seems consistent with my prediction, but I find an estimated multiplier between durable manufacturing and nontradables of 0.03. This is only half of the value I supposed Moretti meant, so there is still a discrepancy I cannot explain. Therefore I leave the distinction between durable and nondurable manufacturing at this, but the estimated values can be found in Table 2.

5.1.3 Local multiplier of tradables on other tradables

Moretti estimates the effect of tradables on other tradables by randomly splitting the 82 tradable sub-sectors in two parts and finds a multiplier of 0.26. From this he concluded the multiplier between tradables is smaller, consistent with his framework. He does not report which groups he used, but it seems like he only used one specific set. I was not able to reproduce this set, so instead I randomly divided the tradable sub-sector into two groups of 41 sub-sectors. I did this ten times and calculated the multiplier for each division. As shown in Table 3 I find an average multiplier of 0.85, which is a more robust predictor of the effect within the tradable sector. It is larger than the value found by Moretti, but still smaller than the multiplier of the tradable sector on the nontradable sector and therefore consistent with the framework used by both Moretti and me.

5.1.4 Skilled and unskilled jobs

Moretti differentiates between skilled jobs, those fulfilled by workers with at least some college education, and unskilled jobs, fulfilled by those with a high school

Tab. 2: Local Multiplier effect of durable and nondurable tradables on nontradables

	Moretti[a]	Replication	Van Dijk
Effect of tradable durable on nontradable			
Elasticity OLS	0.283	0.283***	0.283***
	(0.039)	(0.039)	(0.034)
Elasticity IV	0.006	0.027	0.048
	(0.138)	(0.122)	(0.225)
Additional jobs for each new job	0.73	0.342	0.509
	(1.73)	(1.535)	(2.385)
Effect of tradable nondurable on nontradable			
Elasticity OLS	0.290	0.291***	0.279***
	(0.024)	(0.024)	(0.026)
Elasticity IV	0.250	0.281***	0.195**
	(0.072)	(0.060)	(0.079)
Additional jobs for each new job	1.89	2.134***	1.263**
	(0.54)	(0.453)	(0.511)
Observations		464	464
Adj. R-squared		0.590	0.489
First-stage statistic[b]		14.67	7.52

Note: Robust standard errors clustered by msa reported in parentheses.
[a] The significance level, number of observations, R-squared and F-statistic were not reported by Moretti.
[b] I report the Cragg-Donald Wald F statistic because the Kleibergen-Paap rk Wald F statistic is zero.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Tab. 3: Local Multiplier effect of tradables on other tradables

	Moretti[a]	Replication[b]	Van Dijk[b]
Elasticity OLS	0.546	0.756	0.801
	(0.069)	(0.022)	(0.013)
Elasticity IV	0.176	0.704	0.730
	(0.156)	(0.033)	(0.039)
Additional jobs for each new job	0.26	0.813	0.855
	(0.23)	0.039	(0.046)
Observations		464	464
Adj. R-squared		0.588	0.657
First-stage statistic[c]		62.12	29.44

Note: Robust standard errors clustered by msa reported in parentheses.
[a] The significance level, number of observations, R-squared and F-statistic were not reported by Moretti.
[b] Based on the average of ten random divisions of the tradable sector
[c] The Kleibergen-Paap rk Wald F statistic
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

diploma or less.[4] I applied this definition to the census measure of educational attainment, including everyone up to "Regular high school diploma" as unskilled and everyone starting from "Some college, but less than 1 year" as skilled.[5] I was able to accurately reproduce all estimated elasticities, except for the elasticity between new jobs for skilled workers in the tradable sector and unskilled workers in the nontradable sector, as can be seen in Table 7. I do not know what Moretti did, to get such a different result for this estimate.

Since Moretti does not report the relative size between sectors he uses to convert his estimated elasticities to multipliers I calculated the relative size implied by his estimates and their standard errors and reported them in Table 4. When the relative size between parts of the tradable sector and the nontradable sector are known and these part adds up to the entire tradable sector I use this information to calculate another estimate of the relative size between the tradable and the nontradable sector. If everything goes well these estimates should all be very similar. From this table it becomes apparent there is something inconsistent about the relative sizes used when splitting the nontradable sector into a skilled and an unskilled part.

The elasticity between "All nontradable and Tradable skilled", "Nontradable skilled and Tradable skilled" and "Nontradable unskilled and Tradable

[4] The median level of education for the sample lies one level higher at "1 year of college", therefore it could make sense to split between skilled and unskilled here, resulting into two groups of more equal size.
[5] This leaves out "GED or alternative credential", but no one employed in a MSA was included in this category.

skilled" are all multiplied with the relative size between "Nontradable and Tradable skilled" to determine the employment multiplier size. Since "Nontradable skilled" and "Nontradable unskilled" are both by design about half the size of the entire nontradable sector, this leads to a doubling of the estimated multiplier. This has been corrected in my replication and causes a large downwards correction in the estimated size of the multiplier.

Tab. 4: Estimated relative size between sectors

	Moretti	Replication	Van Dijk
Nontradable to Tradable	4.74	4.74	4.02
Nontradable to tradable (durable + nondurable)	4.70	4.74	4.02
Nontradable to tradable (skilled + unskilled)	4.71	4.74	4.02
Nontradable (skilled + unskilled) to tradable (skilled + unskilled)	9.41	4.74	4.02
Nontradable to tradable skilled	9.81	9.79	9.81
Nontradable (skilled + unskilled) to tradable skilled	19.58	9.79	9.81
Nontradable to tradable unskilled	9.06	9.18	6.80
Nontradable (skilled + unskilled) to tradable unskilled	18.13	9.18	6.80
Nontradable to tradable durable	12.54 [a]	12.60	10.59
Nontradable to tradable nondurable	7.53	7.60	6.47
Nontradable skilled to tradable skilled	9.77	5.66	5.26
Nontradable unskilled to tradable skilled	9.82	4.13	4.55
Nontradable skilled to tradable unskilled	9.05	5.30	3.65
Nontradable unskilled to tradable unskilled	9.08	3.87	3.16

[a] Only based on the relative standard errors, because of the perceived error in the estimated elasticity.

5.2 Improved estimation

After reverse engineering Moretti's assumption I found several ways to make his estimation of the local multiplier more accurate and more robust. As explained in Section 3.2 I made five improvements to Moretti's method:

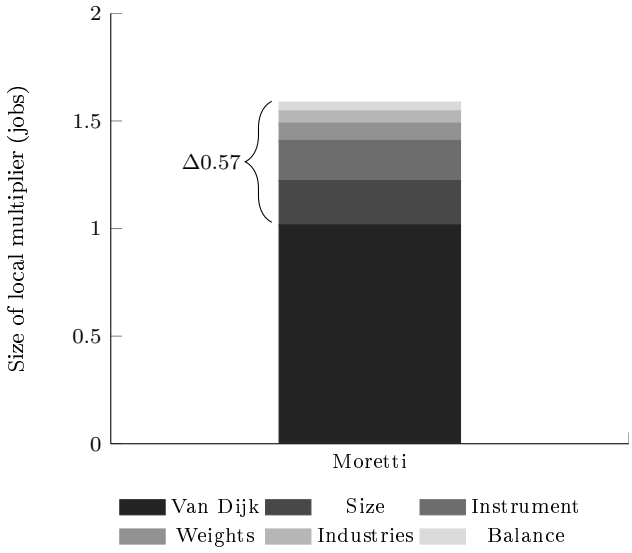
- I remove industries from the analysis that are not observed in every period (balance);
- I do not treat mining and agriculture as nontradable industries (industries);
- I use a more exogenous shift-share instrument (instrument);
- I weigh both time intervals in the dataset equally (weights);
- I provide a more accurate estimate for the relative size of the nontradable sector to the tradable sector (size).

The modified estimation of the local multiplier is 1.02. The average effect of each individual modification is given in Table 5. Coincidentally the average effect for all five changes adds up to the total difference between Moretti's and my estimate of the local multiplier (0.57). Therefore I can easily demonstrate

Tab. 5: Effect of proposed changes on the estimated size of the local multiplier

	Effect on multiplier estimated by Moretti
Exogenous shift-share instrument	-0.19
Correct relative sector size	-0.21
Weigh time intervals equally	-0.08
Remove unbalanced industries	-0.04
Exclude mining and agriculture	-0.06
Total	-0.57

Fig. 1: Effect of proposed changes on size local multiplier



Tab. 6: Local Multiplier effect of tradables on nontradables

	Moretti[a]	Replication	Van Dijk	Linear
Elasticity OLS	0.544	0.554***	0.536***	-0.879
	(0.036)	(0.036)	(0.028)	(0.975)
Elasticity IV	0.335	0.336***	0.253***	-2.768***
	(0.055)	(0.056)	(0.082)	(0.677)
Additional jobs for each	1.59	1.591***	1.017***	-2.768***
new job	(0.26)	(0.263)	(0.328)	(0.677)
Observations		464	464	464
Adj. R-squared		0.611	0.490	-0.139
First-stage statistic[c]		68.56	24.14	25.77

Note: Robust standard errors clustered by msa reported in parentheses.
[a] The significance level, number of observations, R-squared and F-statistic were not reported by Moretti.
[b] The linear estimate is not an elasticity, but a direct estimate of the multiplier size.
[c] The Kleibergen-Paap rk Wald F statistic
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

the impact of each change graphically as shown in Figure 1 on the preceding page.

The weighted LS panel estimation of the elasticity between $\Delta N_{c,t}^{NT}$ and $\Delta N_{c,t}^{T}$ is $\hat{\beta}_{LS} = 0.54$. This strong relationship can also be seen in Figure 2a on page 20. $\hat{\beta}_{LS}$ is an overestimation of the true elasticity β as it includes effects due to the endogeneity of $\Delta N_{c,t}^{T}$ and effects due to omitted variables. A weighted 2SLS panel estimation corrects for these effects. The instrument $\Delta \tilde{N}_{c,t}^{T}$ is strong and there is a clear correlation with the independent variable as shown in Figure 2c. The exogenous independent variable $\Delta \hat{N}_{c,t}^{T}$ is predicted with $\Delta \tilde{N}_{c,t}^{T}$ and $\Delta N_{c,t}^{T}$. A scatter plot of these predicted values against $\Delta N_{c,t}^{NT}$ is shown in Figure 2e. The weighted 2SLS estimate of the elasticity between $\Delta N_{c,t}^{NT}$ and $\Delta N_{c,t}^{T}$ is $\hat{\beta}_{2SLS} = 0.25$. The nontradable sector is 4.02 times larger than the tradable sector. Multiplying the relative size with the elasticity results into the estimated local long-term employment multiplier of 1.02 extra jobs in the nontradable sector for each job created in the tradable sector in the same city. See Table 6 for an overview of these results and a comparison with the other methods used. In Section 3.2 I showed that the five changes I made are improvements and that therefore Moretti's estimate is an overestimation.

A problem that remains in my analysis is that the tradable sector consists only of manufacturing and all services are included as nontradable. So when a tradable industry, that also includes services, booms, the increase in employment in this service sector would be incorrectly attributed to a local multiplier effect. Jensen et al. (2005) used geographical clustering to determine which industries

Tab. 7: Estimated Local Multiplier by Skill Level

	Dependent Variable								
	All nontradable			Nontradable skilled			Nontradable unskilled		
	Morr.	Repli.	v.Dijk	Morr.	Repli.	v.Dijk	Morr.	Repli.	v.Dijk
Independent variable – Tradable skilled									
OLS	0.287	0.307***	0.291***	0.420	0.434***	0.412***	0.109	0.139***	0.133***
	(0.037)	(0.035)	(0.038)	(0.044)	(0.046)	(0.050)	(0.039)	(0.036)	(0.037)
IV	0.257	0.255	0.191	0.208	0.199	-0.075	0.030	0.096	0.159
	(0.157)	(0.168)	(0.079)	(0.176)	(0.192)	(0.311)	(0.172)	(0.190)	(0.380)
Add. jobs	2.52	2.499	1.871	2.03	1.128	-0.395	0.296	0.395	0.723
	(1.54)	(1.647)	(2.910)	(1.72)	(1.087)	(1.636)	(1.68)	(0.783)	(1.730)
Independent variable – Tradable unskilled									
OLS	0.292	0.276***	0.276***	0.125	0.102**	0.109**	0.510	0.497***	0.474***
	(0.033)	(0.035)	(0.031)	(0.042)	(0.438)	(0.043)	(0.037)	(0.042)	(0.036)
IV	0.115	0.119	0.079	-0.010	-0.012	0.097	0.367	0.340***	0.222
	(0.109)	(0.117)	(0.217)	(0.133)	(0.192)	(0.244)	(0.117)	(0.115)	(0.258)
Add. jobs	1.04	1.099	0.539	-0.09	-0.063	0.360	3.34	1.318***	0.702
	(0.99)	(1.073)	(1.479)	(1.21)	(0.801)	(0.890)	(1.06)	(0.445)	(0.813)
Obs.		464	464		464	464		464	464
Adj. R^2		0.633	0.500		0.588	0.288		0.642	0.596
F[b]		19.36	7.65		19.85	7.525		18.79	6.68

Note: Robust standard errors clustered by msa reported in parentheses.
[a] The significance level, number of observations, R-squared and F-statistic were not reported by Moretti.
[b] I report the Cragg-Donald Wald F statistic because the Kleibergen-Paap rk Wald F statistic is zero.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

are domestically tradable. This could be applied to determine which services are tradable and what manufacturing is nontradable and refine my analysis. In fact Faggio and Overman (2014) apply this method in their analysis of tradables and nontradables in the U.K.

5.2.1 Skilled and unskilled jobs

I have also applied my improved method to the analysis of the difference in multiplier between skilled and unskilled jobs. As shown in Table 7 the estimated size of the effect of tradable jobs, both skilled and unskilled, on nontradable jobs is greatly reduced by this improved analysis. Any possible significance disappears. The difference between the multiplier effect of skilled and unskilled tradable jobs Moretti suggests could still exist, but it is not supported by the U.S. census data.

I will not discuss the effect on the estimates when the nontradable sector is split between skilled and unskilled jobs, because the size of these multipliers dependent on a gross overestimation of the size of the nontradable sector. For those interested I did include these and all other improved estimates in Tables 2, 3, 6 and 7.

5.3 Alternative analysis

Finally I test the robustness of the results above by estimating the local employment multiplier again, this time using the direct difference regression method as described in Section 3.3 and used in Moretti and Thulin (2013).[6] This method is more straight forward and could therefore be considered more reliable. When the estimated multiplier is robust, both estimations should yield similar results. But in fact it results into a very large negative multiplier of -2.77.[7] This could indicate the estimated multiplier is strongly dependent on the method of estimation.

It is unlikely that this estimated multiplier of -2.77 is correct as it implies that every new job in the tradable sector crowds out almost three jobs in the nontradable sector. It is important to realise that, if jobs in the tradable sector were competing directly with jobs in the nontradable sector, this would imply a negative local multiplier. But even if the labour supply was fixed a new job in the tradable sector would only make one less worker available for the nontradable sector, implying a lower bound to the local multiplier of -1.

A possible explanation for this result is the effect of outliers. This can be seen in all stages of the analysis as shown in Figure 2b, Figure 2d and Figure 2f. As a comparison these outliers don't have this effect when using log differences as shown in the scatter plots of Figure 2a, 2c and 2e. This could explain why Moretti used log differences for the U.S., but it is unclear whether this problem is unique to the U.S. data. Using the log difference analysis on the Swedish data used in Moretti and Thulin (2013) would be an interesting comparison.

5.4 Income effects

In the framework in section 2 I assumed that local labour supply is not perfectly elastic, so there should also be an effect of employment in the tradable sector on wages in the nontradable sector. To test this I determined the median wage in the nontradable sector in every period in every msa from the U.S. census data. Column "Wage" in Table 8 reports the result of regressing the log change of the median wage in the nontradable sector on the log change in employment in the tradable sector. I find that when employment in the tradable sector in a city increases by 10%, the median wage in the nontradable sector increases by around 4%. This confirms the prediction made based on the framework.

I have shown attracting jobs in the tradable sector increases employment and wages in the nontradable sector. This suggests that attracting tradable jobs is unambiguously beneficial for everyone involved in the city. But when I correct the median wage for the House Price Index[8] of every msa, I can estimate the effect on the real wage. Column "Real wage" in Table 8 shows there is no significant effect of employment in the tradable sector on the real wage in the

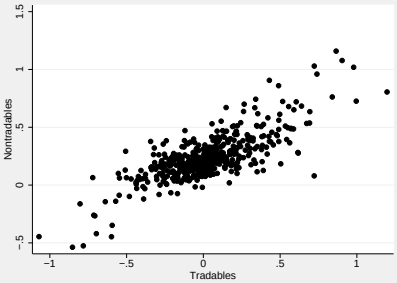
[6] Moretti and Thulin include the U.S. results in their paper on Sweden, but they do not redo the analysis of the U.S. with the method they used for Sweden.

[7] I exclude agriculture and mining, but this has only a minor effect.

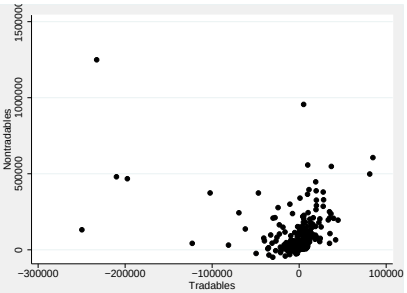
[8] The HPI is a broad measure of the movement of single-family house prices provided by the Federal Housing Finance Agency.

Fig. 2: Scatter plots of the multiplier estimation

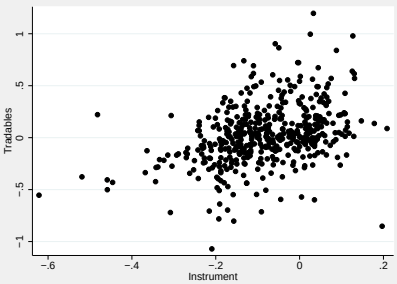
(a) $\Delta N_{c,t}^{T}$ and $\Delta N_{c,t}^{NT}$



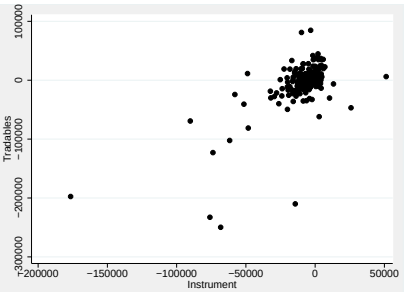
(b) $\blacktriangle N_{c,t}^{T}$ and $\blacktriangle N_{c,t}^{NT}$



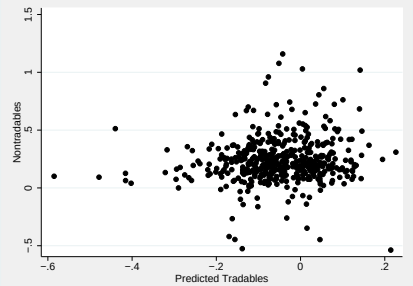
(c) $\Delta \tilde{N}_{c,t}^{T}$ and $\Delta N_{c,t}^{T}$



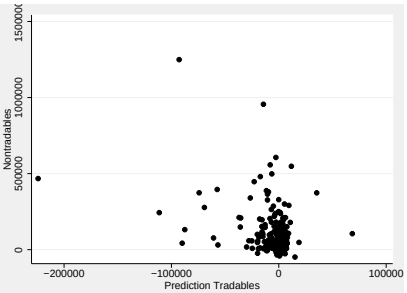
(d) $\blacktriangle \tilde{N}_{c,t}^{T}$ and $\blacktriangle N_{c,t}^{T}$



(e) $\Delta \hat{N}_{c,t}^{T}$ and $\Delta N_{c,t}^{NT}$



(f) $\blacktriangle \hat{N}_{c,t}^{T}$ and $\blacktriangle N_{c,t}^{NT}$



Tab. 8: Local Multiplier effect of jobs in the tradable sector on the median (real) wage in the nontradable sector

Effect of tradable jobs on	Wage	Real wage
Elasticity OLS	0.069***	-0.006
	(0.023)	(0.045)
Elasticity IV	0.392***	-0.092
	(0.111)	(0.128)
Observations	464	149
Adj. R-squared	0.393	0.210
First-stage statistic[a]	24.14	6.303

Note: Robust standard errors clustered by msa reported in parentheses.
[a] The Kleibergen-Paap rk Wald F statistic
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

nontradable sector. In other work, available on request, I show the jobs created in the nontradable sector are fulfilled by persons who migrate from other regions, not by the incumbent population. Combining these two findings suggests incumbent workers in the nontradable sector do not experience a positive effect on their real wage and incumbent unemployed do not find a job in the nontradable sector. Therefore the implications for the welfare of the incumbent population of a city, due to the effect of the tradable sector on the nontradable sector, are ambiguous at best.

5.5 Unemployment

In future work, available on request, I analyse the effect of the unemployment rate on the size of the local multiplier and the impact of the local multiplier on migration. Cities with a high unemployment rate are likely to have a big local employment multiplier. This is very useful as regions with a high unemployment rate tend to experience less growth. This could be an argument for the government to attract tradable jobs to low growth regions. These regions need an employment increase the most and would experience the largest local multiplier. On the other hand even if competing for a tradable firm is beneficial for a city, this might not be beneficial for the country as a whole.

6 Discussion and Conclusion

The Swedish government has cited the study by Moretti and Thulin (2013) in their local employment policy and Moretti uses his estimated multiplier of 1.59 repeatedly in his book "The New Geography of Jobs" to argue the importance

of the tradable sector. My analysis shows this is an overestimation due to an endogenous instrument and four perfunctory assumptions. I estimated that for each job in manufacturing a U.S. city attracts, 1.02 jobs are created in the nontradable sector in the same city. Policy based on Moretti's estimates should be reconsidered in light of these new estimates.

When I apply the linear method used in Moretti and Thulin (2013) to the U.S. census data used in Moretti (2010) I find a local employment multiplier of -2.77. This could indicate a lack of robustness of the original estimate or outliers having a greater effect in the latter estimation.

Moretti suggests skilled tradable jobs have a greater multiplier effect than unskilled tradable jobs, but the statistical evidence for this disappears when an exogenous instrument is used. Some of Moretti's estimates were already inflated by multiplying the estimated elasticity with the incorrect relative size of industries. Still this paper supports that the tradable sector is the backbone of a regional economy.

Policy-makers should also be aware of the migration and welfare effect that follows from the local multiplier effect. The extra jobs created in the nontradable sector by the local multiplier effect will not directly benefit their own constituents. The new jobs in the nontradable sector are not fulfilled by unemployed that were already living in the same city, but by outsiders, and the effect on the real wage in the nontradable sector is ambiguous. Therefore it remains to be seen if policy to attract tradable firms to boost local employment is welfare improving.

Acknowledgement

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