Local multipliers in tradables and non-tradables



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Abstract

In this thesis, I study the local employment multiplier effect; the effect of employment in the tradable sector on employment in the non-tradable sector of the same region. Using a reduced form regression with a shift-share instrument I find a significant local multiplier effect in Metropolitan Statistical Areas in the USA. I show that this result is robust to many different regional definitions, controls and ways of classifying tradable industries. I find larger multipliers for high-wage or high-skilled workers in the tradable sector and I find that most of the jobs created in the non-tradable sector are fulfilled by high-skilled workers who already reside in the region. A replication of the most influential paper in this literature, by Moretti (AER; 2010), demonstrates the sensitivity of his results to six idiosyncrasies of his analysis.

To better understand how these local multipliers work, I develop an efficiency wage model with rural-urban migration for the non-tradable sector. In this model, I consider the impact of a shock to employment in the tradable sector in the city and find a positive local employment multiplier effect. The model predicts that attracting tradable jobs to a city has a bigger positive impact on employment in the non-tradable sector in the same city when the unemployment rate is higher. The model also predicts that this increase is driven by a larger multiplier for current inhabitants and that there is no, or even a negative, effect of the unemployment rate on the multiplier for movers. Both these predictions are reflected in the results of my non-parametric analysis of the data. I find similar results for European TL3 regions. Policies that try to increase growth in less favoured regions by stimulating tradable firms to locate in areas with high unemployment, will both reduce disparities between regions *and* efficiently reduce unemployment across the board.

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Introduction

> "The motor of a city-region's economy is the tradable sector; it provides the jobs that come in and anchor labor 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)

Cities are becoming ever more important, both economically and politically. Cities offer great opportunities for innovation and development, but they are also the scene of some of the most striking inequalities between the rich and the poor. Therefore inclusive growth policies are especially important for cities (OECD, 2016a; European Commission, 2016). Cities are also facing demographic challenges. Although most cities are still growing, some very large cities are already decreasing in population and have an aging population (Woetzel et al., 2016). Although the majority of jobs are in service sectors, industry is still very important to cities. Firms that become more productive are more competitive and are therefore likely to hire more workers. Besides job creation within the firm, this can create large regional benefits. These firms create more demand for local goods and services, which leads to additional employment (OECD, 2016b).

This thesis furthers the understanding of the role of cities in economic development. I analyse the impact of local labour demand shocks, mostly in the USA. This analysis relies on the natural breakdown of local employment between jobs that bring income into the city from elsewhere and jobs that rely on local demand. This divi-

sion is commonly used in theories of regional development and is known by many names. For example, in economic base theory sectors focussed on export are named basic, and sectors producing for the local market are named non-basic (Thulin, 2015). This thesis follows Moretti (2012) and uses the tradable and non-tradable sector, respectively.

The local relationship between the tradable and the non-tradable sector is of great academic interest, as it can help us understand regional development. It is also of interest because local shocks to tradable sector employment can have a great impact on the employment in the non-tradable sector and the well-being of those living nearby, as hinted at by the quote of Storper at the start of this introduction. An understanding of how permanent shocks to tradable-sector employment affect employment in the non-tradable sector of the same region, is also very relevant for policy makers. It allows them estimate the second order effects of policies that attract tradable-sector employment to a specific region.

The shocks to employment in the tradable sector in local labour markets are in part determined by the effects of import competition and export demand. For example, one-quarter of the decline in U.S. manufacturing employment is explained by import competition (Autor et al., 2013). When trade barriers are lowered, foreign firms will export more to the local market. Therefore, some local firms will face extra competition, depending on the industry they are in. The lowering of trade barriers will also allow some local firms to start exporting or expand their current export activities. As a result of changes in international trade, some tradable industries will grow and others will shrink. See Bernard et al. (2007) for more information on the reaction of firms to trade liberalisations.

Due to the variation in the specific mix of tradable industries across cities, the impact on each city will differ. If the home market is flooded with, for example, cheap Chinese computer parts, all firms that produce these parts within the home market

will suffer. If a large share of the tradable sector of a city consists of the production of computer parts, this city will be heavily affected by such a shock. On the other hand, a city where the production of computer parts is a relatively small share of the tradable sector will only be affected very little.

The importance of jobs in the tradable sector relative to jobs in the non-tradable sector can be seen in cities such as Detroit, but it is also clearly illustrated following the division of Germany after the Second World War. Cities in West Germany that were close to the new border saw a significant decline in population. This decline is shown to be a result of their loss in market access (Redding and Sturm, 2008).

Trade plays an important role in the labour demand shocks considered. The relationship between labour market friction and international trade has been studied by Fajgelbaum (2013) with data from Argentina. There can be a significant response from the labour market following trade liberalisation (Dix-Carneiro, 2014). The opening of trade increases wage inequality, but the direction of the effect on unemployment is ambiguous (Helpman et al., 2010).

The interdependence between different sectors has been studied extensively using regional input-output modelling and base theory (Mathur and Rosen, 1974; Isserman, 1975). The idea of moving industry jobs to stimulate the local economy has existed at least since the 1930s (Daly, 1940), and over time the role of local government in local economic development has grown (Bartik, 2004). There is a major consulting industry with firms that produce off-the-shelf multipliers based on assumed input-output links and other modelling assumptions. These firms tend to predict large multipliers without providing standard errors. Policy makers can use these large multipliers and this false sense of precision as an argument to justify the costs associated with attracting tradable jobs to a particular region, for example by giving a tax break to specific firms (Greenstone and Moretti, 2003) or by investing in prestige technology projects. Therefore accurate estimates of the local employment multiplier and a

good understanding of the precision and robustness of these estimates is important.

Traditionally, multiplier effects are determined with input-output models. These models require a lot of data, because they explicitly define the input-output links. Instead, I estimate the effect of changes in employment in the tradable sector of a region on changes in employment in the non-tradable sector of that same region with a reduced form regression using an industry-mix shift-share instrument. This requires far less data and takes general equilibrium effects directly into account. Findings from this method are based on direct aggregate empirical observations of the development of employment in the tradable and non-tradable sector and report standard errors to assess their precision.

Moretti (2010) uses a shift-share approach to estimate exogenous changes in employment in the tradable sector in Metropolitan Statistical Areas (MSAs) in the USA. His paper started a new strain of local multiplier literature and his study has been followed by similar analyses of countries in Europe. These estimates are also influencing policy. For example, Moretti and Thulin (2013) has been cited by the Swedish government. A key policy trend is the shift of focus from maximizing total economic growth to reducing the disparities between different regions by promoting growth in low growth regions. Policies that attract jobs to maximize the local employment multiplier could do so, while also maximizing total growth.

An increase in employment in the tradable sector of a city can affect the non-tradable sector in multiple ways. Firstly, the new or expanded tradable sector firms will increase their demand for locally produced intermediate goods and services, which increases employment in the non-tradable sector. Secondly, the new workers in the tradable sector bring additional income to the city. Part of this income will be spent on local goods, which also creates additional jobs in the non-tradable sector. Thirdly, the wages are likely to increase as well, due to the higher labour demand. This will also increase spending on local goods. Finally, there could be agglomeration

effects. The expansion of an existing firm or the introduction of a new firm in the tradable sector can make other firms, both inside and outside of the tradable sector, more productive. An overview of methods to evaluate the importance of agglomeration is provided by Head and Mayer (2004).

In the literature, the above-mentioned effects are analysed with local employment multipliers. Suppose a permanent shock of 100 jobs to employment in the tradable sector of a city-region creates 110 additional jobs in the non-tradable sector of the same city-region. In the input-output literature and economic base theory, this is commonly refered to as a local employment multiplier of 2.1. In the work of Moretti and related work (which also builds on base theory) this result is called a local employment multiplier of 1.1. Depending on the chapter, both definitions are used in this thesis.

When considering the mechanisms described earlier, it is likely that the type of job in the tradable sector will affect the size of the local employment multiplier. The spending of their income on local goods by the new workers is an important mechanism to increase demand and employment in the non-tradable sector. It seems reasonable that a worker with a higher wage in the tradable sector will spend more on non-tradable goods. High-skilled or high-tech workers are likely to have higher wages, therefore we expect a larger multiplier for these sectors. This has been demonstrated for Sweden by Moretti and Thulin (2013).

The additional jobs created in the non-tradable sector can be fulfilled by different workers. An important distinction is whether these newly created jobs are fulfilled by unemployed workers living in the area, or by workers coming from other regions. New jobs are more likely to go to unemployed current residents, because they are likely to have more information about the local labour market and they face lower thresholds to start working. Another important distinction can be made between skilled and unskilled workers in the non-tradable sector. It is hard to predict which

type of jobs will be created due to a shock in the tradable sector, but it is likely that high-skilled workers are more wanted for all types of jobs.

When I consider where the new non-tradable sector workers come from, rural to urban migration could be an important aspect. This is included in the theoretical model of local employment multipliers, by Harris and Todaro (1970), and predicts the impact of tradable employment on rural to urban migration. The other side of the same coin is the impact of agricultural productivity on industrial development. If agriculture becomes more productive and less labour is needed, workers will move to the city, as for example discussed by Bustos et al. (2013).

The size of the local employment multiplier effect does not need to be the same in each city, because the local economic and labour market conditions differ. This thesis focusses on the effect of the local unemployment rate on the size of the multiplier. A shock to tradable sector employment has a greater impact on employment in the non-tradable sector in cities with high unemployment rate. When the unemployment rate in a city is higher, there are more workers available within the city to fulfil new jobs in the non-tradable sector and the skill set of these available workers is more diverse. When the unemployment rate is low, only few workers are left to respond to new vacancies and these are more likely to be unable or unwilling to fulfil these jobs. This explains why cities with a higher unemployment rate show a larger effect on the number of jobs fulfilled by current inhabitants. The composition of available workers outside of the city does not change due to the local unemployment rate within the city, therefore the multiplier for movers does not increase. The total effect of the unemployment rate, as well as the isolated effect for current inhabitants and the lack of an effect for movers are all shown with a non-parametric analysis of the local employment multiplier. This is closely related to Monte et al. (2015). They use a structural model to analyse the relationship between local employment elasticities and commuting flows.

In summary, the main question of this thesis is: what is the impact of tradable-sector employment on the local economy? This question is answered quantitatively using the local employment multiplier, the ratio of the total number of additional jobs to the number of additional exogenous jobs in the tradable sector. Subsequently, the heterogeneity of the jobs in the tradable sector can be considered. The number of jobs created in the non-tradable sector is likely to depend on the wages and skills of the workers in the new tradable sector jobs. Thirdly, it is possible to consider where the workers in these newly created jobs in the non-tradable sector come from and their skill levels. Finally, the relationship between the tradable and non-tradable sector will differ across cities. The difference in the size of the local employment multiplier depending on the local unemployment rate will be considered.

This thesis proceeds as follows.[1] Chapter 1 provides a background on the estimation of local multipliers and compares two empirical methods for estimating these multipliers. The main specification in this chapter gives an estimate of the local employment multiplier of 2.6.[2]

Chapter 2 is a sensitivity analysis of local employment multiplier estimates. It relies on the same theoretical framework as Chapter 1, but goes beyond trying to find the most accurate multiplier estimate. It assesses how sensitive the multiplier is to different geographical units of analysis, the inclusion of regional fixed effects and different ways of classifying tradable and non-tradable industries. Which industries are considered part of the non-tradable sector and which industries are part of the tradable sector is determined endogenously based on the clustering of each industry across the USA.

Following the main specification, the local multiplier for U.S. MSAs is 2.1. When skilled jobs in the tradable sector are isolated the multiplier is 3.1 and there is no sig-

[1] Chapters 1, 2 and 5 are each written as a self-contained paper, therefore there will be some inevitable overlap between these chapters.

[2] This multiplier is reported as 1.6 in the chapter, because it follows the Moretti (2010) definition of a multiplier: the base multiplier minus one.

nificant multiplier for unskilled tradable sector jobs. The fact that skilled jobs result in larger multipliers tells policy makers they should focus on attracting skilled workers. Finally, this chapter replicates Moretti (2010) and discusses several idiosyncrasies and arithmetical errors in that paper.

Chapter 3 provides a theoretical analysis of local employment multipliers. I build a formal model that fits with the theoretical framework and empirical findings from the first two chapters, but it extends the theory to incorporate unemployment and migration. It develops an efficiency wage model with rural-urban migration for the non-tradable sector. There is unemployment in the city, because workers are incentivised not to shirk by setting the wages too high (Shapiro and Stiglitz, 1984). Workers move to the city from the surrounding hinterlands up to the point where the expected utility in the city is equal to their utility in the rural area (Harris and Todaro, 1970). I then consider the impact of a shock to employment in the tradable sector in the city and find a positive multiplier effect. The size of this multiplier increases with the local unemployment rate. In cities with a higher unemployment rate more jobs are created for current inhabitants of the city as a result of a shock to the tradable sector; the multiplier for workers who move from outside the city decreases, but the former effect dominates. I will test these predictions on unemployment and migration in the next chapter.

Chapter 4 extends the existing multiplier literature by allowing for heterogeneous multipliers. It considers differences in the local employment multiplier both within MSAs and between MSAs. It builds on the empirical method of Chapter 1 with a non-parametric analysis of the relationship between unemployment and the size of the multiplier. The results support the predictions made by the model in Chapter 3. When the unemployment rate lies around 5.2% the MSA is approximately at full employment and the effect of 100 new jobs in the tradable sector is 120 additional jobs in the non-tradable sector. As the unemployment rate increases the number of ad-

ditional jobs in the non-tradable sector increases as well, to 200 at an unemployment rate of 7.7%. Policies that try to increase growth in less favoured regions by stimulating tradable firms to locate in areas with high unemployment, will both reduce disparities between cities *and* efficiently reduce unemployment across the board.

Chapter 5 is an application of the techniques used in the previous chapters to estimate the local employment multiplier for Territorial Level 3 regions in Europe. It shows an average local employment multiplier of 2.1 across Europe.[3] This local employment multiplier is largest in the North, West and South of continental Europe and significantly smaller in Eastern Europe. There is no significant multiplier in the United Kingdom and Ireland. It shows that there is also a positive effect of the unemployment rate on the size of the multiplier in Europe.

My key finding is a significant local employment multiplier between 2.1 and 2.6 for U.S. MSAs. In line with my theoretical expectations the size of the multiplier is larger in MSAs with a higher unemployment rate. The multiplier effect of skilled tradable-sector jobs is larger than the multiplier effect of unskilled tradable-sector jobs. Most of the jobs created in the non-tradable sector, due to the local multiplier effect, are fulfilled by currently unemployed inhabitants, not workers who move from outside the MSA. For European TL3 regions there is also a significant multiplier that increases with the unemployment rate. These findings suggest a clear policy advice. Local policy makers should attract high skilled tradable jobs to MSA with a high unemployment rate. This will maximize the multiplier effect and reduce disparities between MSAs.

Besides these findings and policy recommendations, this thesis contributes to the literature by improving on the estimation techniques used to determine local multiplier. It demonstrates the robustness, but also the sensitivities of this kind of analysis. And finally, it adds to the understanding of the local employment multiplier

[3]This multiplier is reported as 1.1 in the chapter, because it follows the Moretti (2010) definition of a multiplier: the base multiplier minus one.

with a simple model.

Chapter 1

Local employment multipliers in U.S. cities

1.1 Introduction

This chapter sets out to provide a more accurate estimate of the size of the local employment multiplier effect for metropolitan statistical areas (MSAs) in the USA. The local employment multiplier is the number of additional jobs created in the non-tradable sector of a city for each new worker in the tradable sector of that city. The non-tradable sector consists of those industries that mainly sell goods or services within the city in which they are produced, and the tradable sector consists of all industries that provide goods or services that are sold outside the city including those sold internationally. For example, the car industry or the financial sector would be part of the tradable sector and the retail industry would be part of the non-tradable sector.

This regional interdependency has been studied extensively using regional input-output modelling and base theory (Mathur and Rosen, 1974; Isserman, 1975). Moretti (2010) started a new strain of local multiplier literature when he estimated the local

multiplier effect in the USA using a Bartik (1991) shift-share instrument. This study has been followed by similar analyses of Italy (de Blasio and Menon, 2011; Auricchio, 2015), Sweden (Moretti and Thulin, 2013), the United Kingdom (Faggio and Overman, 2014) and Spain (Gerolimetto and Magrini, 2014; Bashford Fernández, 2014). These estimates of local multipliers give insight into the possible impact of regional policy and already influence politicians. For example Moretti and Thulin (2013) has been cited by the Swedish government.

Moretti (2010) is a seminal paper that introduces an innovative and useful way to estimate the local employment multiplier. The chapter presents an estimated local multiplier in the USA of 1.59. Even though Moretti (2010) started a prolific branch of the literature, I could not find any other papers that provide an improved estimate for the USA. Therefore, this is what I aim to achieve in this chapter using insights from Moretti (2010), Moretti and Thulin (2013) and Faggio and Overman (2014). I will estimate the local employment multiplier for MSAs in the USA using two different methods, both of which incorporate an exogenous instrument and allow for tradable services.

The first method is an improvement on Moretti (2010) and the second is based upon Faggio and Overman (2014). Without any additional controls I find a multiplier of 0.95 and 1.06 respectively. When I include controls for city size, education and unemployment the estimated size of the multiplier increases to 1.69 and 1.58. Since these estimates are so close to each other, a local employment multiplier of around 1.6 appears to be a robust result. This is coincidentally a result close to the original Moretti (2010) estimate, which did not include any controls, tradable services or the instrument that is more plausibly exogenous. I find a larger multiplier of about 2.2 for jobs in the tradable sector that pay above the national median wage, but I do not find a significant multiplier for those jobs that pay below the median wage.

In the next section, I will give a short literature review and explain the conceptual

framework that is used in the Moretti (2010) strand of literature. The third and fourth section describe the data used in my analysis of the USA and the empirical methods respectively. I present my results in the fifth section before discussing them and drawing some conclusions in sixth section.

1.2 Literature review

When a new job is created in the tradable sector of a city, additional jobs may be created in the non-tradable sector of the same city. This is the local multiplier effect. I consider all firms that produce goods or services that are consumed outside the metropolitan area in which they are created as part of the tradable sector. Most of these firms are in the manufacturing sector, but some produce tradable services. I consider firms that produce goods or services that are consumed within the metropolitan area in which they are produced part of the non-tradable sector. This sector consists of firms active in construction, transportation, retail trade and most services. Some industries fall between the tradable and non-tradable sectors, such as wholesale trade and some other services. It depends on your definition of *local* as to whether jobs in these industries are tradable or non-tradable. In this chapter I will consider for both alternatives.

1.2.1 Economic base theory

The local multiplier is associated with the economic base model. Thulin (2015) gives an excellent overview of the development of this model during the twentieth century and includes many current applications. The base model is built on the fact that production can be sold locally or exported. All economic activity (T) in a local economy consists of two mutually exclusive sectors: goods and services that are primarily exported are labelled basic (B); and goods and services that are produced

for local consumption are non-basic (NB).

$$T = B + NB \tag{1.1}$$

The base multiplier (M) tells us the effect of a change in the base economy (ΔB) on total economic output.

$$\Delta T = M\Delta B \tag{1.2}$$

The economic base analysis is sensitive to the choice of geographical unit. A firm that exports from the perspective of the city in which it is located, might produce mainly for local consumption from the perspective of the surrounding state. Larger geographical areas are more self-sustainable and therefore less dependent on export to other regions; they will have a relatively smaller base and a larger multiplier.

A crucial question in economic base theory is how to split economic activity between basic and non-basic. This chapter is based on the assumption method. All economic activity is divided into a number of industries and each industry is classified as tradable or non dable; the common terms for the basic and non-basic sector respectively in this literature. In the assumption method this classification is based on the current literature and the researcher's own judgement. This method is used in, for example, Moretti (2010) and Moretti and Thulin (2013). In both papers all services are classified as non-tradable. This is inappropriate when considering, for example, the financial sector in New York. To account for this Faggio and Overman (2014) use a Gini index, developed by Jensen and Kletzer (2006), to determine which services are tradable. This Gini index provides an objective measure, based on the geographical concentration of each service. Services that are more concentrated are assumed to be more tradable. I will follow the method from Faggio and Overman (2014) in my classification of the tradable sector. Thus I use the assumption method, but this chapter *will* differentiate between tradable and non-tradable services.

There are three other methods to make this division, but since they are not applied in this chapter I will mention them only briefly. Thulin (2015) provides a good overview and critique of these methods. The first alternative is the survey method, wherein data on the basic and non-basic sector are collected directly using surveys and interviews, but this is not practical for large scale analysis. The second alternative is based on location quotients. The location quotient is "a measure of the concentration of any particular industry in any given area by comparing the proportion of all occupied persons that were occupied in that industry in the given area with the corresponding proportion for the country as a whole" (Florence, 1937, p. 622). The third is the minimum requirements method developed by Ullman and Dacey (1960). It compares the local employment structure of a region with similar sized regions. For each industry, the minimal output across all these regions is considered the minimum requirement. This is the amount of production needed for the local population. If other regions of a similar size produce more, this part of the product must be for export, according to this method.

1.2.2 Conceptual framework

I use the conceptual framework as described in Moretti (2010, 2011) and Moretti and Thulin (2013). Each metropolitan area is a competitive economy that uses labour to produce different tradable and non-tradable goods and services. The price of tradable goods and services is determined on the national or international market and is considered fixed from the perspective of a city. For the non-tradable goods, the price is determined locally. I assume labour is perfectly mobile across sectors within a city; and worker's utility depends on the net local wage and idiosyncratic preferences for location. Therefore the local labour supply curve is upward sloping. I make the assumption that the local housing supply curve is also upward sloping.

When a city attracts a new firm or the labour productivity of an existing firm

increases we can see a permanent increase in the local labour demand in a tradable industry. This has an obvious direct effect on the local economy: employment in the tradable sector increases. However, more interestingly, it also has an indirect effect on the rest of the tradable sector and the non-tradable sector. This includes general equilibrium effects on local prices: the wages of all workers will go up as well as the cost of housing.

The focus of this chapter lies on the positive effect on the local non-tradable sector. As a result of additional employment in a tradable industry the aggregate income of a city will increase. The aggregate income will increase more if the additional jobs in the tradable sector require high-skilled workers, as these workers command higher wages. Part of this extra income will be spent on non-tradable goods, and the size of this share depends on the consumer preferences for non-tradable goods. This increased demand in non-tradable goods will increase the demand for labour in the non-tradable sector, where the magnitude of the labour demand increase depends on the technology of the non-tradable goods. These new jobs in the non-tradable sector will be fulfilled by existing residents and new residents, depending on geographical mobility.

This positive effect of a permanent increase in labour demand in the tradable sector on employment in the non-tradable sector will be offset in *part* by general equilibrium effects on wages and prices. If the local housing market is constrained, the cost of living will increase more when an industry in the tradable sector grows. In addition when labour mobility is higher, the wage increase as a result of the higher labour demand will be smaller, meaning we will see a larger local employment multiplier. Due to the nature of non-tradable goods they can only be produced locally, and the local labour supply curve is upward sloping, meaning the increase in aggregate income will always lead to at least a weak increase in employment in the non-tradable sector.

The size of the local employment multiplier is larger when labour supply between cities is more elastic. In the the extreme where labour supply is perfectly inelastic, there could still be a local employment multiplier, but only current residents will respond. The situation is similar for local housing supply. If the housing supply is very elastic it is inexpense for workers to move from outside the city in response a labour demand shock. In the extreme case where housing supply is perfectly inelastic it would still be possible to attract workers from outside the city, but they would always have to displace local workers.

In this chapter I define the local employment multiplier as the number of additional jobs created in the non-tradable sector, resulting from one new job in the tradable sector of the same city. This is common in the Moretti (2010) family of multiplier papers and equal to the base multiplier minus one $(M-1)$.

1.3 Data

I estimate the local employment multiplier in U.S. Metropolitan Areas based on U.S. Census data. I retrieved these data from the Integrated Public Use Microdata Series (IPUMS) provided by Ruggles et al. (2015). Moretti (2010) also used this dataset to estimate the local employment multiplier.

The 1980 Census sample consists of a flat 1-in-20 national random sample of the population. The 1990 and 2000 Census samples are also 1-in-20 national random samples of the population, but less densely populated areas are oversampled. It is possible to correct for this by using the included weights when aggregating the census data from individuals to MSAs, which allows me to recreate a flat sample. This does come at the cost of reduced precision.

I am interested in the change of employment over time. To analyse this I need data on a city in at least two consecutive periods. This leaves 220 cities observed at

the start and end of both intervals, 6 cities that are only observed between 1980 and 1990; and 18 cities that are only observed between 1990 and 2000. On average this covers 92% of the metropolitan population.

It is important to note that the population of many MSAs are only partially identified in the Census data, and in many cases the unidentified portion is of considerable size. The reason for incomplete coverage is that the source data for these samples includes no specific information about metro areas. The most detailed geographic information available is based on county groups in 1980 and PUMAs[1] in 1990 and 2000, areas that occasionally straddle official metro area boundaries. If any portion of a straddling area's population resided outside a single metro area, IPUMS uses a conservative assignment strategy and identifies no metro area for all residents of the straddling area.

The Census provides detailed information about the industry that employs each worker, but the industry codes change with each Census. Fortunately IPUMS provides a mapping of the 1980 and 2000 Census industry data to the three-digit industries codes of 1990, allowing for comparison across time. Nonetheless, some of the 1990 industry codes do not fully match the rest of the data and are therefore left with no workers in 1980 or 2000. Since my analysis is based on growth rates, observations of zero workers could lead to estimation problems. To prevent this, I do not consider any of the industries that have no employment in one of the three periods. Luckily, this leaves approximately 99% of the workers.

Initially, I divide all industries into three categories: the tradable sector; the medium-tradable sector; and the non-tradable sector. I consider all manufacturing industries as tradable and all wholesale trade industries as medium tradable. I categorise industries in construction, transportation and retail as non-tradable. Finally, I divide all services between the three categories based on work by Jensen and Klet-

[1] Public Use Microdata Areas (PUMAs) are statistical geographic areas defined for the dissemination of Public Use Microdata Sample (PUMS) data.

zer (2006). They measure the geographical dispersion of all three-digit services in the USA and express this with a Gini coefficient. They split the services into three categories from least to most concentrated and argue that it is easier to concentrate an industry when it is tradable. Using this logic and these categories I consider the most concentrated services as tradable, the middle category as medium tradable and the least concentrated services as non-tradable.

There are clear limitations to the use of a measure of spatial concentration, such as the aforementioned Gini coefficient, as a measure of tradability. For example, mining companies are concentrated because they need to be close to the mines. The concentration of this kind of firm is determined by the availability of natural resources at a specific location, this does not necessarily indicate a tradable good. Another factor could be the strong concentration of demand in a certain sector, this would also cluster firms that do not produce tradable goods. A list of all 77 tradable industries, 37 medium-tradable industries and 80 non-tradable industries is given in Appendix 2.2.

Combining the 1980-1990 and 1990-2000 intervals in the same analysis results in 464 observations. In Appendix 1.A, Table 1.8 shows the distribution of workers across sectors. In 1980, 9% of all tradable jobs were in New York, making this the largest employer of workers in the tradable sector. A very large city could invalidate the instrumental variable analysis I intend to undertake later on, but this should not pose a problem. A more detailed distribution of the MSA size for all workers is shown in Table 1.1.

In Table 1.9 of Appendix 1.A we can find how employment in each sector changed over time. Table 1.10 shows the growth rate rate of each sector and in Table 1.11 we find the contribution of each sector to total employment growth. Because I am interested in the effect of employment in the tradable sector on employment in the non-tradable sector, I will control for other variations between cities, such as total

Table 1.1: *Distribution of MSA sizes in the USA in 1980 and 1990.*

	Total employment (thousands)	
Percentile	1980	1990
Min	40	41
1%	43	47
5%	48	51
10%	51	56
25%	62	67
50%	117	132
75%	284	306
90%	660	802
95%	987	1259
99%	3525	3829
Max	6353	7494

Note: The averages are based on 226 MSAs observed from 1980 till 1990 and 238 MSAs observed from 1990 till 2000.

employment, the level of education and the unemployment rate. These controls are shown in Table 1.12.

1.4 Empirical methods

The effect of labour demand shocks in the tradable sector on employment in the non-tradable sector of the same city can be estimated with the following general regression model

$$\Delta \text{Jobs}^{NT}_{c,t+10} = \alpha + \beta \Delta \text{Jobs}^{T}_{c,t+10} + \gamma X_{c,t} + \delta \text{Time}_t + \varepsilon_{c,t} \tag{1.3}$$

for $c \in C_t$ and $t \in \{1980, 1990\}$. $\Delta \text{Jobs}^{NT}_{c,t+10}$ is a measure of the change in employment in the non-tradable sector in city c between time t and time $t+10$ and $\Delta \text{Jobs}^{T}_{c,t+10}$ is a similar measure for tradable employment. $X_{c,t}$ is a set of city-specific characteristics that affect employment growth in the non-tradable sector, measured in the base year of the interval. Time_t is a dummy variable[2] to control for national

[2] $\text{Time}_{1980} = 0$ for measurements over interval 1980-1990 and $\text{Time}_{1990} = 1$ for 1990-2000.

shocks in employment in the non-tradable sector and $\varepsilon_{c,t}$ is an error term. In this specification the parameter β measures the effect of tradable employment on jobs in the non-tradable sector. Finally C_t is the set of all MSAs observed in both t and $t+10$. The weight of each observation is given by the total number of workers employed in the tradable and non-tradable sector at the start of the interval (time t).

When estimating Eq. (1.3) any co-movement between jobs in the tradable and the non-tradable sector is captured by β. There are three types of co-movement: the effect of tradable jobs on non-tradable jobs, the effect of non-tradable jobs on tradable jobs; and other variables that affect both tradable and non-tradable jobs. The first, the causal effect of extra jobs in the tradable sector on employment in the non-tradable sector, is the effect of interest. The second is not a big issue, the effect of non-tradable employment on tradable jobs will be small as the MSA is small relative to the world and tradable workers don't produce for local consumption. The third type of co-movement is the issue. The estimate of β will be confounded due to endogeneity and omitted variables. For example, effective local government can increase jobs in both sectors. This problem can be addressed by using an exogenous shift-share industry-mix variable as an instrument.

The exact specification of this shift-share instrument, as introduced by Bartik (1991), depends on which measure of change in employment is used. In general, we use 74 three-digit tradable industries (j) to calculate an instrument for the change in tradable employment in city c between time t and time $t+s$ as

$$\sum_{j \in T} E^{j}_{c,t} \left(\frac{\sum_{c' \in C_t \setminus c} E^{j}_{c',t+10}}{\sum_{c' \in C_t \setminus c} E^{j}_{c',t}} - 1 \right) \tag{1.4}$$

In this expression $E^{j}_{c,t}$ is the number of jobs in tradable industry j of city c at time t. It is possible to isolate exogenous shifts in the demand for labour in the tradable sector using this shift-share approach. The shift-share industry mix term can

be calculated for each MSA and year pair. It is the product of MSA employment and the national growth rates for each three-digit tradable industry.

This shift-share analysis decomposes the regional change in employment into the national growth effect, the industry mix effect and the competitive effect. The expression in Eq. (1.4) isolates the first two effects, where $\Delta\text{Jobs}^{T}_{c,t+10}$ includes all three. It is the competitive effect that causes the omitted variable bias; this can be prevented by using Eq. (1.4) as an instrumental variable in Eq. (1.3). This instrument is informative if the difference in national growth between the tradable industries is large enough and the composition of industries varies enough between cities. Under the assumption that there is no correlation between the industry mix effect and the competitive effect, the instrument is also independent. This satisfies the conditions for a valid instrumental variable.

In the remainder of this section I will discuss two different specifications that both belong to the general regression model described above. The first is based on Moretti (2010) and determines the local multiplier through an estimation of the elasticity between the tradable and the non-tradable sector. The second is based on Faggio and Overman (2014) and estimates the multiplier directly. This chapter is the first to apply this valid instrument to the USA and the first to compare multiple models to find a robust estimate of the local multiplier.

1.4.1 Specification 1: tradable and non-tradable sector employment growth

In this first specification, I define the growth rate of employment in the non-tradable sector as the dependent variable

$$\Delta\text{Jobs}^{NT}_{c,t+10} \equiv \frac{E^{NT}_{c,t+10} - E^{NT}_{c,t}}{E^{NT}_{c,t}} \tag{1.5}$$

and the growth rate of employment in the tradable sector as the main regressor

$$\Delta \text{Jobs}^{T}_{c,t+10} \equiv \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{T}_{c,t}}. \tag{1.6}$$

By inserting Eqs. (1.5) and (1.6) into Eq. (1.3) we find Specification 1

$$\frac{E^{NT}_{c,t+10} - E^{NT}_{c,t}}{E^{NT}_{c,t}} = \alpha_1 + \beta_1 \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{T}_{c,t}} + \gamma_1 X_{c,t} + \delta_1 \text{Time}_t + \varepsilon_{c,t} \tag{1.7}$$

for $c \in C_t$ and $t \in \{1980, 1990\}$, which is based on the model used in Moretti (2010). Since both the dependent variable and the main regressor are a growth rate, the parameter β_1 reflects the elasticity between the tradable and the non-tradable sectors. When the tradable sector grows by 1%, the non-tradable sector grows by β_1%. This elasticity can be converted into an estimate of the local employment multiplier by multiplying β_1 by the relative size of the non-tradable sector to the tradable sector

$$\beta_1 \times \frac{\sum_{t \in \{1980,1990\}} \sum_{C_t} E^{NT}_{c,t}}{\sum_{t \in \{1980,1990\}} \sum_{C_t} E^{T}_{c,t}}. \tag{1.8}$$

This does require the assumption that β_1 is constant with respect to the relative size of the non-tradable sector to the tradable sector. In the next section I will show this is not necessary for Specification 2.

Because of the endogeneity problem described earlier, β_1 can only be estimated consistently using a two-stage least squares model. Since our main regressor is the growth rate of the tradable sector we also need to divide the general instrument (1.4) by the size of the tradable sector in the base year. This results in the instrumental variable

$$\text{IV}_1 \quad = \quad \left(E^{T}_{c,t}\right)^{-1} \sum_{j \in T} E^{j}_{c,t} \left(\frac{\sum_{c' \in C_t \setminus c} E^{j}_{c',t+10}}{\sum_{c' \in C_t \setminus c} E^{j}_{c',t}} - 1 \right). \tag{1.9}$$

This instrument is a modification of the instrument used in Moretti (2010). He in-

cludes the own city in the construction of the instrument, which introduces an endogenous element. This is a possible source of concern about the validity of the instrument used in that study.

1.4.2 Specification 2: contribution of the tradable and non-tradable sector to total employment growth

Alternatively, I can define the contribution of employment in the non-tradable sector to total employment growth in the city as the dependent variable

$$\Delta \text{Jobs}^{NT}_{c,t+10} \equiv \frac{E^{NT}_{c,t+10} - E^{NT}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} \tag{1.10}$$

and the contribution of employment in the tradable sector to total employment growth as the main regressor

$$\Delta \text{Jobs}^{T}_{c,t+10} \equiv \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}}. \tag{1.11}$$

By inserting (1.10) and (1.11) into (1.3) we find Specification 2

$$\frac{E^{NT}_{c,t+10} - E^{NT}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} = \alpha_2 + \beta_2 \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} + \gamma_2 X_{c,t} + \delta_2 \text{Time}_t + \varepsilon_{c,t} \tag{1.12}$$

for $c \in C_t$ and $t \in \{1980, 1990\}$, which is based on the model used in Faggio and Overman (2014). They use a similar technique to estimate the effect of employment in the public sector on private sector employment for local areas in the UK. Since the dependent variable and the main regressor are now both divided by the same factor (total employment in the city at the start of the interval), the parameter β_2 reflects the local employment multiplier between the tradable and the non-tradable sectors. When the tradable sector grows by 100 jobs, the non-tradable sector grows by $\beta_2 \times 100$ jobs. This allows us to relax the assumption that the elasticity is constant

with respect to the relative size of the non-tradable sector, which is an advantage over Specification 1.

Since our main regressor is now the contribution of the tradable sector to total employment growth, we need a slightly different instrument. In this case the general instrument (1.4) needs to be divided by the total employment in the base year, just as was done with the main regressor. This results in the instrumental variable

$$\mathrm{IV}_2 \quad = \quad \left(E_{c,t}^{NT} + E_{c,t}^{T}\right)^{-1} \sum_{j \in T} E_{c,t}^{j} \left(\frac{\sum_{c' \in C_t \setminus c} E_{c',t+10}^{j}}{\sum_{c' \in C_t \setminus c} E_{c',t}^{j}} - 1 \right). \tag{1.13}$$

1.5 Results

In this chapter I have divided all industries into three categories: tradable, medium tradable and non-tradable. Since I am interested in the local employment multiplier between the tradable and the non-tradable sectors I can:

- classify medium-tradable goods as non-tradable;
- classify them tradable;
- or not include them in my analysis at all.

I will consider all three cases. I have also discussed two separate methods of analysis in section 1.4, and I will apply both methods to all three cases.

Before I start with this regression analysis, I will explore the relation between the tradable and non-tradable sectors graphically. Figure 1.1 shows a scatter plot, with the change in employment in the tradable sector over ten years on the x-axis, and the change in employment in the medium-tradable and non-tradable sector on the y-axis. Although the positive relation is visible, there are also some clear outliers. To account for this, I need to normalise the change in each sector by some measure of employment in the base year. In Figure 1.2 I do this by dividing the change in each

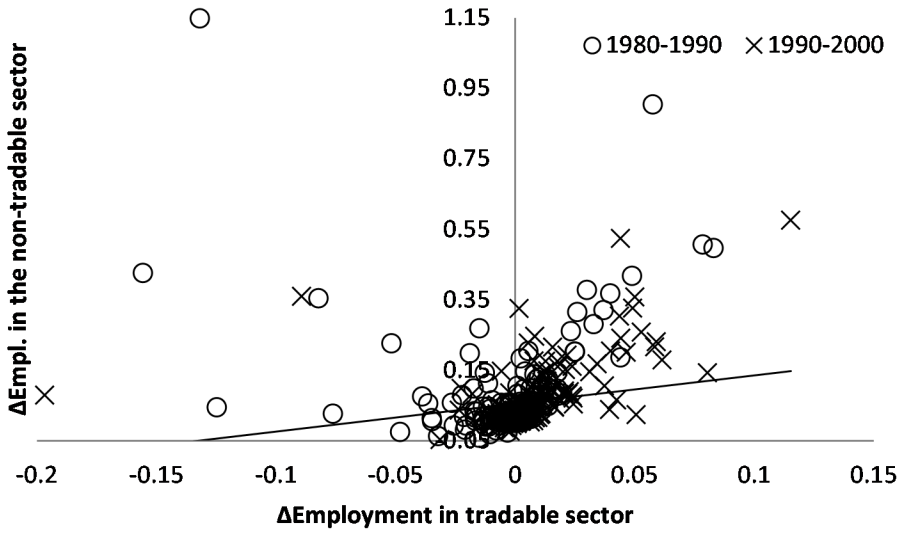


Figure 1.1: *Scatter plot of the changes in employment in the tradable and non-tradable sector (in millions) in U.S. MSAs between 1980 and 2000.*

sector by total employment in the base year. The contribution of the tradable sector to the total change in employment is shown on the x-axis and the contribution of the non-tradable sector is shown on the y-axis.[3] These are the same definitions I use in Eqs. (1.11) and (1.10) respectively.

1.5.1 Regression analysis

The positive relationship between employment in the tradable and non-tradable sectors suggested by Figure 1.2 can be tested with a simple OLS regression. The results of this regression are shown in Table 1.2. Column OLS (1) reports the estimate of the local multiplier using the OLS specification from Eq. (1.7). This model uses the growth rate of the non-tradable and tradable sector as the dependent variable and the main regressor respectively. The OLS estimate for parameter β_1 is 0.68 which is the elasticity between employment in the tradable sector and the non-tradable sector, since both are measured as growth rates. Multiplying this elasticity by the ratio

[3] Both the x- and y-axis are bound between the 5th and 95th percentile of the observed values, such that the cluster around the median is more clear.

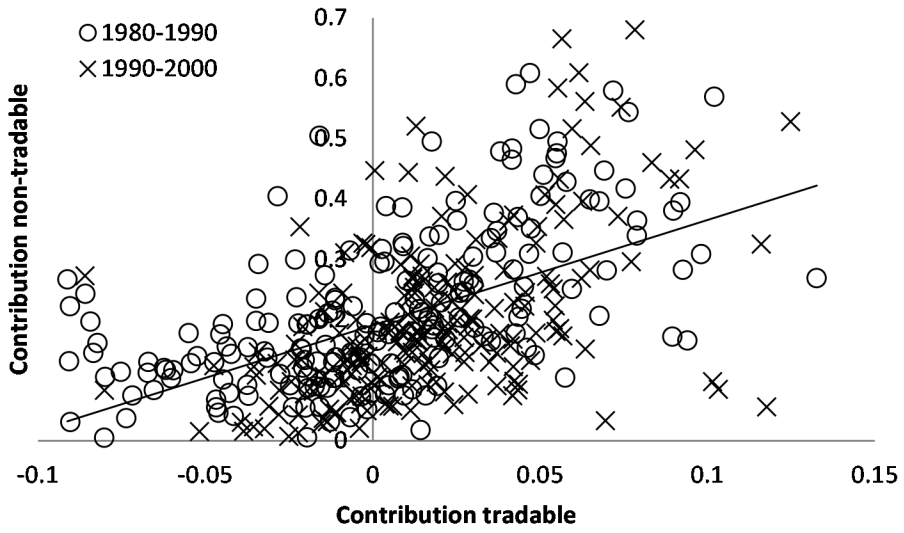


Figure 1.2: *Scatter plot of the contribution of the tradable and non-tradable sector to total employment growth in U.S. MSAs between 1980 and 2000.*

between the number of non-tradable and tradable jobs in our sample we find a local employment multiplier of 2.64.

Column OLS (2) also reports an estimate of the local multiplier, but uses the OLS specification from Eq. (1.12). In this model, the contribution of employment in the non-tradable sector to total employment growth is the dependent variable, and the contribution of employment in the tradable sector is the main regressor. As a result, the OLS estimate $\hat{\beta}_2 = 2.69$ is the size of the local employment multiplier. This second estimate corresponds to the variables shown in Figure 1.2.

As discussed in Section 1.4, the OLS estimation of the local employment multiplier suffers from endogeneity issues in both Specifications 1 and 2. This can be resolved by using a Bartik shift-share instrument such as that given by Eq. (1.9) or Eq. (1.13) respectively. Columns IV (1) and (2) show these instrumental variable estimates, and the first-stage estimates for the instruments are given in Columns A (1) and (2) of Table 1.3. Both specifications find a local multiplier between 1.58 and 1.69, which suggests that the OLS estimates are biased upwards.

The estimated multiplier can be interpreted as follows: for each 100 new jobs

in the tradable sector, there are between 158 and 169 additional jobs created in the non-tradable sector of the same city. The economic intuition behinds this is that the new workers in the tradable sector bring in additional income to the city. Part of this income will be spent on local goods, which creates additional jobs in the non-tradable sector. The influx of tradable sector jobs increases labour demand. If labour supply is not perfectly elastic, wages will increase as well. This will increase local spending even more. Thirdly, there could be agglomeration affects. The expansion of an existing firm or the introduction of a new firm in the tradable sector can make other firms, both inside and outside of the tradable sector, more productive. Finally, the new or expanded tradable sector firms will increase their demand for locally produced intermediate goods and services, and this will also contribute to the multiplier.

For all estimates of the local multiplier in Table 1.2 I control for the total number of workers, the educational composition and the unemployment rate in each city. Tables 1 and 2 of the Appendix 1.C show that, for both specifications, removing the unemployment rate as a control makes only a small difference in the estimated size of the local multiplier. Removing all controls leads to a lower estimate of the size of the multiplier, but the multiplier remains significant.

As discussed at the start of this section, I will do the same analysis under the assumption that medium-tradable goods and services are tradable. Table 1.4 shows the results of the estimation and Columns B (1) and (2) of Table 1.3 give the first-stage estimates. All four Columns of Table 1.4 show that this definition of tradables results in an estimated multiplier of almost half the size of the multiplier found under the previous definition. In this case, the specification of the regression model matters more for the size of the IV estimate. As shown in Columns IV (1) and (2), the estimate for Specification 1 is smaller than the estimate for Specification 2. The lower bound of the size of the local employment multiplier is 0.72. The effect of removing control variables is shown in Tables 3 and 4 of Appendix 1.C.

Table 1.2: *Estimate of the impact of employment in the tradable sector on employment in the medium- and non-tradable sector for MSAs in the USA between 1980 and 2000.*

	OLS		IV	
	(1)	(2)	(1)	(2)
Multiplier	2.64***[a]	2.69***	1.69***[a]	1.58***
	(0.17)	(0.23)	(0.31)	(0.31)
Tradable growth	0.68***		0.43***	
(percentage over ten years)	(0.04)		(0.08)	
Total employment	0.01*	-0.00	-0.01	-0.01***
(logs in base year)	(0.01)	(0.00)	(0.01)	(0.01)
3+ Years of college	-1.66***	-0.79***	-0.97***	-0.31
(percentage in base year)	(0.23)	(0.29)	(0.34)	(0.29)
Grade 12 - 2 years of college	-0.33*	0.04	-0.19	0.09
(percentage in base year)	(0.19)	(0.22)	(0.22)	(0.24)
Unemployment	-1.21***	-0.27	-1.41***	-0.71*
(percentage)	(0.36)	(0.39)	(0.39)	(0.41)
Constant	0.59***	0.39***	0.67***	0.48***
	(0.11)	(0.12)	(0.12)	(0.11)
First-stage statistic[b]			76	49
Observations	464	464	464	464
Adjusted R^2	0.69	0.63	0.62	0.54

Note: Robust standard errors clustered by MSA reported in parentheses. In this case medium-tradable industries are considerd as non-tradable. The instrumental variable is based on the Bartik shift-share method as described in Section 1.4. Specification (1) considers growth rates of the tradable and the non-tradable sectors and Specification (2) consider the contribution of both sectors to total employment growth. Corresponding first-stage estimates for Columns IV (1) and (2) are reported in Table 1.3, Columns A (1) and (2) respectively.

[a] The estimates of β_1 have been multiplied by the relative sector size to find an estimate of the size of the local multiplier effect.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.3: *First-stage regressions for Instrumental Variable estimates of the impact of employment in the tradable sector on employment in the non-tradable sector for MSAs in the USA between 1980 and 2000.*

	A		B		C	
	(1)	(2)	(1)	(2)	(1)	(2)
Instrumental Variable	1.08***	1.00***	1.26***	1.17***	1.08***	0.99***
	(0.12)	(0.14)	(0.18)	(0.19)	(0.12)	(0.14)
Total employment	-0.08***	-0.02***	-0.07***	-0.03***	-0.08***	-0.02***
(logs in base year)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
3+ Years of college	1.34***	0.24***	0.38	0.18	1.33***	0.30***
(percentage in base year)	(0.49)	(0.09)	(0.40)	(0.15)	(0.48)	(0.11)
Grade 12 - 2 years of college	0.29	-0.02	0.26	0.06	0.25	-0.03
(percentage in base year)	(0.41)	(0.08)	(0.36)	(0.14)	(0.40)	(0.09)
Unemployment	-0.66	-0.27	-1.35	-0.68**	-0.68	-0.33
(percentage)	(0.88)	(0.19)	(0.84)	(0.34)	(0.87)	(0.23)
Constant	0.92***	0.20***	0.82***	0.35***	0.91***	0.25***
	(0.24)	(0.05)	(0.22)	(0.09)	(0.24)	(0.06)
Observations	464	464	464	464	464	464
Adjusted R^2	0.33	0.34	0.26	0.23	0.32	0.34

Note: Robust standard errors clustered by MSA reported in parentheses. In Columns A and C the instrumented and the instrumental variable only include employment in the tradable sector itself. In the Columns under B the instrumented and the instrumental variable include employment in both the tradable and the medium tradabe sector. In Columns marked (1) the instrumented variable is the growth rate of the tradable (and medium-tradable) sector and the instrument is a Bartik shift-share instrument that corresponds to this as given by Eq. 1.9. In Columns marked (2) the instrumented variable is the contribution of the tradable (and medium-tradable) sector to total employment growth and the instrument is a Bartik shift-share instrument that corresponds to this as given by Eq. 1.13.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

If I undertake the same analysis a third time, now ignoring any employment in the medium-tradable sector, then Table 1.5 shows that the estimation results lie between the first and the second case. Columns IV (1) and (2) show that the estimates for both specifications are very similar. The first-stage estimates are given in Columns C (1) and (2) of Table 1.3. The effect of removing control variables is shown in Tables 5 and 6 of Appendix 1.C.

Table 1.4: *Estimate of the impact of employment in the tradable and medium-tradable sector on employment in the non-tradable sector for MSAs in the USA between 1980 and 2000.*

	OLS		IV	
	(1)	(2)	(1)	(2)
Multiplier	1.25***[a]	1.37***	0.72***[a]	1.00***
	(0.05)	(0.06)	(0.13)	(0.13)
Tradable growth	0.84***		0.48***	
(percentage over ten years)	(0.03)		(0.09)	
Total employment	-0.00	-0.01**	-0.02**	-0.01***
(logs in base year)	(0.01)	(0.00)	(0.01)	(0.00)
3+ Years of college	-1.16***	-0.53***	-0.57*	-0.32**
(percentage in base year)	(0.20)	(0.12)	(0.30)	(0.15)
Grade 12 - 2 years of college	-0.47**	-0.14	-0.28	-0.08
(percentage in base year)	(0.20)	(0.11)	(0.22)	(0.12)
Unemployment	-0.05	0.52**	-0.72*	0.17
(percentage)	(0.32)	(0.24)	(0.39)	(0.27)
Constant	0.47***	0.27***	0.64***	0.34***
	(0.11)	(0.07)	(0.13)	(0.08)
First-stage statistic[b]			50	38
Observations	464	464	464	464
Adjusted R^2	0.81	0.82	0.68	0.77

Note: Robust standard errors clustered by MSA reported in parentheses. In this case medium-tradable industries are considerd as tradable. The instrumental variable is based on the Bartik shift-share method as described in Section 1.4. Specification (1) considers growth rates of the tradable and the non-tradable sectors and Specification (2) consider the contribution of both sectors to total employment growth. Corresponding first-stage estimates for Columns IV (1) and (2) are reported in Table 1.3, Columns B (1) and (2) respectively.

[a] The estimates of β_1 have been multiplied by the relative sector size to find an estimate of the size of the local multiplier effect.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.5: *Estimate of the impact of employment in the tradable sector on employment in the non-tradable sector for MSAs in the USA between 1980 and 2000.*

	OLS		IV	
	(1)	(2)	(1)	(2)
Multiplier	2.01***[a]	2.11***	1.26***[a]	1.27***
	(0.13)	(0.17)	(0.27)	(0.26)
Tradable growth	0.69***		0.43***	
(percentage over ten years)	(0.04)		(0.09)	
Total employment	0.01	-0.00	-0.01	-0.01**
(logs in base year)	(0.01)	(0.01)	(0.01)	(0.01)
3+ Years of college	-1.70***	-0.81***	-0.97***	-0.35
(percentage in base year)	(0.25)	(0.26)	(0.37)	(0.28)
Grade 12 - 2 years of college	-0.43**	-0.04	-0.29	0.01
(percentage in base year)	(0.21)	(0.21)	(0.23)	(0.23)
Unemployment	-1.04***	-0.07	-1.25***	-0.47
(percentage)	(0.38)	(0.38)	(0.40)	(0.39)
Constant	0.62***	0.38***	0.71***	0.47***
	(0.12)	(0.12)	(0.13)	(0.11)
First-stage statistic[b]			75	48
Observations	464	464	464	464
Adjusted R^2	0.68	0.62	0.60	0.54

Note: Robust standard errors clustered by MSA reported in parentheses. In this case medium-tradable industries are not included in the analysis. The instrumental variable is based on the Bartik shift-share method as described in Section 1.4. Specification (1) considers growth rates of the tradable and the non-tradable sectors and Specification (2) consider the contribution of both sectors to total employment growth. Corresponding first-stage estimates for Columns IV (1) and (2) are reported in Table 1.3, Columns C (1) and (2) respectively.

[a] The estimates of β_1 have been multiplied by the relative sector size to find an estimate of the size of the local multiplier effect.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

1.5.2 Wages and skills

It is clear that employment is not homogeneous, for example workers have different skills and receive different wages. In order to gain a better understanding of the local employment multiplier effect we need to allow for this heterogeneity in our estimation. Our theoretical framework predictw a higher multiplier for higher paying jobs. We expect skilled workers to earn higher wages and to spend more in the non-tradable sector; therefore we predict a higher multiplier for skilled jobs than for unskilled jobs. Finally, there could be a direct effect of skills on the size of the multiplier, outside of the wage channel.

To test the difference between skilled and unskilled jobs I split employment in the tradable sector into two categories and estimate the effect of both parts on the non-tradable sector. To do so, I simply replace the main regressor in Eq. (1.7) or Eq. (1.12) by two regressors, one for each part of the tradable sector. Consequently I also need to replace the instrument with two separate instruments. This allows me to estimate the multiplier size for both skilled and unskilled jobs.

I define all jobs fulfilled by workers with at least some college education as skilled jobs and all other jobs as unskilled jobs. Table 1.6 shows that the estimated size of the multiplier is very sensitive to the model specification. Following the IV result of Specification 1, we find a very large multiplier for skilled workers and a negative multiplier for unskilled workers, where the prior is significant. On the other hand Specification 2 suggests a very small negative multiplier for skilled workers and a large positive multiplier for unskilled workers, where the latter is significant.

The estimation result for Specification 1 is not very reliable. When we investigate the first-stage estimates in Table 1.13, in Appendix 1.B, we see that for each instrumented variable, the corresponding instrument is significant. However the small F-statistic in Table 1.6 still suggests that the instruments are not very informative, as $F = 5$ does not even reject weak identification at the 25% confidence level. The

Table 1.6: *Estimate of OLS and TSLS IV models of the impact of skilled and unskilled employment in the tradable sector on employment in the medium-tradable and non-tradable sector for MSAs in the USA between 1980 and 2000.*

	OLS		IV	
	(1)	(2)	(1)	(2)
Multiplier skilled[a]	2.07***[b]	3.04***	3.70**[b]	-0.16
	(0.27)	(0.36)	(1.46)	(0.90)
Multiplier unskilled[a]	2.07***[b]	2.39***	-1.45[b]	2.43***
	(0.23)	(0.38)	(1.57)	(0.44)
Skilled tradable growth[a]	0.31***		0.56**	
(percentage over ten years)	(0.04)		(0.22)	
Unskilled tradable growth[a]	0.39***		-0.28	
(percentage over ten years)	(0.04)		(0.30)	
Total employment	0.01***	-0.00	-0.01	-0.02***
(logs in base year)	(0.00)	(0.00)	(0.01)	(0.01)
3+ Years of college	-0.92***	-0.86***	-1.04**	0.07
(percentage in base year)	(0.19)	(0.28)	(0.51)	(0.33)
Grade 12 - 2 years of college	-0.15	0.02	-0.27	0.18
(percentage in base year)	(0.18)	(0.23)	(0.30)	(0.27)
Unemployment	-1.04***	-0.35	-1.63***	-0.52
(percentage)	(0.31)	(0.39)	(0.49)	(0.42)
Constant	0.33***	0.38***	0.40*	0.55***
	(0.10)	(0.12)	(0.24)	(0.12)
First-stage statistic[c]			5	20
Observations	464	464	464	464
Adjusted R^2	0.72	0.63	0.45	0.42

Note: Robust standard errors clustered by MSA reported in parentheses. In specification (1) the dependent variable is the growth rate of the medium-tradable and non-tradable sector; and in (2) this is the contribution of medium-tradable and non-tradable sector employment to total employment growth. The instrumental variable is based on the Bartik shift-share method as described in Section 1.4.

[a] These regressors consist of the growth rate of skilled / unskilled workers employed in the tradable sector in specification (1); and in (2) this is the contribution of skilled / unskilled workers employed in the tradable sector to total employment growth.

[b] The estimates of β_1^s and β_1^u have been multiplied by the relative sector size to find an estimate of the size of the local multiplier effect.

[c] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

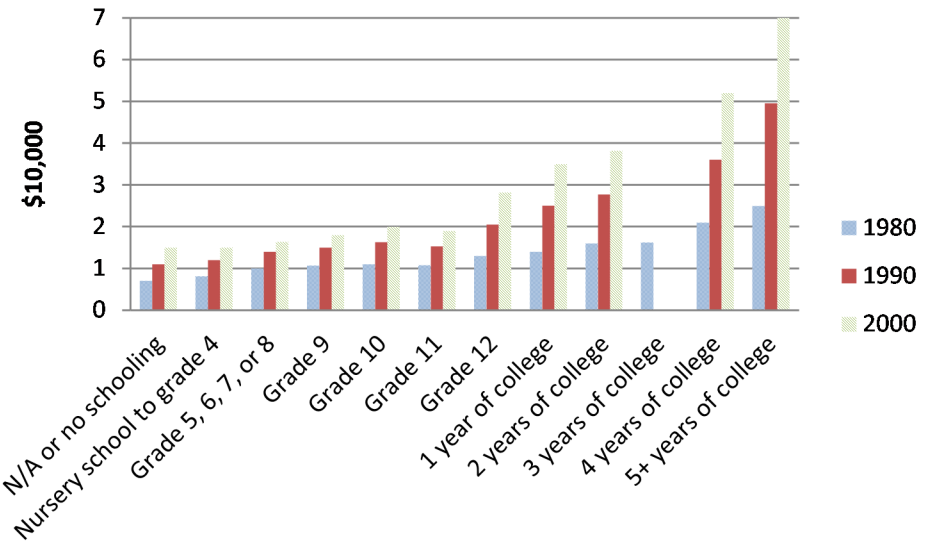


Figure 1.3: *Median wage and salary income for workers in the tradable sector by level of educational attainment in the USA between 1980 and 2000.*

instrument for Specification 2 is clearly stronger, but the results of this estimation are counter-intuitive. One would expect a larger multiplier for skilled jobs, since these jobs tend to command higher wages.

We can test this expectation by looking at the wage distribution in the tradable sector across different levels of education, and Figure 1.3 shows that wages indeed increase with education in our sample. Additionally, we can test for the multiplier of high- and low-wage workers directly. To do so, I determine the median wage across all workers in the tradable sector that live in an MSA for 1980, 1990 and 2000. Within each city, all workers that earn above the median wage of that year are labelled high-wage workers and all others are labelled low-wage workers. This allows me to test another modification of the regression models, where we have two main regressors: one for high- and one for low-wage workers. Again, the dependent variable is unaltered. The results of these estimations are shown in Table 1.7.

Columns IV (1) and (2) show that, for wages, we get a robust result across both specifications. There is a significant multiplier for high-wage workers, and this multiplier is larger than the overall multiplier. In contrast, the multiplier for low-wage

workers is a lot smaller and is not significant. This is exactly what we would expect from the theoretical framework.

Since high-wage jobs have a bigger multiplier and skilled workers have higher paying jobs, we expect a higher multiplier for skilled jobs. I have shown that higher-skilled workers indeed receive higher wages on average, but this isn't the case for each individual worker. Some unskilled workers also receive high wages and some skilled workers may receive low wages. This could explain why I do not find a significant multiplier for skilled workers. This result implies that the multiplier effect of skilled jobs goes through wages and not directly through education. Thus while high-skilled jobs can be important for the local economy, the skill level, by itself, is not especially important for the local multiplier. What matters for the multiplier is the wage the workers receive and their expenditure in the local economy.

1.6 Discussion and conclusion

When employment in the tradable sector of a city in the USA increases by 100 workers, an additional 158 to 169 jobs are created in the non-tradable sector of the same city. This is currently the most accurate estimate of the local multiplier effect.

My estimate of the local multiplier is robust to the method of analysis. Whether I use the growth rate, or the contribution to total growth, of employment in the tradable and non-tradable sectors as variables, I find a similar result. When I do not include city size and education as controls, the estimated multiplier is smaller, but remains significant. Including the unemployment rate as a control has no effect on the results.

An important aspect of all local multiplier estimations is separating the tradable and the non-tradable sectors. I made this less arbitrary by incorporating the division made within the service sector by Jensen and Kletzer (2006). If I consider all concentrated services, with a Gini coefficient greater than 0.1, as tradable, then I find the

Table 1.7: *Estimate of OLS and TSLS IV models of the impact of high- and low-wage employment in the tradable on employment in the medium-tradable and non-tradable sector for MSAs in the USA between 1980 and 2000.*

	OLS		IV	
	(1)	(2)	(1)	(2)
Multiplier high wage[a]	2.10***[b]	3.00***	2.28***[b]	2.02***
	(0.20)	(0.31)	(0.47)	(0.37)
Multiplier low wage[a]	1.77***[b]	2.30***	-1.18[b]	0.82
	(0.25)	(0.43)	(0.94)	(0.84)
High-wage tradable growth[a]	0.40***		0.43***	
(percentage over ten years)	(0.04)		(0.09)	
Low-wage tradable growth[a]	0.27***		-0.18	
(percentage over ten years)	(0.04)		(0.14)	
Total employment	0.01*	-0.00	-0.03**	-0.02***
(logs in base year)	(0.00)	(0.00)	(0.01)	(0.01)
3+ Years of college	-1.65***	-0.87***	-0.97**	-0.40
(percentage in base year)	(0.22)	(0.29)	(0.43)	(0.30)
Grade 12 - 2 years of college	-0.37*	0.09	0.24	0.18
(percentage in base year)	(0.19)	(0.24)	(0.35)	(0.29)
Unemployment	-1.33***	-0.12	-0.61	-0.49
(percentage)	(0.39)	(0.42)	(0.61)	(0.41)
Constant	0.60***	0.39***	0.74***	0.49***
	(0.11)	(0.12)	(0.16)	(0.11)
First-stage statistic[c]			20	15
Observations	464	464	464	464
Adjusted R^2	0.70	0.63	0.45	0.52

Note: Robust standard errors clustered by MSA reported in parentheses. In specification (1) the dependent variable is the growth rate of the medium-tradable and non-tradable sector; and in (2) this is the contribution of medium-tradable and non-tradable sector employment to total employment growth. The instrumental variable is based on the Bartik shift-share method as described in Section 1.4.

[a] These regressors consist of the growth rate of high-/low-wage jobs in the tradable sector in specification (1); and in (2) this is the contribution of high-/low-wage jobs in the tradable sector to total employment growth.

[b] The estimates of β_1^s and β_1^u have been multiplied by the relative sector size to find an estimate of the size of the local multiplier effect.

[c] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

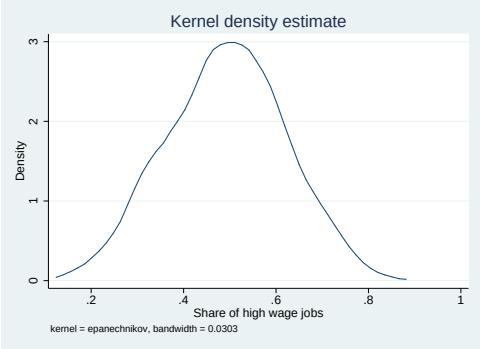
*** Significance at the 1% level.

multiplier of around 1.6 stated above.

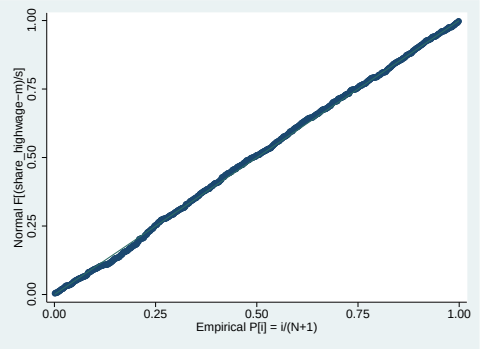
Since the threshold for non-tradable industries of 0.1 is somewhat arbitrary, Jensen and Kletzer (2006) include an intermediate category of all service industries with a Gini coefficient between 0.1 and 0.3. In this chapter I label these industries and all wholesale trade industries as medium tradable. When I assume these medium-tradable industries to be tradable as well, instead of categorising them as non-tradable as I did before, I can re-estimate the local employment multiplier. In this case I find a multiplier between 0.72 and 1.00. This provides a reasonable lower bound for the magnitude of the local multiplier effect. If some of these medium-tradable industries are indeed tradable, the multiplier of 1.6 could be considered an upper bound. This shows that the estimated size of the local multiplier is sensitive to the way the local economy is split between tradables and non-tradables. By determining in more detail which industries are tradable or non-tradable, the local multiplier can be estimated more accurately.

The expected difference in magnitude between the multiplier for skilled and unskilled tradable jobs could not be shown. However, the underlying mechanism through the wage channel *could* be demonstrated: skilled workers earn higher wages than unskilled workers and higher paying jobs *do* have a bigger multiplier. This suggests that skill alone only has a limited effect on the size of the multiplier. There is no significant local employment multiplier for jobs that pay below the median wage, but the local multiplier for jobs that pay above the median wage lies between 2 and 2.3 and *is* significant.

The finding that there is no multiplier for low-wage jobs could be problematic for policy targeted at job creation in low-income regions. Figure 1.4a shows that there are only a few cities that have almost no high-wage jobs, the share of high-wage jobs look more or less normally distributed across U.S. cities. This normal distribution can be confirmed with the standardised normal probability plot shown in Figure 1.4b.



(a) *Kernel density plot*



(b) *Standardised normal probability plot*

Figure 1.4: *Distribution of the share of high-wage jobs across cities in the USA between 1980 and 2000*

Therefore, attracting tradable jobs is most likely effective in most cities, but more effective when attracting high-wage jobs.

Appendix 1.A Employment Statistics

Table 1.8: *U.S. Employment statistics for 226 MSAs in 1980 and 238 MSAs in 1990 and 2000; in thousands of workers.*

Variable	Statistic	1980	1990	2000
Employment, medium- and non-tradable sector	Mean	190	248	272
	SD	420	539	559
	Min	19	24	27
	Max	4660	5808	6168
Employment, tradable sector	Mean	57	56	55
	SD	133	127	115
	Min	2	2	2
	Max	1270	1187	1049
Employment, tradable sector, high wage	Mean	32	30	29
	SD	72	70	64
	Min	1	0	1
	Max	589	615	594
Employment, tradable sector, low wage	Mean	25	25	26
	SD	63	58	53
	Min	1	2	2
	Max	681	604	558
Employment, tradable sector, skilled	Mean	21	29	33
	SD	52	68	72
	Min	0	1	1
	Max	474	604	677
Employment, tradable sector, unskilled	Mean	37	27	22
	SD	82	59	45
	Min	1	1	1
	Max	797	583	449

Table 1.9: *Difference in employment for 226 MSAs between 1980 and 1990; and for 238 MSAs between 1990 and 2000. In thousands of workers.*

Variable	Statistic	1980-1990	1990-2000
Difference in employment,	Mean	59	55
medium- and non-tradable sector	SD	128	83
	Min	-42	-47
	Max	1148	576
Difference in employment, tradable	Mean	-2	6
sector	SD	23	22
	Min	-156	-197
	Max	83	115
Difference in employment, tradable	Mean	-2	2
sector, high wage	SD	17	14
	Min	-126	-151
	Max	69	64
Difference in employment, tradable	Mean	0	3
sector, low wage	SD	13	9
	Min	-158	-69
	Max	41	55
Difference in employment, tradable	Mean	9	8
sector, skilled	SD	19	15
	Min	-14	-63
	Max	131	89
Difference in employment, tradable	Mean	-11	-2
sector, unskilled	SD	28	16
	Min	-263	-163
	Max	35	36

Table 1.10: *Growth rate of employment for 226 MSAs between 1980 and 1990; and for 238 MSAs between 1990 and 2000.*

Variable	Statistic	1980-1990	1990-2000
Growth rate of employment,	Mean	0.26	0.31
medium- and non-tradable sector	SD	0.23	0.33
	Min	-0.41	-0.41
	Max	1.60	1.99
Growth rate of employment,	Mean	0.03	0.20
tradable sector	SD	0.31	0.41
	Min	-0.66	-0.58
	Max	1.15	2.53
Growth rate of employment,	Mean	-0.03	0.17
tradable sector, high wage	SD	0.35	0.49
	Min	-0.71	-0.68
	Max	1.13	2.75
Growth rate of employment,	Mean	0.13	0.25
tradable sector, low wage	SD	0.35	0.39
	Min	-0.70	-0.49
	Max	1.66	2.48
Growth rate of employment,	Mean	0.46	0.40
tradable sector, skilled	SD	0.42	0.50
	Min	-0.43	-0.55
	Max	1.93	3.39
Growth rate of employment,	Mean	-0.20	0.04
tradable sector, unskilled	SD	0.24	0.37
	Min	-0.72	-0.60
	Max	0.80	2.02

Table 1.11: *Contribution to employment growth for 226 MSAs between 1980 and 1990; and for 238 MSAs between 1990 and 2000.*

Variable	Statistic	1980-1990	1990-2000
Contribution to employment	Mean	0.21	0.25
growth, medium- and non-tradable	SD	0.19	0.26
sector	Min	-0.33	-0.34
	Max	1.30	1.65
Contribution to employment	Mean	-0.01	0.03
growth, tradable sector	SD	0.06	0.08
	Min	-0.25	-0.19
	Max	0.22	0.68
Contribution to employment	Mean	-0.01	0.01
growth, tradable sector, high wage	SD	0.04	0.04
	Min	-0.18	-0.17
	Max	0.12	0.32
Contribution to employment	Mean	0.01	0.02
growth, tradable sector, low wage	SD	0.04	0.05
	Min	-0.14	-0.07
	Max	0.16	0.51
Contribution to employment	Mean	0.03	0.03
growth, tradable sector, skilled	SD	0.03	0.04
	Min	-0.03	-0.09
	Max	0.14	0.39
Contribution to employment	Mean	-0.04	0.00
growth, tradable sector, unskilled	SD	0.05	0.04
	Min	-0.22	-0.11
	Max	0.12	0.46

Table 1.12: *Control variables for 226 MSAs in 1980 and 238 MSAs in 1990 and 2000; in the USA.*

Variable	Statistic	1980	1990	2000
Employment (thousands)	Mean	276	338	356
	SD	593	720	718
	Min	39	41	42
	Max	6353	7494	7680
Share “3+ years of college”	Mean	0.37	0.47	0.47
	SD	0.04	0.04	0.04
	Min	0.19	0.27	0.3
	Max	0.47	0.6	0.59
Share “Grade 12 - 2 years of college”	Mean	0.13	0.13	0.16
	SD	0.04	0.04	0.05
	Min	0.06	0.05	0.06
	Max	0.28	0.28	0.36
Unemployment rate	Mean	0.06	0.06	0.06
	SD	0.02	0.02	0.02
	Min	0.02	0.03	0.03
	Max	0.15	0.14	0.13

Appendix 1.B First-stage regressions

Table 1.13: *First-stage regressions for Instrumental Variable estimates of the impact of high and low skill/wage employment in the tradable sector on employment in the medium- and non-tradable sector for MSAs in the USA between 1980 and 2000.*

Category	Skill level				Wage			
Specification	Growth		Contribution		Growth		Contribution	
Variable	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High IV	0.77***	0.18	0.56***	0.03	0.91***	0.00	0.93***	-0.09
	(0.17)	(0.14)	(0.09)	(0.15)	(0.15)	(0.12)	(0.12)	(0.09)
Low IV	0.23	0.93***	0.10	1.22***	0.33	1.09***	0.17	1.34***
	(0.36)	(0.31)	(0.08)	(0.10)	(0.33)	(0.18)	(0.24)	(0.24)
Total employment	-0.11***	-0.07***	-0.01***	-0.01***	-0.09***	-0.09***	-0.01***	-0.01***
(logs in base year)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
3+ Years of college	1.66***	0.36	0.19***	-0.02	1.66***	0.98*	0.19***	0.08*
(percentage in base year)	(0.56)	(0.40)	(0.06)	(0.05)	(0.60)	(0.51)	(0.06)	(0.04)
Grade 12 - 2 years of college	0.33	-0.15	0.01	-0.06*	-0.01	0.86**	-0.05	0.03
(percentage in base year)	(0.48)	(0.37)	(0.04)	(0.04)	(0.53)	(0.42)	(0.05)	(0.04)
Unemployment	-0.54	-1.12	-0.06	-0.20**	-1.69	0.83	-0.21*	-0.03
(percentage)	(1.05)	(0.76)	(0.11)	(0.09)	(1.16)	(0.87)	(0.13)	(0.09)
Constant	1.31***	0.92***	0.10***	0.13***	1.06***	0.68***	0.11***	0.08***
	(0.32)	(0.26)	(0.03)	(0.02)	(0.31)	(0.22)	(0.03)	(0.02)
Observations	464	464	464	464	464	464	464	464
Adjusted R^2	0.28	0.29	0.26	0.55	0.34	0.27	0.46	0.26

Note: Robust standard errors clustered by MSA reported in parentheses. In Columns (1) - (4) the working population of the tradable sector in each city is split between skilled and unskilled workers. In Column (5) - (8) the workers are split between high and low wage. In Columns (1), (2), (5) and (6) the instrumented and instrumental variables are based on the growth rate within parts of the tradable sector, following Specification 1. In Columns (3), (4), (7) and (8) the instrumented and instrumental variables are based on the contribution of each part within the tradable sector to overall employment growth, in accordance with Specification 2.
* Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

Appendix 1.C Different multiplier and control specifications

Table 1.14: *Estimate of OLS and TSLS IV models of the impact of the employment growth rate in the tradable sector on the employment growth rate in the medium-tradable and non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Tradable growth[a]	0.62***	0.68***	0.68***	0.25***	0.44***	0.43***
(percentage over ten years)	(0.05)	(0.04)	(0.04)	(0.09)	(0.08)	(0.08)
Total employment		0.01	0.01*		-0.01	-0.01
(logs in base year)		(0.01)	(0.01)		(0.01)	(0.01)
3+ Years of college		-1.37***	-1.66***		-0.64*	-0.97***
(percentage in base year)		(0.24)	(0.23)		(0.37)	(0.34)
Grade 12 - 2 years of college		-0.29	-0.33*		-0.15	-0.19
(percentage in base year)		(0.21)	(0.19)		(0.23)	(0.22)
Unemployment			-1.21***			-1.41***
(percentage)			(0.36)			(0.39)
Constant	0.28***	0.50***	0.59***	0.28***	0.57***	0.67***
	(0.01)	(0.11)	(0.11)	(0.01)	(0.12)	(0.12)
Observations	464	464	464	464	464	464
Adjusted R^2	0.64	0.69	0.69	0.42	0.61	0.62
First-stage statistic[b]				17	75	76

Note: Robust standard errors clustered by MSA reported in parentheses. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter. [a] This row reports the estimated values of β_1, the elasticity between employment in tradable and the non-tradable sector. [b] The Kleibergen-Paap rk Wald F statistic * Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

Table 1.15: *Estimate of OLS and TSLS IV models of the impact of employment in the tradable sector on employment in the medium-tradable and non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Contribution tradable[a]	2.58***	2.70***	2.69***	1.06***	1.63***	1.58***
(ten year intervals)	(0.20)	(0.23)	(0.23)	(0.34)	(0.29)	(0.31)
Total employment		-0.00	-0.00		-0.02***	-0.01***
(logs in base year)		(0.01)	(0.00)		(0.01)	(0.01)
3+ Years of college		-0.73**	-0.79***		-0.16	-0.31
(percentage in base year)		(0.29)	(0.29)		(0.30)	(0.29)
Grade 12 - 2 years of college		0.04	0.04		0.10	0.09
(percentage in base year)		(0.22)	(0.22)		(0.25)	(0.24)
Unemployment			-0.27			-0.71*
(percentage)			(0.39)			(0.41)
Constant	0.24***	0.37***	0.39***	0.23***	0.43***	0.48***
	(0.01)	(0.11)	(0.12)	(0.01)	(0.11)	(0.11)
Observations	464	464	464	464	464	464
Adjusted R^2	0.60	0.63	0.63	0.40	0.54	0.54
First-stage statistic[b]				24	51	49

Note: Robust standard errors clustered by MSA reported in parentheses. The dependent variable is the contribution of medium-tradable and non-tradable sector employment to total employment growth. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter.

[a] Contribution tradable denotes the contribution of tradable sector employment to total employment growth.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.16: *Estimate of OLS and TSLS IV models of the impact of the employment growth rate in the tradable and medium-tradable sector on the employment growth rate in the non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
(Medium) tradable growth[a]	0.80***	0.84***	0.84***	0.24**	0.50***	0.48***
(percentage over ten years)	(0.04)	(0.03)	(0.03)	(0.10)	(0.09)	(0.09)
Total employment		-0.00	-0.00		-0.02***	-0.02**
(logs in base year)		(0.01)	(0.01)		(0.01)	(0.01)
3+ Years of college		-1.15***	-1.16***		-0.41	-0.57*
(percentage in base year)		(0.18)	(0.20)		(0.31)	(0.30)
Grade 12 - 2 years of college		-0.46**	-0.47**		-0.26	-0.28
(percentage in base year)		(0.20)	(0.20)		(0.23)	(0.22)
Unemployment			-0.05			-0.72*
(percentage)			(0.32)			(0.39)
Constant	0.12***	0.47***	0.47***	0.21***	0.58***	0.64***
	(0.01)	(0.10)	(0.11)	(0.02)	(0.12)	(0.13)
Observations	464	464	464	464	464	464
Adjusted R^2	0.77	0.81	0.81	0.40	0.68	0.68
First-stage statistic[b]				10	54	50

Note: Robust standard errors clustered by MSA reported in parentheses. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter.

[a] This row reports the estimated values of β_1, the elasticity between employment in tradable and the non-tradable sector.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.17: *Estimate of OLS and TSLS IV models of the impact of employment in the tradable and medium-tradable sector on employment in the non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Contribution (medium) tradable[a]	1.31***	1.36***	1.37***	0.27	0.99***	1.00***
(ten year intervals)	(0.06)	(0.06)	(0.06)	(0.25)	(0.12)	(0.13)
Total employment		-0.01*	-0.01**		-0.01***	-0.01***
(logs in base year)		(0.00)	(0.00)		(0.00)	(0.00)
3+ Years of college		-0.65***	-0.53***		-0.36**	-0.32**
(percentage in base year)		(0.11)	(0.12)		(0.17)	(0.15)
Grade 12 - 2 years of college		-0.15	-0.14		-0.09	-0.08
(percentage in base year)		(0.11)	(0.11)		(0.13)	(0.12)
Unemployment			0.52**			0.17
(percentage)			(0.24)			(0.27)
Constant	0.07***	0.31***	0.27***	0.13***	0.35***	0.34***
	(0.01)	(0.07)	(0.07)	(0.02)	(0.07)	(0.08)
Observations	464	464	464	464	464	464
Adjusted R^2	0.78	0.82	0.82	0.28	0.77	0.77
First-stage statistic[b]				6	43	38

Note: Robust standard errors clustered by MSA reported in parentheses. The dependent variable is the contribution of non-tradable sector employment to total employment growth. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter.

[a] Contribution (medium) tradable denotes the contribution of tradable and medium-tradable sector employment to total employment growth.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.18: *Estimate of OLS and TSLS IV models of the impact of the employment growth rate in the tradable sector on the employment growth rate in the non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Tradable growth[a]	0.63***	0.69***	0.69***	0.23**	0.44***	0.43***
(percentage over ten years)	(0.05)	(0.04)	(0.04)	(0.09)	(0.09)	(0.09)
Total employment		0.00	0.01		-0.01	-0.01
(logs in base year)		(0.01)	(0.01)		(0.01)	(0.01)
3+ Years of college		-1.45***	-1.70***		-0.67*	-0.97***
(percentage in base year)		(0.26)	(0.25)		(0.40)	(0.37)
Grade 12 - 2 years of college		-0.40*	-0.43**		-0.26	-0.29
(percentage in base year)		(0.22)	(0.21)		(0.24)	(0.23)
Unemployment			-1.04***			-1.25***
(percentage)			(0.38)			(0.40)
Constant	0.25***	0.54***	0.62***	0.25***	0.62***	0.71***
	(0.01)	(0.12)	(0.12)	(0.01)	(0.13)	(0.13)
Observations	464	464	464	464	464	464
Adjusted R^2	0.63	0.68	0.68	0.37	0.59	0.60
First-stage statistic[b]				18	74	75

Note: Robust standard errors clustered by MSA reported in parentheses. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter.

[a] This row reports the estimated values of β_1, the elasticity between employment in tradable and the non-tradable sector.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 1.19: *Estimate of OLS and TSLS IV models of the impact of employment in the tradable sector on employment in the non-tradable sector for MSAs in the U.S. between 1980 and 2000.*

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Contribution tradable[a]	2.01***	2.12***	2.11***	0.74***	1.30***	1.27***
(ten year intervals)	(0.15)	(0.17)	(0.17)	(0.25)	(0.24)	(0.26)
Total employment		-0.00	-0.00		-0.02***	-0.01**
(logs in base year)		(0.01)	(0.01)		(0.01)	(0.01)
3+ Years of college		-0.80***	-0.81***		-0.25	-0.35
(percentage in base year)		(0.26)	(0.26)		(0.30)	(0.28)
Grade 12 - 2 years of college		-0.03	-0.04		0.02	0.01
(percentage in base year)		(0.21)	(0.21)		(0.23)	(0.23)
Unemployment			-0.07			-0.47
(percentage)			(0.38)			(0.39)
Constant	0.20***	0.38***	0.38***	0.19***	0.43***	0.47***
	(0.01)	(0.11)	(0.12)	(0.01)	(0.11)	(0.11)
Observations	464	464	464	464	464	464
Adjusted R^2	0.59	0.63	0.62	0.36	0.54	0.54
First-stage statistic[b]				21	49	48

Note: Robust standard errors clustered by MSA reported in parentheses. The dependent variable is the contribution of non-tradable sector employment to total employment growth. The instrumental variable is based on the Bartik shift-share method as described in Section 4 of the chapter.

[a] Contribution tradable denotes the contribution of tradable sector employment to total employment growth.

[b] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Appendix 1.D List of 1990 Census industries by tradability

Non-tradable All construction; Newspaper publishing and printing; Railroads Bus service and urban transit; Taxicab service; Trucking service; Warehousing and storage; U.S. Postal Service; Water transportation; Air transportation; Radio and television broadcasting and cable; Electric light and power; Gas and steam supply systems; Electric and gas, and other combinations; Water supply and irrigation; Sanitary services; Utilities, n.s.; Lumber and building material retailing; Hardware stores; Retail nurseries and garden stores; Department stores; Miscellaneous general merchandise stores; Grocery stores; Retail bakeries; Food stores, n.e.c.; Motor vehicle dealers; Auto and home supply stores; Gasoline service stations; Miscellaneous vehicle dealers; Apparel and accessory stores, except shoe; Shoe stores; Furniture and home furnishings stores; Radio, TV, and computer stores; Eating and drinking places; Drug stores; Liquor stores; Sporting goods, bicycles, and hobby stores; Book and stationery stores; Jewellery stores; Sewing, needlework, and piece goods stores; Catalog and mail order houses; Vending machine operators; Direct selling establishments; Fuel dealers; Retail florists; Miscellaneous retail stores; Retail trade, n.s.; Banking Savings institutions, including credit unions; Services to dwellings and other buildings; Automobile parking and carwashes; Automotive repair and related services; Electrical repair shops; Miscellaneous repair services; Private households Lodging places, except hotels and motels; Laundry, cleaning, and garment services; Barber shops; Funeral service and crematories; Bowling centers; Miscellaneous entertainment and recreation services; Offices and clinics of physicians; Offices and clinics of dentists; Offices and clinics of chiropractors; Offices and clinics of optometrists; Hospitals Nursing and personal care facilities; Health services, n.e.c.; Elementary and secondary schools; Colleges and universities; Libraries; Educational services,

n.e.c.; Job training and vocational rehabilitation services; Child day care services; Residential care facilities, without nursing; Social services, n.e.c.; Religious organizations; Membership organizations, n.e.c.; Engineering, architectural, and surveying services; Accounting, auditing, and bookkeeping services

Medium tradable Printing, publishing, and allied industries, except newspapers; Services incidental to transportation; Telephone communications; Telegraph and miscellaneous communications services; Motor vehicles and equipment; Furniture and home furnishings; Lumber and construction materials; Metals and minerals, except petroleum; Electrical goods; Hardware, plumbing and heating supplies; Machinery, equipment, and supplies; Scrap and waste materials; Miscellaneous wholesale, durable goods; Paper and paper products; Drugs, chemicals, and allied products; Apparel, fabrics, and notions; Groceries and related products; Farm-product raw materials; Petroleum products; Alcoholic beverages; Farm supplies; Miscellaneous wholesale, nondurable goods; Wholesale trade, n.s.; Credit agencies, n.e.c.; Insurance Real estate, including real estate-insurance offices; Advertising; Personnel supply services; Detective and protective services; Business services, n.e.c.; Hotels and motels; Beauty shops; Miscellaneous personal services; Legal services Museums, art galleries, and zoos; Management and public relations services; Miscellaneous professional and related services

Tradable Meat products; Dairy products; Canned, frozen, and preserved fruits and vegetables; Grain mill products; Bakery products; Sugar and confectionery products; Beverage industries; Misc. food preparations and kindred products; Food industries, n.s.; Tobacco manufactures; Knitting mills; Dyeing and finishing textiles, except wool and knit goods; Carpets and rugs; Yarn, thread, and fabric mills; Apparel and accessories, except knit; Miscellaneous fabricated textile products; Pulp, paper, and paperboard mills; Miscellaneous paper and pulp products; Paperboard containers

and boxes; Plastics, synthetics, and resins; Drugs Soaps and cosmetics; Paints, varnishes, and related products; Agricultural chemicals; Industrial and miscellaneous chemicals; Petroleum refining; Miscellaneous petroleum and coal products; Tires and inner tubes; Other rubber products, and plastics footwear and belting; Miscellaneous plastics products; Footwear, except rubber and plastic; Leather products, except footwear; Logging Sawmills, planing mills, and millwork; Wood buildings and mobile homes; Furniture and fixtures; Glass and glass products; Cement, concrete, gypsum, and plaster products; Structural clay products; Pottery and related products; Misc. nonmetallic mineral and stone products; Blast furnaces, steelworks, rolling and finishing mills; Iron and steel foundries; Primary aluminum industries; Other primary metal industries; Cutlery, handtools, and general hardware; Fabricated structural metal products; Metal forgings and stampings; Ordnance; Miscellaneous fabricated metal products; Metal industries, n.s.; Engines and turbines; Farm machinery and equipment; Construction and material handling machines; Metalworking machinery; Computers and related equipment; Machinery, except electrical, n.e.c.; Machinery, n.s.; Household appliances; Radio, TV, and communication equipment; Electrical machinery, equipment, and supplies, n.e.c.; Motor vehicles and motor vehicle equipment; Aircraft and parts; Ship and boat building and repairing; Railroad locomotives and equipment; Guided missiles, space vehicles, and parts; Cycles and miscellaneous transportation equipment; Scientific and controlling instruments; Medical, dental, and optical instruments and supplies; Toys, amusement, and sporting goods; Miscellaneous manufacturing industries; Manufacturing industries, n.s.; Security, commodity brokerage, and investment companies; Computer and data processing services; Shoe repair shops; Theaters and motion pictures; Research, development, and testing services

Chapter 2

Robustness of local multipliers

2.1 Introduction

This chapter sets out to estimate the size of the local employment multiplier effect in the USA and evaluate the robustness of these estimates. The local employment multiplier is the ratio of the total number of additional jobs to the number of additional exogenous jobs.[1] I consider an exogenous shock to employment in the tradable sector, all industries that provide goods or services that are sold outside of the area in which they are produced including those sold internationally; and measure the effect on employment in the non-tradable sector, industries that mainly sell goods or services within the area in which they are produced. For example, a car manufacturing plant, an investment company or a movie studio is part of the tradable sector; and a restaurant, a car repair shop or a school is part of the non-tradable sector.

There is a major consulting industry with firms that produce off-the-shelf multipliers based on assumed input-output links and other modelling assumptions. These firms tend to predict large multipliers without providing standard errors. Policy makers can use these large multipliers and this false sense of precision as an ar-

[1] This is equivalent to the multiplier definition in the previous chapter plus one.

gument to justify the costs associated with attracting tradable jobs to a particular region. For example, by giving a tax break to specific firms (Greenstone and Moretti, 2003) or by investing in prestige technology projects.

Moretti (2010) uses a shift-share approach to estimate exogenous changes in employment in the tradable sector in Metropolitan Statistical Areas (MSAs) in the USA. An overview of shift-share identities is provided by Loveridge and Selting (1998) and it is used for example by Bartik (1991), Blanchard and Katz (1992) and Bound and Holzer (2000).

Moretti (2010) subsequently estimates the effect of changes in employment in the tradable sector within an MSA on changes in employment in the non-tradable sector of that same MSA, using the shift-share approach to create an instrument for the changes in employment in the tradable sector. He finds a local employment multiplier of 2.6. This is a useful way to estimate local multipliers as it requires far less data than, for example, a traditional input-output model, which explicitly defines the input-output links. The findings are based on direct aggregate empirical observations of the development of employment in the tradable and non-tradable sector and report standard errors to assess their precision.

Van Dijk (2016) extends Moretti (2010) by using a more plausibly exogenous instrument, including more controls and allowing for tradable services. He compares a modified version of Moretti's (2010) non-linear approach to the linear approach of Faggio and Overman (2014). This chapter investigates the sensitivity of these estimates. Section 2.5 uses an estimation method similar to the linear approach from Van Dijk (2016), only without regression weights. This method is described in Section 2.4. The estimates in Moretti (2010) and Van Dijk (2016) are based on the MSA location of the worker. This chapter uses the same data and compares it to other area definitions: MSA location of the job data, Public Use Microdata Areas (PUMAs) and Commuting Zones (CZs). A description of the data used is provided in Section

2.3. The impact of including fixed effects, allowing for a more flexible classification of industries between the tradable and non-tradable sector, and an alternative data source are also considered. I show that the local employment multiplier for MSAs in the USA is 2.1 and that this result is robust to two data sets, a range of controls and different ways of classifying tradable industries.

I also consider the impact of the type of job on the multiplier size by splitting employment in the tradable and non-tradable sector into two categories: skilled and unskilled jobs. A shock to skilled employment in the tradable sector has a local employment multiplier of 3.05. I find that 100 new skilled jobs in the tradable sector create 89 skilled and 116 unskilled additional jobs in the non-tradable sector. The multiplier for unskilled jobs in the tradable sector is not significant.

The large predicted multipliers from Moretti (2010) have gathered a lot of attention, also outside of the scientific community, possibly due to the inclusion of the results in Moretti's recent book (2012). Therefore, Section 2.6 pays special attention to these results by replicating them and demonstrating the sensitivity of his results to six idiosyncrasies of his analysis. The replication of Moretti (2010) shows that he misreported the estimates for durable and non-durable tradable goods: in contrast to his reported finding the multiplier for durable goods *is* significant and the multiplier for non-durable goods is *not* significant. Finally, Moretti made some arithmetic errors in determining the effect of skilled and unskilled jobs in the tradable sector on (un)skilled jobs in the non-tradable sector, which led to over-reporting the effect by a factor of two.

2.2 Conceptual framework

My analysis starts from the conceptual framework as used in Moretti (2010), which builds on Rosen (1979) and Roback (1982) and is described in more detail in Moretti

(2011). In this framework, each MSA is a competitive economy that uses labour to produce different tradable and non-tradable goods and services. The price of tradable goods and services is determined on the national or international market and is considered fixed from the perspective of an MSA. For the non-tradable goods, the price is determined locally. I assume labour is perfectly mobile across sectors within a region; and worker's utility depends on the net local wage and idiosyncratic preferences for location. Therefore the local labour supply curve is upward sloping. I make the assumption that the local housing supply curve is also upward sloping.

Consider a permanent increase in the local labour demand in a tradable industry. This has an obvious direct effect on the local economy: employment in the tradable sector increases. However, more interestingly, it also has an indirect effect on the rest of the tradable sector and the non-tradable sector. This includes general equilibrium effects on local prices: the wages of all workers will go up as well as the cost of housing.

The focus of this chapter lies on the positive effect on the local non-tradable sector. As a result of additional employment in a tradable industry the aggregate income of a region will increase. The aggregate income will increase more if the additional jobs in the tradable sector require high-skilled workers, as these workers command higher wages and these households consume more (Van Dijk and Oosterhaven, 1986). Part of this extra income will be spent on non-tradable goods, and the size of this share depends on the consumer preferences for non-tradable goods. This increased demand in non-tradable goods will increase the demand for labour in the non-tradable sector, where the magnitude of the labour demand increase depends on the technology of the non-tradable goods.

I determine the size of the local employment multiplier using a reduced form regression with a shift-share instrument. Section 2.4 discusses this estimation strategy in detail. This approach has several advantages over the standard input-output or

CGE type models. It does not make any *a priori* structural assumptions such as input-output links and it reports standard errors to assess the estimates' precision. The point estimates without standard errors in input-output models give a false sense of precision.

2.3 Data

Two separate data sources are used for my estimations of the local employment multiplier. The first data source is the Integrated Public Use Microdata Series (IPUMS) (Ruggles et al., 2015) and the second is the Quarterly Census of Employment & Wages of the Bureau of Labor Statistics (BLS) . This section starts out with a discussion of the IPUMS data and returns to the BLS data at the end. I use individual education, work and place of work data, as well as household geographic data from the 1980, 1990 and 2000 U.S. Census. Unfortunately, the 2010 Census does not provide three-digit industry data for employed individuals.

The 1980 Census sample consists of a flat 1-in-20 national random sample of the population. The 1990 and 2000 Census samples are also 1-in-20 national random samples of the population, but less densely populated areas are oversampled. It is possible to correct for this using the included weights, which allows me to recreate a flat sample. This does come at the cost of reduced precision.

The Census data is aggregated by year, area, education and industry. I consider four different regional definitions for the aggregation by area: metropolitan area of residence (MSA), commuting zone (CZ), Consistent Public Use Microdata Area (CPUMA) and metropolitan area of work (MSA of work).

It is important to note that the population of many MSAs are only partially identified in the Census data, and in many cases the unidentified portion is of considerable size. 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 based on county groups in 1980 and PUMAs in 1990 and 2000, areas that occasionally straddle official metro area boundaries. If any portion of a straddling area's population resided outside a single metro area, IPUMS uses a conservative assignment strategy and identifies no metro area for all residents of the straddling area. The MSA borders are also not defined consistently over time, which could bias the multiplier estimates. The issues with the MSA of work are similar to those of the MSA of residence.

The advantage of the CPUMA data is that it is defined consistently over time, but the area of analysis is considerably smaller than the MSA. Finally, CZs are also defined in a consistent way over time, but this data is not provided by IPUMS. Based on the cross-walk provided by Autor and Dorn (2013), the county group and Public Use Microdata Area (PUMA) data are converted into 1990 Commuting Zones.

IPUMS only provides data on 303 MSAs across the USA. For a fixed effects analysis of the local employment multiplier only the 219 MSAs that are observed in 1980, 1990 and 2000 can be used. My estimates are based on changes over time, so this results into 438 observations. Without fixed effects any MSA that has been observed for at least two consecutive Censuses can be used, allowing for 464 observations. A full list of MSAs included in the IPUMS data can be provided upon request. There are 221 MSAs of work observed in every Census, 543 CPUMAs and 740 CZs.

For MSAs and CPUMAs the smallest observed region - Sheboygan, Wisconsin - had 99660 inhabitants in 1980. On the other hand, there are 880 CZ observations with a population of less than 100. This is a result of the cross-walk used to determine the CZs. To make the CZ sample comparable to the other samples I truncate any CZ that is smaller than the smallest CPUMA at the start of the period, which leaves 246 CZs.

I am also interested in the heterogeneity of the multiplier across different types of jobs. The focus lies on the difference between jobs that require skilled labour and

those that do not. As a proxy for skill, the workers are split into two types based on education: skilled workers with at least one year of college education and unskilled workers with less than one year of college education.

For each employed individual the Census provides a three-digit NAICS industry. These industries are classified as tradable or non-tradable. The easiest way to do this, is by looking at super-industries. One can classify all manufacturing jobs as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. This division is proposed by Moretti (2010) and includes all services as non-tradable.[2]

Jensen and Kletzer (2006) use the geographic concentration of each service industry to determine its tradability. They calculate a Gini coefficient for all services and categorize Security, commodity brokerage, and investment companies; Computer and data processing services; Shoe repair shops; Theaters and motion pictures; Labour unions and Management; and public relations services as tradable services. They also classify Printing, publishing, and allied industries, except newspapers as non-tradable, although it is a NAICS manufacturing industry.

Instead of following Moretti (2010) or relying on Jensen and Kletzer (2006), I can also determine the geographical concentration of each three-digit industry myself. I exclude government jobs, but I will not restrict myself in any other way apart from the Gini coefficient I estimate. The Gini coefficient of each industry is calculated based on the MSA of work data using the method described by Jensen and Kletzer (2006). The Gini coefficient is given by

$$G_j = \left| 1 - \sum_c \left(\sigma Y_{j,c-1} + \sigma Y_{j,c} \right) \left(\sigma X_{j,c-1} - \sigma X_{j,c} \right) \right|$$

where c's index MSAs (sorted by the MSA's share of industry employment), $\sigma Y_{j,c}$ is

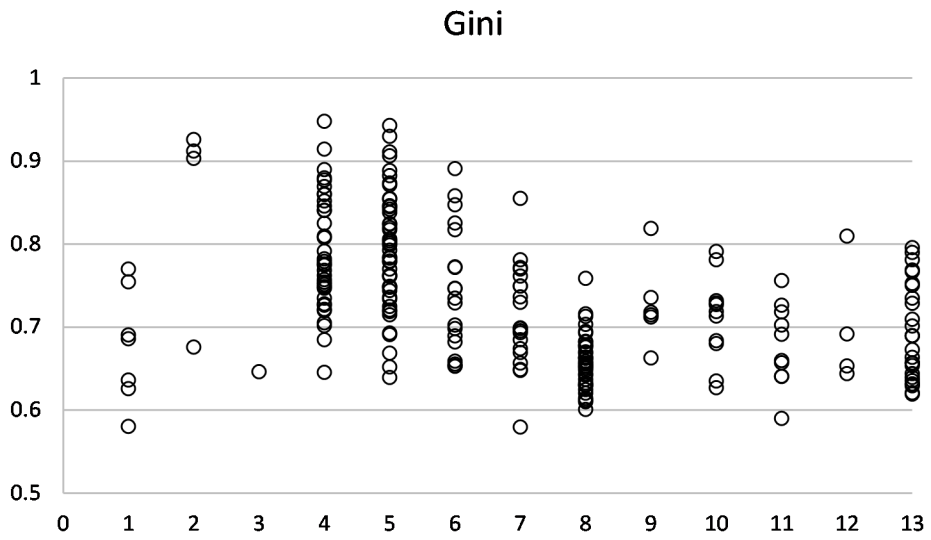
[2]Although in the empirical estimation of his multipliers Moretti classifies both agriculture and mining as non-tradable. I show this in my replication of his estimates in Section 2.6.

the cumulative share of industry j employment in MSA c and $\sigma X_{j,c}$ is the cumulative share of total employment in MSA c. The estimated Gini coefficients range from 0.58 to 0.95. An industry that has an equal share of employment in each MSA would have a Gini coefficient of 0 and an industry that is only located in a single MSA would have a Gini coefficient of approximately 1. When the goods or services produced can be easily traded, there is less of a need for firms to be close to their costumers which allows them to cluster. Therefore I assume that industries with a low Gini coefficient are (mostly) non-tradable and industries with a high Gini coefficient are (mostly) tradable. My estimations considers three different cut-off points: 0.72, 0.75 and 0.80. These points are chosen such that 70%, 80% or 90% of all workers respectively are employed in the non-tradable sector. This analysis focusses around 80%, because this results into a tradable sector of comparable size to all manufacturing industries combined. This way the size of the tradable sector is not changed with respect to Moretti (2010). Section 2.5 shows that most of my results are robust to the choice of cut-off point.

Figure 2.1 shows the Gini coefficient for all three-digit industries by category: 1) agriculture; 2) mining; 3) construction; 4) non-durable manufacturing; 5) durable manufacturing; 6) transportation; 7) wholesale trade; 8) retail trade; 9) finance; 10) business services; 11) personal services; 12) entertainment; and 13) professional services. Considering the 0.80 cut-off, only mining, manufacturing and transportation have a large share of industries in the tradable sector. All other sectors are almost exclusively non-tradable. This is not surprising, but there are also many non-tradable industries in manufacturing; and some non-manufacturing industries such as Apparel, fabrics, and notions; Security, commodity brokerage, and investment companies; and Theaters and motion pictures are tradable.

Finally, the Bureau of Labor Statistics published quarterly employment data for MSAs with detailed industry information from 1990 till 2014 based on the place of

Figure 2.1: *Spatial concentration of three-digit industries.*



work. This allows me to do some robustness checks on the IPUMS data with more recent observations. For example, the yearly data from 1990, 1998, 2006 and 2014. Reducing the time interval to eight years allows for three observations per MSA instead of two. These extra observations are needed, because a significant part of the detailed industry data is suppressed by the Bureau of Labor Statistics. To adjust for this I add up employment across all three-digit industries for each MSA and year pair. The BLS also provides data on total employment for each pair, if less than 90% of this employment is captured in the three-digit data the observation is dropped.

The cleaned BLS data contains 171 MSAs. 82 MSAs can be used in the fixed effects analysis, because they are observed at least three times, for a total of 219 observations. This data set does not include education data. I use the same Gini coefficient approach to determine which industries are tradable and non-tradable.

2.4 Empirical method

I am interested in the effect of labour demand shocks in the tradable sector on employment in the non-tradable sector of the same region.[3] This effect is estimated with the following regression model

$$\begin{aligned}\frac{E^{\mathrm{NT}}_{c,t+s}-E^{\mathrm{NT}}_{c,t}}{E^{\mathrm{NT}}_{c,t}+E^{\mathrm{T}}_{c,t}} &= \alpha+\beta\frac{E^{\mathrm{T}}_{c,t+s}-E^{\mathrm{T}}_{c,t}}{E^{\mathrm{NT}}_{c,t}+E^{\mathrm{T}}_{c,t}}+\gamma S_{c,t}+ \\ &\sum_{y}\delta_y 1\left(t=y\right)+\sum_{a}\delta_a 1\left(c=a\right)+\varepsilon_{c,t}. \qquad (2.1)\end{aligned}$$

In this expression $E^{\mathrm{NT}}_{c,t}$ is the total employment in the non-tradable sector of region c at time t and $E^{\mathrm{T}}_{c,t}$ is the total employment in the tradable sector. $S_{c,t}$ is the share of persons in the labour force with at least one year of college education. The dependent variable can be interpreted as the contribution of employment in the non-tradable sector to total employment growth in region c between year t and year $t+s$. The main regressor can be interpreted in a similar manner for the contribution of the tradable sector. The sum of the dependent variable and the main regressor is equal to the total growth rate of employment in the region.

When estimating Eq. (2.1) any co-movement between jobs in the tradable and the non-tradable sector is captured by β. There are three types of co-movement: the effect of tradable jobs on non-tradable jobs, the effect of non-tradable jobs on tradable jobs; and other variables that affect both tradable and non-tradable jobs. The first, the causal effect of extra jobs in the tradable sector on employment in the non-tradable sector, is the effect of interest. The second is not a big issue, the effect of non-tradable employment on tradable jobs will be small as the MSA is small relative to the world and tradable workers don't produce for local consumption. The issue is this estimation is the third effect, the estimate of β will be confounded due to endogeneity and omitted variables, for example effective local government will

[3] This could be an MSA, CZ or CPUMA.

increase jobs in both sectors.

The causal effect of employment in the tradable sector on employment in the non-tradable sector is isolated with an instrumental variable analysis. It is possible to isolate exogenous shifts in the demand for labour in the tradable sector using a shift-share approach

$$B_{c,t+s} = \sum_{j \in T} \left\{ E^{j}_{c,t} \frac{\sum_{c' \in C \setminus c} E^{j}_{c',t+s}}{\sum_{c' \in C \setminus c} E^{j}_{c',t}} \right\}. \tag{2.2}$$

It consists of a weighted average of the national growth of each three-digit tradable industry by the lagged size of each industry in the region. $E^{j}_{c,t}$ is the employment in tradable industry j of region c at time t. C is the set of all observed regions. I do not include the own region c in determining the national trend for each industry. It is possible to use $B_{c,t+s}$ to construct an instrumental variable for the contribution of the tradable sector to employment growth, which allows me to use the following first-stage regression

$$\begin{aligned} \frac{E^{\mathrm{T}}_{c,t+s} - E^{\mathrm{T}}_{c,t}}{E^{\mathrm{NT}}_{c,t} + E^{\mathrm{T}}_{c,t}} &= \pi_0 + \pi_1 \frac{B_{c,t+s} - E^{\mathrm{T}}_{c,t}}{E^{\mathrm{NT}}_{c,t} + E^{\mathrm{T}}_{c,t}} + \pi_2 S_{c,t} + \\ &\quad \sum_{y} \phi_y 1\left(t = y\right) + \sum_{a} \phi_a 1\left(c = a\right) + \mu_{c,t}. \end{aligned} \tag{2.3}$$

Using this two-stage least squares approach it is possible to find a consistent estimate for β, where $1 + \beta$ can be interpreted as the local employment multiplier. It is also possible to use $B_{c,t+s}$ to construct an alternative main regressor and directly estimate the local multiplier, see for example Partridge et al. (2016).

An alternative is the Regress-M instrument as described in Détang-Dessendre et al. (2016). Instead of determining the national growth rate, this approach uses a regression across all regions to determine the impact of each tradable industry on tradable employment growth. This is determined by regressing employment growth

on the share of each industry

$$\frac{E^{\mathrm{T}}_{c',t+s} - E^{\mathrm{T}}_{c',t}}{E^{\mathrm{NT}}_{c',t} + E^{\mathrm{T}}_{c',t}} = \sum_{j \in T} \left(b^{j}_{c,t} \frac{E^{j}_{c',t}}{E^{\mathrm{NT}}_{c',t} + E^{\mathrm{T}}_{c',t}} \right) + v_{c',t} \quad \text{for } c' \in C \setminus c. \tag{2.4}$$

If $b^{j}_{c,t}$ is large and positive, most cities with a high share of industry j have had a growing tradable sector. On the other hand, if $b^{j}_{c,t}$ is negative, cities with a large share in industry j experienced a smaller growth or a decline of their tradable sector. The Regress-M instrument is based on the predicted values

$$R_{c,t+s} = \sum_{j \in T} \left(\hat{b}^{j}_{c,t} \frac{E^{j}_{c,t}}{E^{\mathrm{NT}}_{c',t} + E^{\mathrm{T}}_{c',t}} \right). \tag{2.5}$$

The region for which the instrument is predicted is not included in the regression to estimate the parameters used in the prediction. In the first-stage regression shown in Eq. (2.3), $B_{c,t+s}$ can be replaced by $R_{c,t+s}$.

It is also possible to differentiate between the effect of a shock to skilled workers in the tradable sector and unskilled workers in the tradable sector. This can be achieved by splitting the main regressor into two parts

$$\begin{aligned} \frac{E^{\mathrm{NT}}_{c,t+s} - E^{\mathrm{NT}}_{c,t}}{E^{\mathrm{NT}}_{c,t} + E^{\mathrm{T}}_{c,t}} &= \alpha + \beta_S \frac{E^{\mathrm{T,S}}_{c,t+s} - E^{\mathrm{T,S}}_{c,t}}{E^{\mathrm{NT}}_{c,t} + E^{\mathrm{T}}_{c,t}} + \beta_U \frac{E^{\mathrm{T,U}}_{c,t+s} - E^{\mathrm{T,U}}_{c,t}}{E^{\mathrm{NT}}_{c,t} + E^{\mathrm{T}}_{c,t}} + \\ &\quad \gamma S_{c,t} + \sum_{y} \delta_y 1\,(t = y) + \sum_{a} \delta_a 1\,(c = a) + \varepsilon_{c,t}. \end{aligned} \tag{2.6}$$

In this expression $E^{\mathrm{T,S}}_{c,t}$ is the total number of skilled workers in the tradable sector of region c at time t and $E^{\mathrm{T,U}}_{c,t}$ represents unskilled workers in the same sector. It is also possible to only consider the effect on skilled workers in the non-tradable sector by replacing $E^{\mathrm{NT}}_{c,t+s} - E^{\mathrm{NT}}_{c,t}$ with $E^{\mathrm{NT,S}}_{c,t+s} - E^{\mathrm{NT,S}}_{c,t}$ in the numerator on the LHS of Eq. (2.6), or to consider the effect on unskilled workers in the non-tradable sector by using $E^{\mathrm{NT,U}}_{c,t+s} - E^{\mathrm{NT,U}}_{c,t}$ instead.

Regardless of the choice of dependent variable two instrumental variables are

needed, one for the contribution of skilled tradable employment to total employment growth and one for the contribution of unskilled tradable employment to total employment growth. These instruments are constructed in a method completely analogous to the unsplit case, only both based on approximately half of the tradable employment data.

My approach is based on Moretti (2010), Tsvetkova and Partridge (2016) and Faggio and Overman (2014). I stay closest to Faggio and Overman (2014), but my method has some significant differences with respect to Moretti (2010). Because Section 2.6 replicates and discusses some of the idiosyncrasies of Moretti (2010), I briefly show Moretti's approach in this section as well.

Moretti estimates the elasticity between the tradable and the non-tradable sector with the following model

$$\ln E^{\mathrm{NT}}_{c,t+s} - \ln E^{\mathrm{NT}}_{c,t} = \alpha^M + \beta^M \left(\ln E^{\mathrm{T}}_{c,t+s} - \ln E^{\mathrm{T}}_{c,t}\right) + \delta^M 1\left(t = 1990\right) + e_{c,t}. \quad (2.7)$$

He only includes a single time dummy variable, and he does not include any other controls or MSA fixed effects. His regression is weighted by $E^{\mathrm{NT}}_{c,1990} + E^{\mathrm{T}}_{c,1990}$, the sum of employment in the tradable and non-tradable for the MSA in 1990, without clear justification. The instrument he uses is also based on the Bartik shift-share approach, but includes the own region

$$B^M_{c,t+s} = \sum_{j \in T} \left\{ E^j_{c,t} \left[\ln \left(\sum_{c' \in C} E^j_{c',t+s} \right) - \ln \left(\sum_{c' \in C} E^j_{c',t} \right) \right] \right\}. \quad (2.8)$$

His first-stage regression is given by

$$\ln E^{\mathrm{T}}_{c,t+s} - \ln E^{\mathrm{T}}_{c,t} = \pi^M_0 + \pi^M_1 \frac{B^M_{c,t+s}}{E^{\mathrm{T}}_{c,t}} + \phi^M 1\left(t = 1990\right) + u_{c,t}. \quad (2.9)$$

The estimated value for β^M using the two-stage least squares approach could be

biased due to the possible endogeneity of the instrument. To interpret β^M as a multiplier it has to be multiplied by the relative size of the non-tradable sector to the tradable sector. Moretti uses the relative size of both sectors in 1990 to calculate the following multiplier

$$\beta^M \frac{\sum_{c \in C_t} E^{\mathrm{NT}}_{c,1990}}{\sum_{c \in C_t} E^{\mathrm{T}}_{c,1990}}. \tag{2.10}$$

This multiplier, as reported in Moretti's paper, does not follow the conventional definition. It is possible to convert Moretti's multiplier to a traditional input-output multiplier by adding one.

2.5 Results

I estimate the effect of a shock to employment in the tradable sector on employment in the non-tradable sector of the same MSA. The main regressor is the contribution of the tradable sector to total employment growth over a ten year period and the dependent variable is the change in employment in the non-tradable sector measured in an analogous way.

I measure the geographical spread of each industry and calculate a corresponding Gini coefficient. All private sector employment is split into three-digit NAICS industries and ordered by their Gini coefficient. The cut-off is defined such that 80% of all workers are employed in an industry with a Gini coefficient below this point and 20% of all workers are employed in an industry above this point. The former is the non-tradable sector and the latter the tradable sector.

A control is included for the share of those participating in the labour market with at least 1 year of college education in each MSA. Fixed effects for each MSA and a dummy variable for the second time period are also included. The result of this estimation is shown in Column (1) of Table 2.1. The estimated coefficient of

2.97 is likely to suffer from omitted variable bias.[4] Therefore I estimate the change in employment in the tradable sector using a shift-share approach and use this as in instrument for the actual change. This allows me to do an instrumental variable analysis.

The outcome of the IV estimation with the shift-share instrument is shown in Column (2). The estimated coefficient of 0.58 suggests that the OLS result is biased upwards.[5] The coefficient can be interpreted as follows: a shock of 100 new jobs in the tradable sector creates 58 additional jobs in the non-tradable sector; the total number of jobs created is 158. This is a local employment multiplier of 1.58. The effect of a shock to employment in the tradable sector is not significant in this case.[6] The first-stage F-statistic of 22 and the first-stage estimates in Column (1) of Table 2.2 suggest no weak instrument problem.

This identification strategy does have some limitations, because of the effect of commuting and changing MSA borders over time. Multipliers should be based on firm job creation and not on the worker; for each worker the variable of interest is their place of work, not their place of residence. When workers do not commute there is no problem to rely on the place of residence as it will be the same as the place of work. But for workers that do commute, an estimation of the multiplier based on place of residence data will be biased.

The issue of commuting can be addressed in two different ways. The first approach is to use the cross-walk to 1990 Commuting Zones (CZs) provided by Autor and Dorn (2013), instead of clustering county groups and Public Use Microdata Area's (PUMAs) into MSAs. These areas are defined to capture the majority of com-

[4]Because Anchorage, Alaska and Honolulu, Hawaii are not connected to the U.S. mainland, I can leave them out as a robustness check. The estimated coefficient for contribution tradable is 3.00 when I do not include Anchorage and Honolulu.

[5]The estimated coefficient for contribution tradable is 0.47 when Anchorage, Alaska and Honolulu, Hawaii are not included.

[6]Although the multiplier effect is 2.2 and significant when the MSA fixed effects are not included, as shown in Table 2.16 of Appendix 2.A.

Table 2.1: *OLS and Bartik IV estimates of the local employment multiplier for five different geographical definitions*

	MSA		CZ		CPUMA		work MSA		BLS MSA	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Contribution tradable	2.97***	0.58	3.45***	2.17***	1.00***	1.01***	2.71***	1.09***	0.93***	1.40**
	(0.28)	(0.45)	(0.14)	(0.31)	(0.09)	(0.11)	(0.15)	(0.30)	(0.17)	(0.58)
1+ Years of college education	-0.26	-0.22	1.62***	2.38***	-0.73***	-0.73***	-0.31	-0.21		
	(0.40)	(0.58)	(0.39)	(0.52)	(0.12)	(0.12)	(0.46)	(0.71)		
Constant	0.25	0.17	-0.19*	-0.28*	0.36***	0.36***	0.32*	0.27	0.08**	0.07
	(0.17)	(0.22)	(0.11)	(0.14)	(0.04)	(0.04)	(0.19)	(0.28)	(0.04)	(0.05)
Observations	438	438	492	492	1,086	1,086	438	438	219	219
Adjusted R^2	0.53	0.13	0.66	0.54	0.61	0.61	0.60	0.38	0.57	0.55
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		22		40		245		21		9

Note: Robust standard errors in parentheses. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.2: *First-stage estimations for both the Bartik and the regression instrument*

	MSA		CZ		CPUMA		work MSA		BLS MSA	
	Bartik	Regress	Bartik	Regress	Bartik	Regress	Bartik	Regress	Bartik	Regress
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Instrument	0.77***	0.20***	1.25***	0.17**	1.01***	0.67***	0.93***	0.23***	0.63***	0.16***
	(0.12)	(0.05)	(0.14)	(0.07)	(0.05)	(0.04)	(0.14)	(0.05)	(0.16)	(0.05)
1+ Years of college education	-0.09	0.02	0.56***	0.61***	-0.29***	-0.12**	-0.11	0.10		
	(0.15)	(0.15)	(0.17)	(0.18)	(0.05)	(0.05)	(0.30)	(0.32)		
Constant	0.01	-0.03	-0.03	-0.08	0.09***	0.02	0.03	-0.05	0.02	0.03**
	(0.06)	(0.06)	(0.06)	(0.07)	(0.02)	(0.02)	(0.12)	(0.13)	(0.01)	(0.01)
Observations	438	438	492	492	1,086	1,086	438	438	219	219
Adjusted R^2	0.12	0.07	0.00	-0.12	0.69	0.66	0.13	0.06	0.27	0.24
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. The dependent variable is the contribution of employment in the tradable sector to total employment growth. In all odd columns instrument is based on Bartik's shift-share approach and in all even columns it is based on the Regress-M instrument. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

muting, therefore the concern of individuals working outside of the CZ they reside in is reduced. The second approach is to use the MSA of work, instead of the MSA of residence, as reported in the Census to determine the location of each job. The results for both these approaches are also found in Table 2.1. A comparison of the OLS and Bartik IV results shows that the OLS estimates have a consistent upwards bias. The Bartik IV results show a local employment multiplier of 3.17 and 2.09 for the CZs and MSAs of work respectively.[7] Both estimates are large and significant with a strong first-stage result as shown in Table 2.2.

A limitation that remains is the changing borders of MSAs over time. This is not an issue for the CZ estimations, but it can also be addressed by using the specially constructed Consistent Public Use Microdata Area (CPUMA). The CPUMAs allow for a more detailed geographical level of analysis. The results in Table 2.1 do not show a bias for the OLS estimate compared to the Bartik IV approach. The Bartik IV result is a significant local employment multiplier of 2.01.[8] This is larger than the multiplier estimated for MSAs, which suggests that the changing of MSA borders over time creates a downwards bias for the estimation results. The larger estimate for CZs could be explained by the average size of CZs included in the sample compared to CPUMAs. The average included CZ has 736 thousand inhabitants, whilst the average CPUMAs only has 464 thousand inhabitants. One would expect larger areas to have bigger multipliers, as a larger share of the effect can be captured.

Although I compared four different ways of clustering employment geographically, the estimates all stem from the same Census data. As a robustness check this is compared to the Quarterly Census of Employment & Wages of the Bureau of Labour Statistics. For this data the geographical unit of analysis is once again the MSA, but the data is more recent (1990-2014) and allows me to consider three eight year

[7]The MSA of work multiplier is 2.06 when the Anchorage, Alaska and Honolulu, Hawaii are not included.

[8]The multiplier is 2.02 when Anchorage, Alaska and Honolulu, Hawaii are not included.

periods instead of two ten year periods. The results are also shown in Table 2.1. In this case the OLS estimates are biased downwards. The size of the local multiplier is 2.40 for the Bartik IV estimation. Part of the BLS data is suppressed, so only MSAs for which 90% of employment was identified at the three-digit level are considered. This still left some incomplete observations, which could explain the low first-stage F-statistic of 9. The BLS data also did not include any education data, therefore this control is missing. The BLS results can be interpreted as a robustness check over time, the multiplier seems to have increased a little since 2000. The first-stage estimates for all IV results in Table 2.1 are shown in Table 2.2.

I have compared five OLS and IV estimates using a shift-share instrument. It is possible to test the robustness of this instrument by comparing it to an alternative, the "Regress Instrument" (Détang-Dessendre et al., 2016). Table 2.3 shows the estimation results for all five geographical definitions using this instrument. In comparison to Table 2.1 the results using the shift-share instrument are always more conservative. Unfortunately the regression instrument only provides limited information as it suffers from a weak instrument problem in all cases but the CPUMA. This can be seen from the first-stage F-statistics as shown in Table 2.3. The first-stage estimates for this instrument are also shown in Table 2.2.

Place of work data seem theoretically most appropriate and the MSA of work estimations from the IPUMS data appear to give a robust yet conservative estimate of the size of the local multiplier, therefore further robustness checks are focussed here. Two robustness checks are performed. First, the allocation of the three-digit industries between the tradable and the non-tradable sector is changed. Second, the control for education and the MSA fixed effects are removed. The same robustness checks for the Metropolitan Areas of residence, the Commuting Zones, the Consistent Public Use Microdata Areas and the Bureau of Labor Statistics data are given in Appendix 2.A.

Table 2.4 shows estimates for the size of the effect of employment in the tradable

Table 2.3: *IV estimates using the regression instrument of the local employment multiplier for five different geographical definitions*

	MSA (1)	CZ (2)	CPUMA (3)	work MSA (4)	BLS MSA (5)
Contribution tradable	1.06	4.50***	1.54***	1.92***	1.84**
	(0.89)	(0.96)	(0.14)	(0.52)	(0.75)
1+ Years of	-0.23	0.99	-0.65***	-0.26	
college education	(0.53)	(0.65)	(0.13)	(0.54)	
Constant	0.19	-0.11	0.34***	0.30	0.05
	(0.21)	(0.14)	(0.04)	(0.22)	(0.05)
Observations	438	492	1,086	438	219
Adjusted R^2	0.27	0.58	0.59	0.55	0.50
Year FE	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES
First-stage statistic	7	3	179	10	5

Note: Robust standard errors in parentheses. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. Each estimation is based on an instrumental variable approach using the Regress-M Instrument. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

sector on employment in the non-tradable sector for five different definitions of these sectors within the MSA of work.[9] In the first two columns the tradable sector is defined as all manufacturing jobs and the non-tradable as all other jobs except for agriculture, mining and government; which are left out of the analysis. In Columns (3) and (4) the tradable and non-tradable sector are defined in a similar manner, except some services are now included in the tradable sector. These services are classified as tradable based on the Gini coefficient analysis of Jensen and Kletzer (2006). Finally, Columns (5) - (10) consider the spatial distribution of all three-digit industries. The result labelled 80% are the same as shown in Columns (7) and (8) of

[9]The estimated multiplier is 1%-3% smaller when Anchorage, Alaska and Honolulu, Hawaii are not included.

Table 2.4: *OLS and Bartik IV estimates of the local employment multiplier for the MSA of work and five different definitions of the tradable and non-tradable sector*

	Services		Nontrad. Services		70% nontrad.		80% nontrad.		90% nontrad.	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Contribution tradable	2.67***	1.47***	2.53***	1.53***	1.80***	1.14***	2.71***	1.09***	3.99***	1.12**
	(0.16)	(0.26)	(0.17)	(0.25)	(0.10)	(0.19)	(0.15)	(0.30)	(0.39)	(0.46)
1+ Years of college education	-1.31***	-0.91	-1.42***	-1.04	-0.25	-0.21	-0.31	-0.21	-0.59	-0.30
	(0.44)	(0.65)	(0.46)	(0.64)	(0.32)	(0.43)	(0.46)	(0.71)	(0.78)	(1.02)
Constant	0.76***	0.59**	0.79***	0.63**	0.27*	0.25	0.32*	0.27	0.49	0.33
	(0.18)	(0.26)	(0.19)	(0.25)	(0.14)	(0.17)	(0.19)	(0.28)	(0.33)	(0.40)
Observations	438	438	438	438	438	438	438	438	438	438
Adjusted R^2	0.69	0.56	0.70	0.60	0.74	0.64	0.60	0.38	0.42	0.19
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		18		19		18		21		33

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (1) and (2), all manufacturing jobs are classified as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. In Columns (3) and (4), some services are classified tradable. In Columns (5)-(10), all three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70%, 80% or 90% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.1 as the cut-off was chosen such that 80% of all jobs are in the non-tradable sector as described at the start of this section. The results labelled 70% and 90% are constructed in a similar manner with fewer or more jobs allocated to the non-tradable sector respectively.

The OLS results span a wide range, indicating a multiplier between 2.80 and 4.99, but compared to the IV results they are all upwards biased. The IV results lie closer together ranging from a multiplier of 2.09 to 2.53. In the final three cases, where only industries with a large enough spatial clustering are labelled tradable, the multiplier estimates are all very close to 2.1. This suggests that my analysis is not sensitive to the exact cut-off between tradable and non-tradable industries. These three cases are also very similar when considering CPUMAs as shown in Table 2.14 in Appendix 2.A. In the appendix, Tables 2.12 and 2.15 show that the IPUMS MSA of residence data and the BLS MSA of work data are a bit more sensitive, but the CZ estimates are clearly the most sensitive. The multiplier in Commuting Zones ranges from 2.68 at the 70% level to 3.27 at the 90% level as shown in Table 2.13 in the Appendix 2.A.

Finally, consider the impact of the control for education and the area fixed effects. Table 2.5 shows these controls have little effect on the OLS estimates and removing the controls increases the estimated size of the multiplier when using the shift-share instrument.[10] Considering this result and the limited sensitivity to the exact definition of the tradable and non-tradable sector, a local employment multiplier of 2.1 seems to be a robust lower bound. A shock of 100 new jobs in the tradable sector creates 110 additional jobs in the non-tradable sector.

Table 2.16 in Appendix 2.A shows that removing the area fixed effects also increases the multiplier size when considering the MSAs of residence. For CZs, CPUMAs and the BLS MSAs the estimated size of the local multiplier is smaller

[10]The estimated multiplier is 0.4%-1.4% smaller when Anchorage, Alaska and Honolulu, Hawaii are not included.

Table 2.5: *OLS and Bartik IV estimates of the local employment multiplier for the MSA of work with different combinations of controls*

	OLS (1)	Bartik IV (2)	OLS (3)	Bartik IV (4)	OLS (5)	Bartik IV (6)
Contribution tradable	2.66***	1.37***	2.74***	1.41***	2.71***	1.09***
	(0.15)	(0.26)	(0.16)	(0.30)	(0.15)	(0.30)
1+ Years of			-0.32***	-0.04	-0.31	-0.21
college education			(0.10)	(0.11)	(0.46)	(0.71)
Constant	0.20***	0.25***	0.31***	0.26***	0.32*	0.27
	(0.01)	(0.01)	(0.04)	(0.04)	(0.19)	(0.28)
Observations	475	475	475	475	438	438
Adjusted R^2	0.64	0.49	0.65	0.50	0.60	0.38
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	NO	NO	NO	NO	YES	YES
First-stage statistic		47		32		21

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

without the area fixed effects, as shown in Tables 2.17, 2.18 and 2.19 respectively. Without the area fixed effects the estimated local employment multiplier for CPUMAs is 1.44. The multiplier for the other three regional definitions ranges between 2.07 and 2.26, which is close to the estimate based on the MSA of work.

2.5.1 Skilled and unskilled workers in the tradable sector

It is possible to split the tradable sector into a skilled and unskilled part and consider the effect of a shock to each part separately. Again 80% of all jobs are considered non-tradable and a control for the share of skilled workers and year and area fixed effects are included. The results for the MSA of work are given in Table 2.6. The OLS results for the impact of skilled and unskilled tradable sector jobs on all non-tradable jobs are given in Column (1); there is a large significant effect for both parts of the

Table 2.6: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the MSA of work at 80% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	2.24***	2.05***	1.19***	0.89***	1.05***	1.16***
	(0.20)	(0.44)	(0.11)	(0.18)	(0.12)	(0.29)
Tradable - unskilled	3.48***	-0.34	1.71***	1.16***	1.77***	-1.50***
	(0.46)	(0.68)	(0.21)	(0.30)	(0.26)	(0.47)
1+ Years of	-0.62	0.37	-1.07***	-0.99***	0.45*	1.36**
college education	(0.47)	(0.76)	(0.23)	(0.27)	(0.27)	(0.54)
Constant	0.47**	-0.02	0.63***	0.59***	-0.16	-0.61***
	(0.20)	(0.31)	(0.10)	(0.12)	(0.12)	(0.21)
Observations	438	438	438	438	438	438
Adjusted R^2	0.61	0.34	0.77	0.73	0.56	0.04
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES
First-stage statistic		13		13		13

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

tradable sector. The IV estimates in Column (2) show that this is upwards biased.

The local employment multiplier for skilled tradable jobs is 3.05, which is significant and larger than the multiplier for all tradable jobs. This multiplier can be decomposed into estimates of the effect on skilled and unskilled non-tradable employment as shown in Column (4) and (6) respectively. For each 100 new skilled jobs in the tradable sector, there are 89 additional skilled jobs and 116 additional unskilled jobs created in the non-tradable sector of the same MSA. I don't find a significant overall effect of a shock to unskilled jobs in the tradable sector. The first-stage results

Table 2.7: *First-stage estimations for skilled and unskilled jobs in the tradable sector for four different geographical definitions*

	MSA		CZ		CPUMA		work MSA	
	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tradable - skilled IV	0.59***	-0.08	0.83***	0.04	0.62***	-0.19***	0.94***	-0.02
	(0.22)	(0.07)	(0.10)	(0.10)	(0.05)	(0.03)	(0.23)	(0.09)
Tradable - unskilled IV	0.04	0.74***	0.32***	1.22***	0.09***	1.09***	-0.14	0.70***
	(0.09)	(0.08)	(0.10)	(0.16)	(0.03)	(0.04)	(0.18)	(0.10)
1+ Years of	-0.26***	0.21***	0.04	0.55***	-0.35***	0.12***	-0.18	0.18
college education	(0.08)	(0.08)	(0.08)	(0.10)	(0.03)	(0.03)	(0.19)	(0.14)
Constant	0.10***	-0.09***	0.06**	-0.06	0.13***	-0.03***	0.06	-0.08
	(0.03)	(0.03)	(0.03)	(0.04)	(0.01)	(0.01)	(0.08)	(0.05)
Observations	438	438	492	492	1,086	1,086	438	438
Adjusted R^2	0.24	0.52	0.38	0.22	0.78	0.81	0.32	0.37
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. The dependent variable is the contribution of (un)skilled employment in the tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

are reported in Columns (1) and (2) of Table 2.7.

As a first robustness, the cut-off point for the non-tradable sector is changed. Tables 2.20 and 2.21 in Appendix 2.A show similar results when 70% or 90% of all workers are employed in the non-tradable sector respectively. In all three cases the following holds: skilled tradable jobs have a larger effect than unskilled tradable jobs on total employment in the non-tradable sector; and skilled tradable jobs have a positive effect and unskilled tradable jobs have a negative effect on unskilled employment in the non-tradable sector. The difference is that the overall effect of unskilled tradable jobs *is* significant in the 70% case.

As a second robustness check the MSA of residence, the CZ and the CPUMA are considered, keeping the cut-off at 80%. As shown in Tables 2.22, 2.23 and 2.24, the actual estimates differ, but all agree that: a shock to skilled jobs in the tradable sector has a significant positive effect on both skilled and unskilled employment in the non-tradable sector; a shock to unskilled jobs in the tradable sector also has a significant positive effect on skilled employment in the non-tradable sector, but never has a significant positive effect on unskilled employment in the non-tradable sector. The first-stage estimates for all geographical units of analysis are given in Table 2.7.

2.6 Moretti's results

The local employment multipliers as predicted by Moretti (2010) have gained a lot of attention and are cited in the media to support considerably larger multipliers and larger spillovers than what has long been conventional economic wisdom. Therefore it felt appropriate to pay extra attention to this publication. I replicate Moretti's results based on a partial specification provided by Moretti to me in private communication. This section discusses the outcomes of this replication as well as some arithmetic errors found in Moretti's publication. Subsequently it discusses the impact of several

idiosyncrasies in Moretti's approach on the estimated size of the local multiplier.

2.6.1 Replication

Moretti (2010) uses a log approach to estimate the elasticity between a shock to employment in the tradable sector and employment in the non-tradable sector. The outcome of my replication of the estimation of these elasticities is shown in Table 2.8. The top rows report the dependent variable of each estimation as well as the one or two main regressors. The estimates for these regressors are reported with three decimals to allow for full comparison with Moretti, as he does the same. The estimates Moretti reports are included at the bottom of the table for convenience, he did not report first-stage F-statistics or the R^2.

Moretti provided a detailed description of the estimation of the elasticity between the complete tradable and non-tradable sector, shown in Columns (1) and (2). As can be seen, I have been able to recreate his reported estimates almost exactly. I should note one important distinction between the method reported in his paper and the method I used for this replication, based on his personal communication with me. In the paper he states he does not consider agriculture or mining as either tradable or non-tradable, but to replicate his results one must include both as non-tradable.

Moretti splits the manufacturing sector into a durable and a non-durable part. He did not include the method used for this estimation in his communications with me, therefore I have to extend the method used for the previous estimation myself. Moretti does not state how he splits the manufacturing sector, so I assume he follows the definition given by the Census industry data. The results Moretti presents in his paper are given at the bottom of Columns (3) and (4). Moretti comments on these findings by stating: "when I split the manufacturing sector into durable and non-durable goods, I find a significantly larger elasticity for the latter". My replication of Moretti's results in the same columns suggests that Moretti accidentally switched the

Table 2.8: *Replication of the elasticity estimates from Moretti (2010)*

Dependent variable	All Non-tradable		All Non-tradable		All Non-tradable		Non-trad. - skilled		Non-trad. - unskilled	
Independent variable 1	All Tradable		Trad. - durable		Trad. - skilled		Trad. - skilled		Trad. - skilled	
Independent variable 2	-		Trad. - non-dur.		Trad. - unskilled		Trad. - unskilled		Trad. - unskilled	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Replication of Moretti 1	0.554***	0.336***	0.291***	0.250***	0.300***	0.298**	0.457***	0.243	0.091**	0.011
	(0.036)	(0.056)	(0.024)	(0.049)	(0.037)	(0.142)	(0.041)	(0.166)	(0.040)	(0.152)
Replication of Moretti 2			0.283***	0.074	0.283***	0.103	0.084**	-0.050	0.534***	0.408***
			(0.039)	(0.091)	(0.031)	(0.087)	(0.034)	(0.099)	(0.035)	(0.096)
Constant	0.30***	0.29***	0.29***	0.29***	0.26***	0.20**	0.43***	0.47***	0.12***	0.11
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.08)	(0.02)	(0.09)	(0.03)	(0.09)
Observations	464	464	464	464	464	464	464	464	464	464
Adjusted R^2	0.71	0.61	0.71	0.60	0.71	0.64	0.87	0.79	0.82	0.78
First-stage statistic		69		18		13		13		13
Moretti 1	0.554	0.335	0.283	0.006	0.287	0.257	0.420	0.208	0.109	0.03
	(0.036)	(0.055)	(0.039)	(0.138)	(0.037)	(0.157)	(0.044)	(0.176)	(0.039)	(0.172)
Moretti 2			0.290	0.250	0.292	0.115	0.125	-0.010	0.510	0.367
			(0.024)	(0.072)	(0.033)	(0.109)	(0.042)	(0.133)	(0.037)	(0.117)

Note: Robust standard errors in parentheses. Replication of the elasticities estimated in Moretti (2010). The results reported by Moretti are shown on the bottom rows.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

results for durable and non-durable goods. My OLS replication matches his results exactly when you switch his results around and my IV estimates come very close. So in fact, the multiplier for *durable* goods is significantly larger than the multiplier for non-durable goods.

Finally, I extend the description he provided, such that I could replicate his estimates for skilled and unskilled workers. Columns (5) - (8) shows some small differences, but generally my replication matches his estimated elasticities. These elasticities are converted into what Moretti calls "local multipliers", using his method, by multiplying them with the relative sector size. Traditionally the outcome of this operation would be considered the local multiplier minus one. The results of this conversion for the IV estimates are shown in Table 2.9. Columns (1) - (3) are what one would expect considering the discussion so far, but Columns (4) and (5) point to an arithmetic error made by Moretti. These columns consider the effect of shocks in tradable employment on only the skilled or unskilled part of the non-tradable sector. In Table 2.8 my replication of the elasticities is close to the values reported by Moretti, but the multipliers reported by Moretti are off by around a factor of two. This can be explained by the relative size between sectors Moretti uses to convert his elasticities into multipliers. He uses the relative size of the (un)skilled tradable sector to the *entire* non-tradable sector, whilst he only considers the skilled *or* unskilled workers in the non-tradable sector in this case.[11] As the skilled and unskilled part of the non-tradable sector are approximately evenly sized, this explains the overestimation of the multipliers by about a factor two.

[11] In 1990 8.4% of all jobs were skilled tradable, 8.9% were unskilled tradable, 47.8% were skilled non-tradable and 34.9% were unskilled non-tradable. Based on this the relative size of the skilled (unskilled) non-tradable sector to the skilled tradable sector is 5.7 (4.2), but Moretti used 9.8 in both cases; and the relative size of the skilled (unskilled) non-tradable sector to the unskilled tradable sector is 5.3 (3.9), but Moretti used 9.2 in both cases.

Table 2.9: *Replication of the "multiplier" estimates from Moretti (2010)*

Dependent variable	All Non-tradable	All Non-tradable	All Non-tradable	Non-trad. - skilled	Non-trad. - unskilled
Independent variable 1	All Tradable	Trad. - durable	Trad. - skilled	Trad. - skilled	Trad. - skilled
Independent variable 2	-	Trad. - non-dur.	Trad. - unskilled	Trad. - unskilled	Trad. - unskilled
	(1)	(2)	(3)	(4)	(5)
Replication of Moretti 1	1.60***	1.91***	2.93**	1.38	0.05
	(0.26)	(0.37)	(1.40)	(0.94)	(0.63)
Replication of Moretti 2		0.93	0.95	-0.26	1.59***
		(1.15)	(0.81)	(0.53)	(0.37)
Moretti 1	1.59	0.73	2.52	2.03	0.296
	(0.26)	(1.73)	(1.54)	(1.72)	(1.68)
Moretti 2		1.89	1.04	-0.09	3.34
		(0.54)	(0.99)	(1.21)	(1.06)

Note: Robust standard errors in parentheses. Replication of the "multipliers" estimated in Moretti (2010). The results reported by Moretti are shown on the bottom rows.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

2.6.2 Idiosyncrasies

The replication performed in the previous section gave me insight in several idiosyncrasies that are discussed here. Moretti's (2010) regressions are weighted by total employment, therefore he is estimating the average multiplier for residents of MSAs, instead of the average multiplier for U.S. MSAs. He included the own MSA in the calculation of the shift-share instrument, which could introduce an endogeneity problem into his estimation. He estimated the local multiplier in a non-linear way, because he uses log values. Therefore his results can be heavily affected by the relative employment shares in the sectors being considered, which can greatly change over time. He does not include any controls or area fixed effect, he only includes year fixed effects. He considers the MSA of residence instead of the MSA of work, this could lead to a biased estimate due to commuting. Finally, he did not allow for tradable services and included agriculture and mining as non-tradable.

Table 2.10 shows the effect of all these idiosyncrasies. Columns (1) and (2) repeat the replication of Moretti and all other columns show the estimated effect with a single change. The OLS results are reported in the odd columns and the IV results in the even columns. Column (4) shows that removing the regression weights reduces the estimates size of the multiplier by 0.38. Column (6) shows that removing the own MSA from the calculation of the instrument reduces the multiplier by 0.21. Changing to the linear estimation method as used in Section 2.5 increases the multiplier by 0.39 as shown in Column (8). Column (10) shows that including a control for skilled workers and area fixed effects reduces the multiplier by 0.22. Column (12) shows that considering the MSA of work instead of the MSA of residence reduces the multiplier by 0.11. Finally, determining which industries are classified as tradable and non-tradable based on their geographical concentration reduces the multiplier by 0.60 as shown in Column (14).

Table 2.11 is constructed in a similar fashion, but starts with all changes *imple-*

Table 2.10: *Effect of every change with respect to the reproduction of Moretti (2010)*

	Replication		No weights		Different IV		Linear		Controls and FE		MSA of work		Trad. Services	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Contribution Tradable	2.64***	1.60***	2.72***	1.22***	2.64***	1.39***	3.07***	1.99***	2.92***	1.38***	2.78***	1.49***	2.37***	1.00***
	(0.17)	(0.26)	(0.14)	(0.33)	(0.17)	(0.34)	(0.31)	(0.28)	(0.17)	(0.29)	(0.22)	(0.29)	(0.16)	(0.27)
1+ Years of college education									-0.39	0.94**				
									(0.29)	(0.46)				
Constant	0.30***	0.29***	0.25***	0.24***	0.30***	0.29***	0.30***	0.29***	0.40**	-0.17	0.34***	0.36***	0.16***	0.20***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.17)	(0.20)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	464	464	464	464	464	464	464	464	438	438	475	475	464	464
Adjusted R^2	0.71	0.61	0.61	0.42	0.71	0.57	0.66	0.58	0.73	0.56	0.72	0.60	0.65	0.45
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO
First-stage statistic		69		56		29		60		43		59		52

Note: Robust standard errors in parentheses. Column (1) and (2) replicate the "multipliers" as estimated in Moretti (2010). All other columns show the effect of one of the idiosyncrasies of Moretti's method on the estimation result, by replicating Moretti's approach apart from one change noted at the top.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

mented in Columns (1) and (2). The other columns show the estimated multiplier with all but one change implemented. Combining these findings with the results from Table 2.10 allows for some more general statements about the discussed idiosyncrasies. The estimated size of the multiplier reduces when: the instrument does not rely on the own MSA for determining the national trend; the multiplier is estimated with a log approach; area fixed effects and a control for the share of skilled workers are included; industries are classified tradable or non-tradable based on their geographical concentration. The effect of including regression weights or changing from MSA of residence to MSA of work is ambiguous.

2.7 Discussion and conclusion

All in all, I conclude that the local employment multiplier for Metropolitan Statistical Areas in the USA is 2.1. This result is based on MSA of work data from the U.S. Censuses between 1980 and 2000 and relies on two-stage least squares (2SLS) estimates with a control for education, and year and MSA fixed effect, employing an instrument that uses a shift-share approach.

I use place of work data; this is theoretically most appropriate because multipliers are based on firm job creation. And I classify all private sector three-digit industries as tradable or non-tradable based on their geographical clustering. The 10% to 30% of all jobs that are in the most clustered industries are considered tradable. The size of the multiplier is not affected by the exact choice of cut-off.

If I also consider estimations based on the MSA of work data from the Bureau of Labor statistics between 1990 and 2014 and take estimates without MSA fixed effects into consideration, all estimates lie between 2.02 and 2.41. To address worries about the effect of changing borders, one could also consider the estimates based on Consistent Public Use Microdata Areas, which should provide a lower bound as

Table 2.11: *Effect of every change with respect to the estimation in Section 5*

	All changes		Weights		Moretti IV		Non-linear		No controls		MSA of residence		No trad, services	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Contribution Tradable	2.71***	1.09***	2.83***	0.88*	2.71***	1.18***	2.50***	0.50	2.66***	1.37***	2.97***	0.58	2.73***	1.48***
	(0.15)	(0.30)	(0.14)	(0.47)	(0.15)	(0.27)	(0.14)	(0.36)	(0.15)	(0.26)	(0.28)	(0.45)	(0.17)	(0.26)
1+ Years of college education	-0.31	-0.21	0.63	0.69	-0.31	-0.22	-0.57	-0.25			-0.26	-0.22	-1.25***	-0.86
	(0.46)	(0.71)	(0.54)	(1.15)	(0.46)	(0.69)	(0.46)	(0.66)			(0.40)	(0.58)	(0.45)	(0.67)
Constant	0.32*	0.27	-0.03	-0.05	0.32*	0.28	0.50**	0.31	0.20***	0.25***	0.25	0.17	0.70***	0.54**
	(0.19)	(0.28)	(0.22)	(0.45)	(0.19)	(0.27)	(0.23)	(0.26)	(0.01)	(0.01)	(0.17)	(0.22)	(0.19)	(0.27)
Observations	438	438	438	438	438	438	438	438	475	475	438	438	438	438
Adjusted R^2	0.60	0.38	0.72	0.44	0.60	0.40	0.56	0.18	0.64	0.49	0.53	0.13	0.69	0.55
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES
First-stage statistic		21		26		23		34		47		22		17

Note: Robust standard errors in parentheses. Column (1) and (2) show the effect of employment in the tradable sector on employment in the non-tradable sector in an estimation without any of Moretit's idiosyncrasies. All other columns show the effect of one of the idiosyncrasies of Moretti's method on the estimation result, by including the change noted at the top in the estimation used in Columns (1) and (2).

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

the average CPUMA is smaller than the average MSA. These estimates range from 1.97 to 2.07 when CPUMA fixed effects are included. Considering these robustness checks, the estimate of the local employment multiplier effect for U.S. MSAs of 2.1 can be considered a reliable and robust, although perhaps slightly conservative, result.

When I distinguish between jobs created for skilled and unskilled workers, I find that a shock to skilled employment in the tradable sector has a local employment multiplier of 3.1; for each 100 new skilled jobs in the tradable sector, 89 skilled and 116 unskilled additional jobs are created in the non-tradable sector. The local employment multiplier for unskilled jobs in the tradable sector is not significant. This shows a clear incentive for policy makers to focus on *skilled* jobs if they want to attract jobs to the tradable sector.

Compared to the multiplier of 2.1 found in this chapter, the estimated multiplier of 2.6 in Moretti (2010) and Van Dijk (2016) is possibly an overestimate due to the lack of fixed effects and the use of MSA of residence data instead of MSA of work data. The result is similar for skilled jobs in the tradable sector; I find a multiplier of 3.1 instead of 3.5. The robustness of the local multiplier estimates is shown by comparing MSAs, CPUMAs and CZs; by considering an alternative data source; and by allowing for a more flexible classification of industries between the tradable and non-tradable sector.

My replication of the well-cited Moretti (2010) paper shows that he misreported the estimates for durable and non-durable tradable goods: in contrast to his reported finding the multiplier for durable goods *is* significant and the multiplier for non-durable goods is *not* significant. It also revealed Moretti made some arithmetic errors in determining the effect of skilled and unskilled jobs in the tradable sector on (un)skilled jobs in the non-tradable sector, which led to over-reporting the effect by a factor of two. The replication gave me insight into six idiosyncrasies of his analysis.

He included the own MSA in his calculation of the shift-share instrumental variable he uses; he did not include any controls for skill or MSA fixed effects; and he did not allow for tradable services and included agriculture and mining as non-tradable. These choices had a positive effect on the estimated size of the multiplier. His estimated multipliers are non-linear, because he uses log values. This had a negative effect on the size of the multiplier and it can be heavily affected by the relative employment shares in the sectors being considered. He also included regression weights and used data on the MSA of residence instead of the MSA of work, which both had an ambiguous effect on the estimated size of the multiplier.

To conclude, my estimate of a local employment multiplier of 2.1 seems to be both more realistic and more reliable than the multiplier of 2.6 as estimated by Moretti (2010) and Van Dijk (2016). The same holds for the estimated multiplier for skilled tradable jobs of 3.1 instead of 3.5. This chapter also shows the sensitivity of these multipliers. As noted in the introduction, local employment multipliers are quite important for the decisions of policy makers. And in light of my findings, they should perhaps be a bit more conservative in their expectations of the size of the local multiplier effect and focus their efforts on *skilled* tradable jobs.

Appendix 2.A Alternative specifications

Table 2.12: *OLS and Bartik IV estimates of the local employment multiplier within MSAs using five different definitions of the tradable and non-tradable sector.*

	Services		Nontrad. Services		70% nontrad.		80% nontrad.		90% nontrad.	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Contribution tradable	2.74***	0.68	2.61***	0.75*	2.03***	0.93***	2.97***	0.58	4.27***	0.47
	(0.25)	(0.43)	(0.22)	(0.39)	(0.15)	(0.30)	(0.28)	(0.45)	(0.34)	(0.51)
1+ Years of	-1.07***	-0.62	-1.17***	-0.69	-0.27	-0.25	-0.26	-0.22	-0.15	-0.19
college education	(0.37)	(0.57)	(0.37)	(0.56)	(0.26)	(0.40)	(0.40)	(0.58)	(0.54)	(0.68)
Constant	0.61***	0.37	0.63***	0.39*	0.24**	0.19	0.25	0.17	0.25	0.16
	(0.15)	(0.23)	(0.16)	(0.22)	(0.12)	(0.16)	(0.17)	(0.22)	(0.23)	(0.26)
Observations	438	438	438	438	438	438	438	438	438	438
Adjusted R^2	0.56	0.20	0.58	0.25	0.72	0.48	0.53	0.13	0.35	0.01
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		27		24		13		22		47

Note: Robust standard errors in parentheses. All estimates are based on the MSA of residence. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (1) and (2), all manufacturing jobs are classified as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. In Columns (3) and (4), some services are classified tradable. In Columns (5)-(10), all three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70

* Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

Table 2.13: *OLS and Bartik IV estimates of the local employment multiplier within CZs using five different definitions of the tradable and non-tradable sector*

	Services		Nontrad. Services		70% nontrad.		80% nontrad.		90% nontrad.	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Contribution tradable	2.49***	1.58***	2.49***	1.49***	2.35***	1.68***	3.45***	2.17***	4.52***	2.27***
	(0.11)	(0.26)	(0.11)	(0.29)	(0.08)	(0.19)	(0.14)	(0.31)	(0.32)	(0.49)
1+ Years of	0.73*	1.60***	0.79*	1.72***	0.97***	1.63***	1.62***	2.38***	2.51***	3.23***
college education	(0.42)	(0.54)	(0.43)	(0.57)	(0.33)	(0.45)	(0.39)	(0.52)	(0.58)	(0.70)
Constant	0.07	-0.06	0.07	-0.07	-0.12	-0.20*	-0.19*	-0.28*	-0.23	-0.35*
	(0.13)	(0.17)	(0.12)	(0.17)	(0.11)	(0.12)	(0.11)	(0.14)	(0.17)	(0.21)
Observations	492	492	492	492	492	492	492	492	492	492
Adjusted R^2	0.65	0.54	0.64	0.52	0.77	0.69	0.66	0.54	0.41	0.27
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CZ FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		9		11		18		40		43

Note: Robust standard errors in parentheses. All estimates are based on Commuting Zones. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (1) and (2), all manufacturing jobs are classified as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. In Columns (3) and (4), some services are classified tradable. In Columns (5)-(10), all three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70%, 80% or 90% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.14: *OLS and Bartik IV estimates of the local employment multiplier within CPUMAs using five different definitions of the tradable and non-tradable sector*

	Services		Nontrad. Services		70% nontrad.		80% nontrad.		90% nontrad.	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Contribution tradable	0.77***	0.99***	0.82***	0.93***	1.11***	0.97***	1.00***	1.01***	0.87***	1.07***
	(0.09)	(0.14)	(0.09)	(0.14)	(0.06)	(0.11)	(0.09)	(0.11)	(0.11)	(0.13)
1+ Years of	-0.98***	-0.98***	-1.03***	-1.03***	-0.56***	-0.59***	-0.73***	-0.73***	-1.00***	-1.00***
college education	(0.13)	(0.13)	(0.12)	(0.13)	(0.10)	(0.10)	(0.12)	(0.12)	(0.13)	(0.13)
Constant	0.46***	0.46***	0.47***	0.47***	0.28***	0.29***	0.36***	0.36***	0.44***	0.44***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Observations	1,086	1,086	1,086	1,086	1,086	1,086	1,086	1,086	1,086	1,086
Adjusted R^2	0.58	0.58	0.59	0.59	0.67	0.66	0.61	0.61	0.60	0.60
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CPUMA FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		207		157		119		245		428

Note: Robust standard errors in parentheses. All estimates are based on CPUMAs. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (1) and (2), all manufacturing jobs are classified as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. In Columns (3) and (4), some services are classified tradable. In Columns (5)-(10), all three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70%, 80% or 90% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.15: *OLS and Bartik IV estimates of the local employment multiplier within BLS MSAs using five different definitions of the tradable and non-tradable sector*

	Services		70% nontrad.		80% nontrad.		90% nontrad.	
	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV	OLS	Bartik IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Contribution tradable	1.10***	0.75**	0.92***	1.08***	0.93***	1.40**	0.95***	1.02
	(0.23)	(0.34)	(0.14)	(0.42)	(0.17)	(0.58)	(0.24)	(0.66)
Constant	0.12***	0.12***	0.06*	0.05	0.08**	0.07	0.14***	0.13***
	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.05)	(0.03)	(0.03)
Observations	219	219	219	219	219	219	219	219
Adjusted R^2	0.51	0.50	0.61	0.61	0.57	0.55	0.51	0.51
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES	YES	YES
First-stage statistic		99		11		9		5

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work data from the BLS. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (1) and (2), all manufacturing jobs are classified as tradable and all other jobs - except for agriculture, mining and government - as non-tradable. In Columns (3)-(8), all three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70%, 80% or 90% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.16: *OLS and Bartik IV estimates of the local employment multiplier within MSAs using different combinations of controls*

	OLS (1)	Bartik IV (2)	OLS (3)	Bartik IV (4)	OLS (5)	Bartik IV (6)
Contribution tradable	2.84***	1.16***	2.99***	1.21***	2.97***	0.58
	(0.28)	(0.32)	(0.31)	(0.40)	(0.28)	(0.45)
1+ Years of college education			-0.42***	-0.03	-0.26	-0.22
			(0.10)	(0.12)	(0.40)	(0.58)
Constant	0.15***	0.17***	0.30***	0.18***	0.25	0.17
	(0.01)	(0.01)	(0.04)	(0.04)	(0.17)	(0.22)
Observations	464	464	464	464	438	438
Adjusted R^2	0.60	0.39	0.62	0.40	0.53	0.13
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	NO	NO	NO	NO	YES	YES
First-stage statistic		80		45		22

Note: Robust standard errors in parentheses. All estimates are based on the MSA of residence. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Table 2.17: *OLS and Bartik IV estimates of the local employment multiplier within CZs using different combinations of controls*

	OLS (1)	Bartik IV (2)	OLS (3)	Bartik IV (4)	OLS (5)	Bartik IV (6)
Contribution tradable	3.67***	1.55***	3.82***	1.07**	3.45***	2.17***
	(0.19)	(0.30)	(0.22)	(0.51)	(0.14)	(0.31)
1+ Years of college education			-0.46***	0.33	1.62***	2.38***
			(0.13)	(0.22)	(0.39)	(0.52)
Constant	0.13***	0.13***	0.29***	0.02	-0.19*	-0.28*
	(0.01)	(0.01)	(0.05)	(0.08)	(0.11)	(0.14)
Observations	542	542	542	542	492	492
Adjusted R^2	0.72	0.48	0.73	0.36	0.66	0.54
Year FE	YES	YES	YES	YES	YES	YES
CZ FE	NO	NO	NO	NO	YES	YES
First-stage statistic		116		54		40

Note: Robust standard errors in parentheses. All estimates are based on Commuting Zones. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Table 2.18: *OLS and Bartik IV estimates of the local employment multiplier within CPUMAs using different combinations of controls*

	OLS (1)	Bartik IV (2)	OLS (3)	Bartik IV (4)	OLS (5)	Bartik IV (6)
Contribution tradable	1.64***	0.51***	1.83***	0.44**	1.00***	1.01***
	(0.10)	(0.14)	(0.11)	(0.20)	(0.09)	(0.11)
1+ Years of college education			-0.24***	0.03	-0.73***	-0.73***
			(0.04)	(0.06)	(0.12)	(0.12)
Constant	0.17***	0.18***	0.25***	0.17***	0.36***	0.36***
	(0.00)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)
Observations	1,086	1,086	1,086	1,086	1,086	1,086
Adjusted R^2	0.37	0.21	0.39	0.19	0.61	0.61
Year FE	YES	YES	YES	YES	YES	YES
CPUMA FE	NO	NO	NO	NO	YES	YES
First-stage statistic		283		135		245

Note: Robust standard errors in parentheses. All estimates are based on CPUMAs. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.19: *OLS and Bartik IV estimates of the local employment multiplier within BLS MSAs using different combinations of controls*

	OLS (1)	Bartik IV (2)	OLS (3)	Bartik IV (4)
Contribution tradable	1.03***	1.26**	0.93***	1.40**
	(0.17)	(0.55)	(0.17)	(0.58)
Constant	0.13***	0.13***	0.08**	0.07
	(0.01)	(0.02)	(0.04)	(0.05)
Observations	259	259	219	219
Adjusted R^2	0.44	0.44	0.57	0.55
Year FE	YES	YES	YES	YES
MSA FE	NO	NO	YES	YES
First-stage statistic		8		9

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work data from the BLS. The dependent variable is the contribution of employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.20: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the MSA of work at 70% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	1.26***	1.36***	0.69***	0.51***	0.57***	0.84***
	(0.17)	(0.24)	(0.08)	(0.15)	(0.10)	(0.21)
Tradable - unskilled	2.55***	1.16**	1.18***	1.82***	1.37***	-0.66
	(0.21)	(0.46)	(0.11)	(0.25)	(0.12)	(0.41)
1+ Years of college education	-0.68*	-0.15	-0.98***	-1.27***	0.30	1.11***
	(0.35)	(0.42)	(0.19)	(0.23)	(0.20)	(0.39)
Constant	0.48***	0.22	0.58***	0.72***	-0.09	-0.49***
	(0.16)	(0.18)	(0.08)	(0.10)	(0.09)	(0.15)
Observations	438	438	438	438	438	438
Adjusted R^2	0.75	0.67	0.83	0.80	0.70	0.20
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES
First-stage statistic		6		6		6

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 70% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.21: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the MSA of work at 90% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	4.01***	1.95***	2.15***	0.98***	1.86***	0.97***
	(0.39)	(0.68)	(0.23)	(0.34)	(0.18)	(0.36)
Tradable - unskilled	3.97***	0.05	2.07***	1.15***	1.89***	-1.10**
	(0.81)	(0.75)	(0.38)	(0.36)	(0.44)	(0.45)
1+ Years of college education	-0.58	0.07	-1.13***	-1.07**	0.55	1.14*
	(0.82)	(1.12)	(0.40)	(0.50)	(0.44)	(0.64)
Constant	0.49	0.15	0.68***	0.64***	-0.19	-0.50*
	(0.35)	(0.45)	(0.17)	(0.20)	(0.18)	(0.26)
Observations	438	438	438	438	438	438
Adjusted R^2	0.42	0.19	0.65	0.57	0.41	0.09
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES
First-stage statistic		27		27		27

Note: Robust standard errors in parentheses. All estimates are based on the MSA of work. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 90% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.22: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the MSA of residence at 80% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	2.54***	3.38***	1.52***	1.37***	1.02***	2.01***
	(0.52)	(0.90)	(0.19)	(0.38)	(0.34)	(0.61)
Tradable - unskilled	3.62***	-1.47*	1.61***	0.54*	2.01***	-2.01***
	(0.47)	(0.81)	(0.18)	(0.32)	(0.31)	(0.54)
1+ Years of college education	-0.55	1.09	-1.07***	-0.81***	0.51*	1.90***
	(0.52)	(0.69)	(0.24)	(0.30)	(0.31)	(0.44)
Constant	0.39*	-0.45	0.61***	0.47***	-0.21	-0.92***
	(0.23)	(0.29)	(0.10)	(0.13)	(0.14)	(0.19)
Observations	438	438	438	438	438	438
Adjusted R^2	0.54	0.21	0.70	0.63	0.62	0.20
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	YES	YES	YES	YES	YES	YES
First-stage statistic		2		2		2

Note: Robust standard errors in parentheses. All estimates are based on the MSA of residence. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.23: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the CZ at 80% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	3.40***	3.38***	1.91***	1.51***	1.49***	1.88***
	(0.36)	(0.64)	(0.16)	(0.28)	(0.21)	(0.40)
Tradable - unskilled	3.48***	1.33**	1.32***	1.14***	2.16***	0.20
	(0.38)	(0.67)	(0.16)	(0.29)	(0.24)	(0.43)
1+ Years of college education	1.60***	2.89***	0.05	0.16	1.55***	2.73***
	(0.46)	(0.67)	(0.22)	(0.27)	(0.27)	(0.43)
Constant	-0.18	-0.51**	0.19***	0.19**	-0.37***	-0.70***
	(0.15)	(0.22)	(0.07)	(0.09)	(0.08)	(0.14)
Observations	492	492	492	492	492	492
Adjusted R^2	0.66	0.54	0.75	0.73	0.69	0.49
Year FE	YES	YES	YES	YES	YES	YES
CZ FE	YES	YES	YES	YES	YES	YES
First-stage statistic		25		25		25

Note: Robust standard errors in parentheses. All estimates are based on Commuting Zones. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Table 2.24: *OLS and Bartik IV estimates of the local employment multiplier for skilled and unskilled jobs within the CPUMA at 80% cut-off*

	All non-tradable		Nontrad. - skilled		Nontrad. - unskill.	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Tradable - skilled	1.81***	2.72***	1.08***	1.53***	0.73***	1.19***
	(0.15)	(0.28)	(0.10)	(0.17)	(0.08)	(0.15)
Tradable - unskilled	0.29**	-0.07	0.37***	0.56***	-0.08	-0.63***
	(0.12)	(0.16)	(0.06)	(0.09)	(0.07)	(0.10)
1+ Years of college education	-0.19	0.30	-0.92***	-0.79***	0.74***	1.09***
	(0.14)	(0.20)	(0.08)	(0.11)	(0.09)	(0.11)
Constant	0.12**	-0.08	0.44***	0.39***	-0.32***	-0.47***
	(0.05)	(0.07)	(0.03)	(0.04)	(0.03)	(0.04)
Observations	1,086	1,086	1,086	1,086	1,086	1,086
Adjusted R^2	0.62	0.61	0.83	0.82	0.69	0.67
Year FE	YES	YES	YES	YES	YES	YES
CPUMA FE	YES	YES	YES	YES	YES	YES
First-stage statistic		41		41		41

Note: Robust standard errors in parentheses. All estimates are based on CPUMAs. In Columns (1) and (2) the dependent variable is the contribution of employment in the non-tradable sector to total employment growth. In Columns (3) and (4) the dependent variable is the contribution of skilled employment in the non-tradable sector to total employment growth. In Columns (5) and (6) the dependent variable is the contribution of unskilled employment in the non-tradable sector to total employment growth. All three-digit industries are classified as either tradable or non-tradable based on their geographical concentration, with a cut-off such that 80% of all workers are employed in the non-tradable sector.

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Chapter 3

Theoretical model

3.1 Introduction

In the first two chapters I estimated the size of the local employment multiplier in the USA using many different empirical approaches and robustness checks. So far, I only provided the reader with an estimate of the average local multiplier, without considering the heterogeneity across cities. This chapter provides a theoretical analysis of the local employment multiplier and seeks to predict how the size of the multiplier differs between cities. It also considers the role of migration in the local employment multiplier.

I model the local employment multiplier effect using the Harris and Todaro (1970) model of migration and unemployment, and the Shapiro and Stiglitz (1984) model of efficiency wages. These models have been combined before to allow for endogenous wages in the Harris-Todaro mechanism (Moene, 1988) and to model the informal sector (Rauch, 1991), but I could not find any article that uses this combination to model the local employment multiplier effect. The model follows Zenou (2011), but it determines the impact of tradable sector jobs, instead of the impact of unemployment benefits, on urban employment and unemployment.

I build a simple model that shows how demand shocks, for example from employment in the tradable sector, affect the non-tradable sector. The model explains how this interaction is affected by the unemployment rate. It considers a single city with a static tradable sector and a non-tradable sector that experiences migration from the surrounding hinterlands.

I show there is a positive local employment multiplier, where the size of the multiplier depends on consumer preferences and the wages in the non-tradable sector. Using a combination of the Harris-Todaro and Shapiro-Stiglitz model I can determine the wage in the non-tradable sector based on the exogenous quit rate for all jobs in the non-tradable sector, the detection rate of shirkers, the discount factor for all workers, the effort the workers need to exert and the local unemployment rate. Most importantly, I show that the size of the local multiplier increases with the unemployment rate, but this increase diminishes for higher unemployment rates. This result is driven by the impact of the unemployment rate on the multiplier size for current inhabitants of the city; the multiplier for workers that move to the city as a result of a shock to the tradable sector decreases with the unemployment rate.

This is an important result for local policy makers: policies that try to increase growth in less favoured regions by stimulating tradable firms to locate in areas with high unemployment will both reduce disparities between cities *and* efficiently reduce unemployment across the board.

3.2 The model

Consider a world with two types of workers: there is a continuum of *ex ante* identical tradable-sector workers and a continuum of *ex ante* identical non-tradable-sector workers, whose masses are L^T and L^{NT} respectively. In the previous chapters, I assume these workers are perfectly mobile across sectors within a city. I will drop

this assumption in this chapter. Tradable-sector workers are not necessarily higher skilled than non-tradable-sector workers, or vice-versa, but I assume the required skills are different and it is prohibitively costly to switch. This assumption is less realistic, but it makes the model more tractable. First, I will describe the dynamics of the non-tradable-sector workers and subsequently I will show the impact of tradable-sector employment on the non-tradable sector.

3.2.1 The non-tradable-sector workers

Of the non-tradable-sector workers L_C^{NT} live in the city and L_R^{NT} live in the surrounding rural area, such that

$$L^{NT} = L_C^{NT} + L_R^{NT}, \tag{3.1}$$

$$L_C^{NT} = E_C^{NT} + U_C^{NT} \text{ and} \tag{3.2}$$

$$L_R^{NT} = E_R^{NT}, \tag{3.3}$$

where E_g^{NT} and U_g^{NT} are the respective level of employment and unemployment in region $g \in \{C,R\}$ (C for city and R for rural area). There is no unemployment in the rural area, because the wage is flexible enough to guarantee employment. By combining Eqs. (3.1) - (3.3), I obtain:

$$U_C^{NT} = L^{NT} - E_C^{NT} - E_R^{NT}. \tag{3.4}$$

The unemployment rate in the city is then given by

$$u^C = \frac{U_C^{NT}}{E_C^{NT} + U_C^{NT}} = \frac{L^{NT} - E_C^{NT} - E_R^{NT}}{L^{NT} - E_R^{NT}}. \tag{3.5}$$

3.2.1.1 The worker's choice

Non-tradable-sector workers in the rural area receive a wage w_R^{NT} and have the choice of moving to the city. Following Harris and Todaro (1970), workers will do so when the expected utility within the city is larger than outside it. If a worker chooses to move to the city, they will start out unemployed without any wage or benefits, but with a probability a of finding a job. Once they find a job they can choose whether to exert effort. Following the Shapiro and Stiglitz (1984) model, they can shirk and exert minimal effort ($e = 0$) or some positive effort ($e = \bar{e}$). Regardless of this choice they will receive a wage w_C^{NT}, but when they do not exert effort there is a probability q that they will be detected and fired. For all employed workers in the city, there is a probability b that they will become unemployed due to some exogenous circumstance, therefore the probability that shirkers lose their job is $b+q$. All workers derive utility from their wage and experience an additional increase in utility when they do not put in effort. In the hinterland a worker does not have to put in any effort. Workers maximize the expected present discounted value of utility with a discount rate $r > 0$.

I use the Shapiro and Stiglitz (1984) definition of expected lifetime utility, with V_E^S for an employed shirker, V_E^N for an employed non-shirker, V_R for a worker in the hinterlands and V_U for an unemployed worker in the city. The *steady-state* Bellman equations are given by

$$rV_E^S = w_C^{NT} + \bar{e} + (b+q)\left(V_U - V_E^S\right), \tag{3.6}$$

$$rV_E^N = w_C^{NT} + b\left(V_U - V_E^N\right), \tag{3.7}$$

$$rV_U = a\left(V_E - V_U\right), \tag{3.8}$$

where V_E is the expected utility of an employed worker (which equals V_E^N in equilibrium).

The firm is only efficient when none of the workers shirk, therefore the firm will

set a wage w_C^{NT} such that $V_E^N = V_E^S = V_E$, this is the *no-shirking condition*. Thus, by combining this condition with Eqs. (3.6) and (3.7), I obtain:

$$V_E - V_U = \frac{\bar{e}}{q}, \tag{3.9}$$

$$w_C^{NT} = \frac{b+r}{q}\bar{e} + rV_U, \tag{3.10}$$

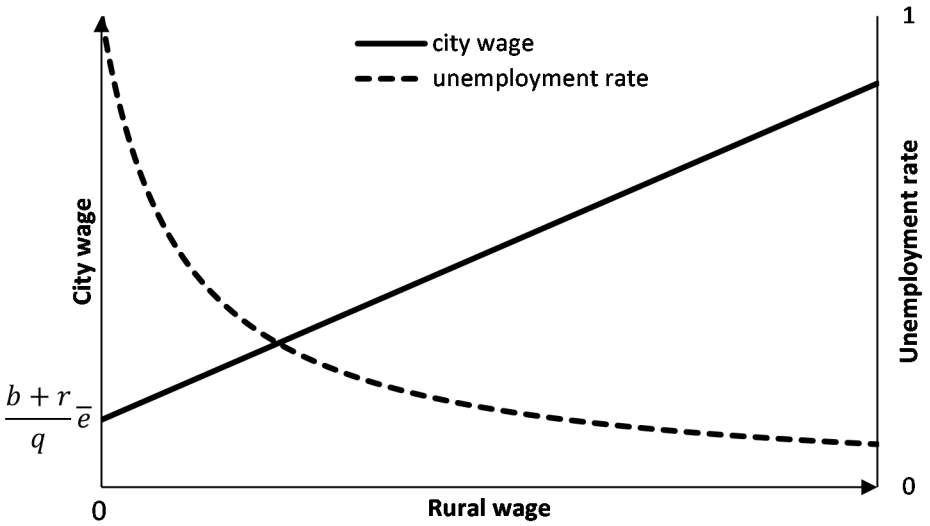
where $\bar{e}/q$ is the surplus from being employed in the city; this is a pure incentive to deter shirking. Following Harris and Todaro (1970), workers will move from the hinterlands to the city as long as this increases their expected lifetime utility, or $rV_U > rV_R$, and workers are guaranteed a wage w_R^{NT} outside of the city, therefore $rV_U = rV_R = w_R^{NT}$, and plugging this into Eq. (3.10) result in an expression for the wage in the non-tradable sector of the city:

$$w_C^{NT} = \frac{b+r}{q}\bar{e} + w_R^{NT}. \tag{3.11}$$

If there is no unemployment a worker has no incentive to put in effort, because he will immediately find a new job when he is fired. Therefore firms need to pay a premium above the wage in the hinterlands; this incentivises more workers to move to the city and creates involuntary unemployment which incentivises employed workers to put in effort. The non-shirking wage is greater: the higher the wage in the hinterlands w_R^{NT}; the larger the effort $\bar{e}$; the higher the interest rate r; the higher the quit rate b; and the smaller the detection probability q. This is all consistent with the original Shapiro and Stiglitz (1984) model.

In the steady state the flow *into* the unemployment pool bE_C^{NT} and the flow *out* aU_C^{NT} must be equal; in combination with the Bellman equation for unemployed

Figure 3.1: *The wage and the unemployment rate in the city as a function of rural wage*



workers, Eq. (3.8), this results in:

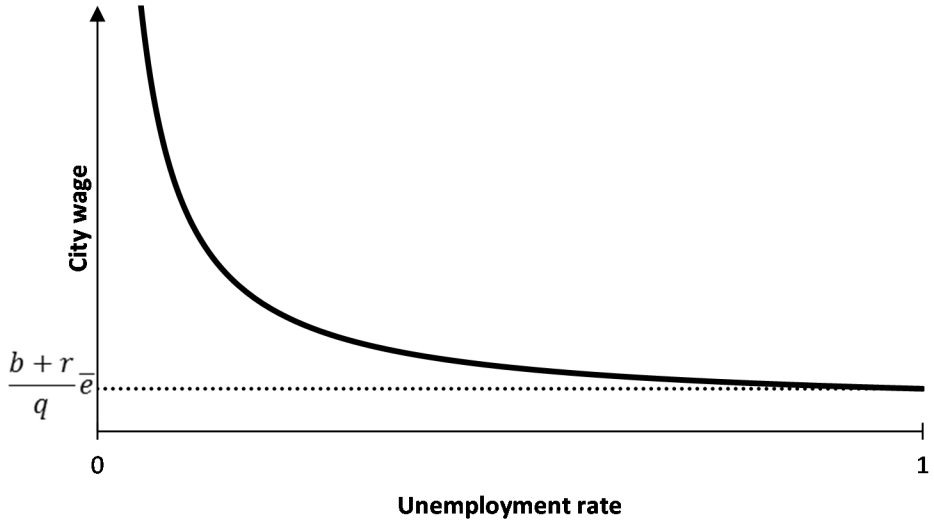
$$rV_U = b\frac{E_C^{NT}}{U_C^{NT}}\left(V_E - V_U\right), \tag{3.12}$$

in which I can insert Eqs. (3.5), (3.9) and the Harris-Todaro condition $rV_U = rV_R = w_R^{NT}$ to find an expression for unemployment:

$$u_C^{NT} = \frac{b\bar{e}}{b\bar{e} + qw_R^{NT}}. \tag{3.13}$$

I have pinned down the wage and the unemployment rate in the non-tradable sector of the city as a function of the wage in the hinterlands as shown in Figure 3.1; both are independent of the labour demand in the city. The wage stays constant, because any increase in labour demand will result in a proportional increase in workers moving to the city. This is the result of the Harris and Todaro (1970) condition that, workers will move from the hinterlands to the city as long as this increases their expected lifetime utility. Hence both the wage in the non-tradable sector and the unemployment rate always return to the same level.

Figure 3.2: *The relationship between the wage and the unemployment rate in the city*



Finally, I can re-express the wage in the non-tradable sector of the city as a function of the unemployment rate in the city, by combining Eqs. (3.11) and (3.13), I obtain:

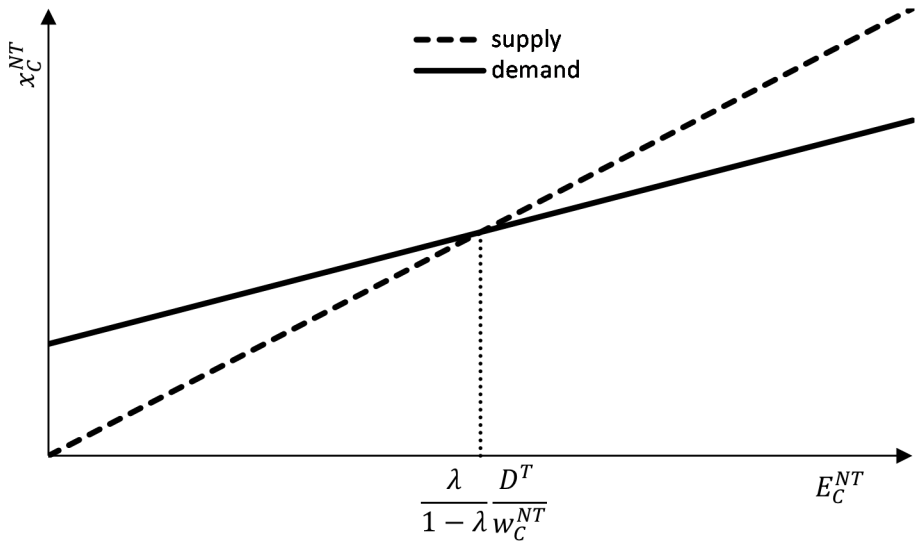
$$w_C^{NT} = \frac{b + r u_C^{NT}}{u_C^{NT}} \frac{\bar{e}}{q}, \tag{3.14}$$

as shown in Figure 3.2.

3.2.2 Employers

Given the wage in the non-tradable sector and the unemployment rate I want to pin down the total number of non-tradable sector workers that are employed in the city. To allow for a simple analytical solution of the model I assume all firms in the non-tradable sector are in a competitive equilibrium and produce a homogeneous good with a constant returns to scale technology and only one factor, labour $x_C^{NT} = E_C^{NT}$. Since there are zero profits all firms set their prices equal to marginal labour costs $p^{NT} = w_C^{NT}$. The non-tradable-sector firms will select E_C^{NT} such that their total output

Figure 3.3: *Supply and demand of the non-tradable good in the city*



is equal to the total demand for the non-tradable good.

This is where I reintroduce the tradable-sector workers. For simplicity I assume, all employed workers, both in the tradable sector and in the non-tradable sector in the city, have the same Cobb-Douglas preferences over tradable and non-tradable goods. They all spend a share λ of their income on the non-tradable good, therefore the total expenditure on non-tradable good in the city is $p^{NT}x_C^{NT} = \lambda\left(w_C^T E_C^T + w_C^{NT} E_C^{NT}\right)$. For simplicity I define the total expenditure of the tradable-sector workers in the city as $D^T \equiv w_C^T E_C^T$, which can be generalised to a fixed demand from everyone in the city with an income (or savings) that does not compete for the jobs in the non-tradable sector.

The market for the non-tradable good within the city clears when total employment is given by

$$E_C^{NT} = \frac{\lambda}{1-\lambda}\frac{D^T}{w_C^{NT}}, \tag{3.15}$$

as shown in Figure 3.3.

Employment is larger: the lower the wage in the non-tradable sector w_C^{NT}; the greater the preferences for the non-tradable good λ; and the higher the demand from

outside the non-tradable sector D^T. The detection probability, quit rate, interest rate, wage in the hinterlands and effort only affect employment through the non-tradable-sector wage in the city.

3.3 Local employment multiplier

Inserting the expression for the wage found in Eq. (3.11) into the market clearing condition given in Eq. (3.15), results in:

$$E_C^{NT} = \frac{\lambda}{1-\lambda} \frac{q}{(b+r)\bar{e} + q w_R^{NT}} D^T. \tag{3.16}$$

When I interpret D^T as expenditure from all workers in the tradable sector, the total local employment multiplier between the tradable and the non-tradable sector is given by

$$M = \frac{\lambda}{1-\lambda} \frac{q w_C^T}{(b+r)\bar{e} + q w_R^{NT}}. \tag{3.17}$$

This can be interpreted as follows. When the rural wage w_R^{NT} is lower, the outside option for workers in the non-tradable sector is less attractive. This will result in a higher unemployment rate in the city. The wage offered by the firms in the non-tradable sector w_C^{NT} is above the market clearing wage in order to ensure workers do not shirk, but this premium can be smaller when unemployment is higher, getting fired is already more risky for the workers. Therefore, the firms in the non-tradable sector firms can offer lower wages and are more flexible in responding to demand shocks. As a result the size of the multiplier is larger.

Differentiating Eq. (3.16) gives

$$E_C^{NT} = E_C^{NT}\left(\underset{+}{\lambda}, \underset{+}{q}, \underset{-}{b}, \underset{-}{r}, \underset{-}{\bar{e}}, \underset{-}{w_R^{NT}}\right), \tag{3.18}$$

a higher λ, or q, or a lower b, or r, or $\bar{e}$, or w_R^{NT}, increases the size of the local

employment multiplier.

The impact on the total number of (employed and unemployed) workers L_C^{NT} in the non-tradable sector of the city in equilibrium can be obtained by inserting Eqs. (3.13) and (3.16) into Eq. (3.5), resulting into

$$L_C^{NT} = \frac{\lambda}{1-\lambda} \frac{b\bar{e} + qw_R^{NT}}{(b+r)\bar{e} + qw_R^{NT}} \frac{D^T}{w_R^{NT}}. \tag{3.19}$$

Differentiating this expression, I get:

$$L_C^{NT} = L_C^{NT}\left(\underset{+}{\lambda}, \underset{+}{q}, \underset{+}{b}, \underset{-}{r}, \underset{-}{\bar{e}}, \underset{-}{w_R^{NT}}\right). \tag{3.20}$$

All parameters have the same directional effect on the multiplier for the total number of workers as they have on the multiplier for employed workers, except for b. If the exogenous quit rate increases, the unemployment rate increases; as a result a shock to the tradable sector will attract more workers, but fewer are employed.

The local employment multiplier can be split into two parts, the extra jobs in the non-tradable sector that are fulfilled by workers that move to the city and the extra jobs in the non-tradable sector that are fulfilled by previously unemployed inhabitants. The number of jobs fulfilled by movers is equal to the number of workers that move to the city multiplied with the probability that each migrant finds a job

$$\begin{aligned} E_{C,M}^{NT} &= aL_C^{NT} \\ &= \frac{qw_R^{NT}}{\bar{e}} \times \frac{\lambda}{1-\lambda} \frac{b\bar{e} + qw_R^{NT}}{(b+r)\bar{e} + qw_R^{NT}} \frac{D^T}{w_R^{NT}} \\ &= \frac{\lambda}{1-\lambda} \frac{q}{\bar{e}} \frac{b\bar{e} + qw_R^{NT}}{(b+r)\bar{e} + qw_R^{NT}} D^T; \end{aligned} \tag{3.21}$$

all other jobs created in the non-tradable sector are fulfilled by current inhabitants

$$\begin{aligned} E_{C,L}^{NT} &= E_C^{NT} - aL_C^{NT} \\ &= \frac{\lambda}{1-\lambda}\frac{q}{(b+r)\,\bar{e}+qw_R^{NT}}D^T - \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{b\bar{e}+qw_R^{NT}}{(b+r)\,\bar{e}+qw_R^{NT}}D^T \qquad (3.22) \\ &= \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{(1-b)\,\bar{e}-qw_R^{NT}}{(b+r)\,\bar{e}+qw_R^{NT}}D^T. \qquad (3.23) \end{aligned}$$

Differentiating Eq. (3.21) gives

$$E_{C,M}^{NT} = E_{C,M}^{NT}\left(\underset{+}{\lambda},\underset{+}{q},\underset{+}{b},\underset{-}{r},\underset{-}{\bar{e}},\underset{+}{w_R^{NT}}\right), \qquad (3.24)$$

a higher λ, or q, or b, or w_R^{NT}, or a lower r, or $\bar{e}$, increases the size of the impact of new tradable sector jobs for movers. From Eq. (3.23) I can see that the multiplier for current inhabitants is positive if and only if the wage in the rural area is low enough:

$$E_{C,L}^{NT} > 0 \quad \Leftrightarrow \quad w_R^{NT} < (1-b)\,\frac{\bar{e}}{q}. \qquad (3.25)$$

If I differentiate Eq. (3.23) under this assumption, I get:

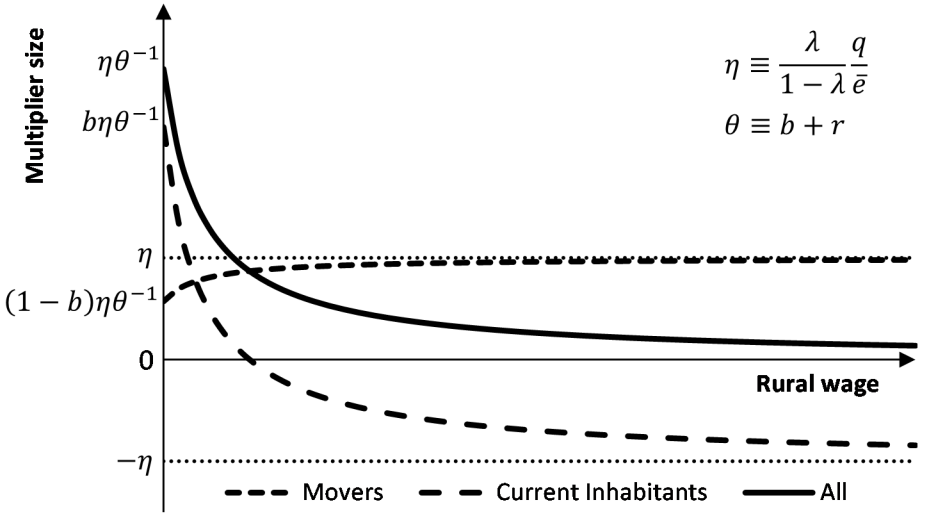
$$E_{C,L}^{NT} = E_{C,L}^{NT}\left(\underset{+}{\lambda},\underset{\pm}{q},\underset{-}{b},\underset{-}{r},\underset{\mp}{\bar{e}},\underset{-}{w_R^{NT}}\right); \qquad (3.26)$$

a higher λ, or a lower b, or r, or w_R^{NT}, increases the size of the impact of the local employment multiplier for current inhabitants. The multiplier increases with the detection probability q and decreases with the effort $\bar{e}$ if and only if the wage in the rural area is low enough:

$$\frac{dE_{C,L}^{NT}}{dq} > 0, \frac{dE_{C,L}^{NT}}{d\bar{e}} < 0 \quad \Leftrightarrow \quad w_R^{NT} < \frac{\bar{e}}{q}\left(\sqrt{(1+r)\,(b+r)} - (b+r)\right), \qquad (3.27)$$

which is a stricter condition than Eq. (3.25). The effect of the rural wage, w_R^{NT}, for

Figure 3.4: *The size of the local employment multiplier effect as a function of the rural wage*



each multiplier is shown in Figure (3.4).

I am specifically interested in the effect of the unemployment rate on the size of the multiplier. The unemployment rate is independent of any demand shocks, just like the wage. I can re-express Eqs. (3.16), (3.21) and (3.23) as

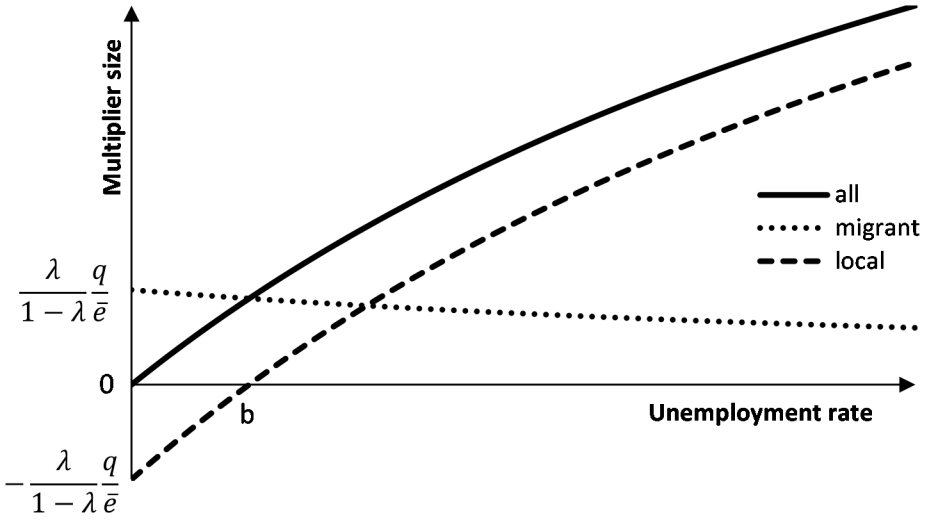
$$E_C^{NT} = \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{u_C^{NT}}{b+u_C^{NT}r}D^T, \tag{3.28}$$

$$E_{C,M}^{NT} = \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{b}{b+u_C^{NT}r}D^T, \tag{3.29}$$

$$E_{C,L}^{NT} = \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{u_C^{NT}-b}{b+u_C^{NT}r}D^T. \tag{3.30}$$

From Eq. (3.28) I can see that there is a positive local multiplier, and I can also see that the size of this multiplier increases with the unemployment rate, u. Eq. (3.29) shows that the multiplier for workers that move to the city is also positive, but decreases in size with the unemployment rate. In contrast, Eq. (3.30) shows that the multiplier for current inhabitants can actually be negative for very low unemployment rates, but the multiplier increases with the unemployment rate and becomes positive

Figure 3.5: *The size of the local employment multiplier effect as a function of the unemployment rate*



when $u > b$. Finally the multiplier for current inhabitants depends more strongly on the unemployment rate than the multiplier for migrants:

$$\left| \frac{\partial \Delta E_{C,L}^{NT} / \partial u_C^{NT}}{\partial \Delta E_{C,M}^{NT} / \partial u_C^{NT}} \right| = 1 + \frac{1}{r} > 1.$$

This can all also be seen in Figure 3.5.

3.4 Extensions

3.4.1 Changing wage in the rural area

Thus far I assumed the wage in the rural area w_R^{NT} is fixed. I can generalize the model by letting the wage in the rural area be some function of the number of work-

ers $w_R^{NT}\left(L_R^{NT}\right)$. In this case the model is defined by the following four equations:

$$w_C^{NT} = (b+r)\frac{\bar{e}}{q} + w_R^{NT}\left(E_R^{NT}\right), \tag{3.31}$$

$$w_R^{NT}\left(E_R^{NT}\right) = b\frac{E_C^{NT}}{U_C^{NT}}\frac{\bar{e}}{q}, \tag{3.32}$$

$$E_C^{NT} = \frac{\lambda}{1-\lambda}\frac{D^T}{w_C^{NT}}, \tag{3.33}$$

$$U_C^{NT} = L^{NT} - E_C^{NT} - E_R^{NT}, \tag{3.34}$$

and as a result Eqs. (3.28) - (3.30) still hold, but w_C^{NT} and u_C^{NT} are no longer independent of D^T. This should not affect the findings for the multiplier of shocks to the tradable sector if I assume these shocks ΔD^T are small relative to the total demand from the tradable sector D^T.

3.4.2 Intermediary non-tradable goods

In the model I use D^T as a generalised expression for expenditure outside of the non-tradable sector within the city. The main interpretation is the consumption by tradable-sector workers in the city, $D^T = w_C^T E_C^T$. I can extend this model by including the use of non-tradable goods as intermediary goods in the production of tradable goods in the city. I assume all firms in the tradable sector produce a tradable good using two factors: labour and the non-tradable good. All firms have a Cobb-Douglas production function $x_C^T = \left(x_C^{NT}\right)^{\alpha}\left(L_C^T\right)^{1-\alpha}$ and produce the tradable good using the optimal ratio of labour and the non-tradable good given the prices of each, w_C^T and p_C^{NT} respectively.

The optimal ratio will satisfy the following minimization problem

$$\min_{x_C^{NT}, L_C^T} p_C^{NT} x_C^{NT} + w_C^T L_C^T \quad \text{s.t. } \left(x_C^{NT}\right)^{\alpha}\left(L_C^T\right)^{1-\alpha} \geq \bar{x}_C^T. \tag{3.35}$$

For each tradable-sector worker, the firm will spend $\frac{\alpha}{1-\alpha} w_C^T$ on the non-tradable good. All workers in the city still have the same Cobb-Douglas preferences as in the original model, so each tradable-sector worker spends λw_C^T on the non-tradable good and each employed non-tradable-sector worker spends λw_C^{NT} on the non-tradable good. Therefore the total expenditure is given by

$$p^{NT} x_C^{NT} = \lambda \left(w_C^T E_C^T + w_C^{NT} E_C^{NT} \right) + \frac{\alpha}{1-\alpha} w_C^T E_C^T. \tag{3.36}$$

As in the original model, the production function of the non-tradable good is given by $x_C^{NT} = E_C^{NT}$, therefore the market for the non-tradable good clears when

$$E_C^{NT} = \frac{\lambda + \frac{\alpha}{1-\alpha}}{1-\lambda} \frac{w_C^T E_C^T}{w_C^{NT}}. \tag{3.37}$$

This shows that the original model is a special case where $\alpha = 0$. The local employment multiplier in this extended model is given by

$$E_C^{NT} = \frac{\lambda + \frac{\alpha}{1-\alpha}}{1-\lambda} \frac{q}{(b+r)\bar{e} + q w_R^{NT}} w_C^T E_C^T. \tag{3.38}$$

The size of the local employment multiplier increases with the share of non-tradable goods used in the production of tradable goods in the city, α, but the fundamental structure of the model does not change.

3.5 Concluding remarks

In this chapter, I develop an efficiency wage model with rural-urban migration for the non-tradable sector. There is unemployment in the city, because wages are above the market clearing level to incentivise workers not to shirk (Shapiro and Stiglitz, 1984). Workers move to the city from the surrounding hinterlands up to the point where

the expected utility in the city is equal to their utility in the rural area (Harris and Todaro, 1970). I then consider the impact of a shock to employment in the tradable sector in the city and find a positive local employment multiplier effect. The size of this multiplier increases with the local unemployment rate. In cities with a higher unemployment rate more jobs are created for current inhabitants of the city as a result of a shock to the tradable sector; the multiplier for workers who move from outside the city decreases, but the former effect dominates.

It is important to note that this model is a stylistic description of the interaction between the tradable and the non-tradable sector. I use rural-urban migration as a catch-all for migration to the city as a result of a shock to the tradable sector. For simplicity I also assume there is no unemployment in the rural areas. This is clearly not realistic for the USA, but it does add the possibility of migration to the multiplier interaction in a tractable way. A general equilibrium model that allows for migration between cities would be a welcome addition. I have also assumed that it is prohibitively costly for workers to switch between the tradable and the non-tradable sector. This assumption is not consistent with my larger theoretical framework and has been included to simplify the model.

When I extend the model by allowing the wage in the rural area to change, or by allowing for the intermediary use of non-tradable goods in the production of tradable good, these results hold. This is an important result for local policy makers: policies that try to increase growth in less favoured regions by stimulating tradable firms to locate in areas with high unemployment, will both reduce disparities between cities *and* efficiently reduce unemployment across the board.

Chapter 4

Investing in lagging regions is efficient

4.1 Introduction

This chapter sets out to look at differences in the local employment multiplier both within MSAs and between MSAs. I segment the jobs created in the non-tradable sector of each MSA in two ways: I differentiate between high- and low-skilled workers; and between current inhabitants of the MSA and workers that recently moved to the MSA to work in the non-tradable sector. This chapter also shows how the size of the local employment multiplier for each subsection, and in total, depends on the local unemployment rate within the MSA.

I show that two-thirds of all jobs created in the non-tradable sector as a result of a shock to the tradable sector are fulfilled by workers that were currently unemployed, but already living within the MSA. Workers that have to move to the MSA are at a disadvantage: there is only a significant multiplier effect for skilled movers.

With a non-parametric analysis, I estimate the size of the local multiplier for each level of unemployment between 4.3% and 7.7%. When the unemployment rate lies

around 5.2% the MSA is approximately at full employment and the effect of 100 new jobs in the tradable sector is 120 additional jobs in the non-tradable sector. As the unemployment rate increases the number of additional jobs in the non-tradable sector increases as well, to 200 at an unemployment rate of 7.7%. This increase was also predicted by the model from Chapter 3.

The model also predicts that this increase is driven by a larger multiplier for current inhabitants and that there is no, or even a negative, effect of the unemployment rate on the multiplier for movers. This is confirmed by the non-parametric analysis.

4.2 Data

This chapter uses the same Integrated Public Use Microdata Series (Ruggles et al., 2015) as in Chapter 1. MSA of residence data is used, because the local unemployment rate cannot be determined based on MSA of work data. The unemployment rate is used to explain differences in the multiplier size in the non-parametric analysis. The distribution of the unemployment rate and total employment for all MSAs are shown in Figure 4.1.

4.2.1 Migration

To distinguish between current inhabitants of an MSA and recent movers to the MSA, I use the migration statistic from the Census. This variable indicates where the household lived five years earlier; this does not cover the complete ten year interval over which I measure the multiplier, but it should be a good indicator. It does not specifically indicate whether a person moved from outside the MSA, but only from outside their county (in 1980) or PUMA (in 2000). I assume that everyone who remained within the same county or PUMA is a current inhabitant and everyone else is a migrant. I also do not observe the place of work, but I assume all workers

Figure 4.1: *Scatter plot of the unemployment rate and total employment for U.S. MSAs in 1980 and 1990*

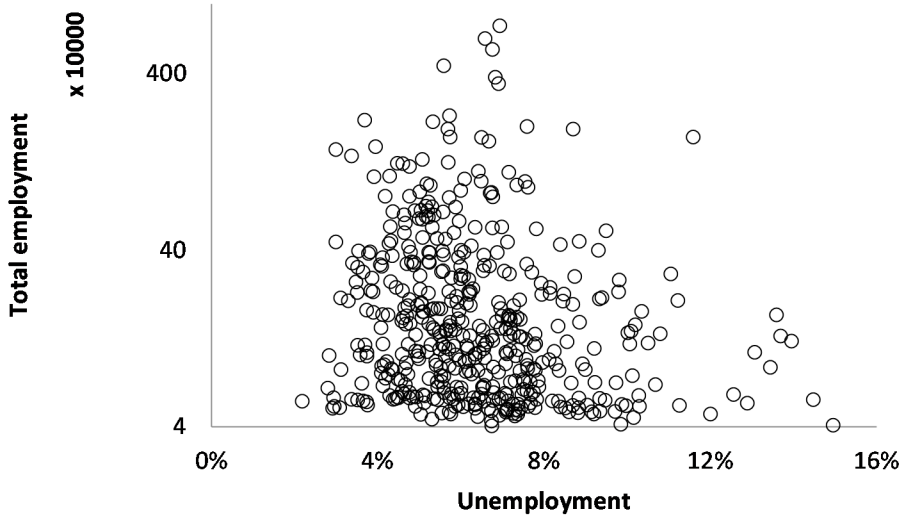


Table 4.1: *Migration to U.S. cities*

	Original data			Adjusted data	
	1980	1990	2000	1980	1990
N/A	50%	0%	0%		
Same house	25%	51%	53%	49%	
Moved within state, within county/PUMA	14%	0%	26%	27%	27%
Moved within state, between counties/PUMAs	5%	0%	9%	11%	10%
Moved within state, unknown	0%	37%	0%		
Moved from out of state	6%	12%	11%	13%	

commute within the MSA they live in.

In every period I observe whether the household remained in the same house, moved within the state or moved from out of state. In 1980 I also observe, for those who moved within the state, whether they moved within the county or between counties. In 2000 I observe, for those who moved within the state, whether they moved within the PUMA or between PUMAs. But in 1990 I don't have any extra information on the persons that moved within the state. Furthermore there is a significant number of missing observations in 1980. The proportion of each type of migration can be found in Table 4.1.

There is a lot of unknown data on migration in both 1980 and 1990, but in both

cases I have enough information to define a group that definitely consists of current inhabitants and a group that consists of migrants. Therefore these data on observed migration can be used for analysis.

Additionally I can estimate the distribution of the missing observations. If I assume that it is random within each city whether a worker's migration status is observed by the Census, then the share of migration within the unobserved group is distributed the same as within the observed group for each city. For example, if I observe a city where 44% of the workers in a city is a current inhabitant and 11% is a migrant, this implies 1-in-5 workers is a migrant. If I apply this to the 45% of the workers for whom the migration status is unknown this implies that in total 77.25% of the workers is a current inhabitant and 22.25% is a migrant. This provides us with an adjusted number of current inhabitants and migrants that adds up to the total number of workers in a city.

For those that moved within the state I can see a stable share moved within county/PUMA in both 1980 and 2000. It is reasonable to assume that for each city in 1990 this share will lie between the shares found in 1980 and 2000. Therefore I can split the "Moved within state, unknown" group observed in 1990 into two parts based upon the relative sizes of "Moved within state, within county/PUMA" and "Moved within state, between county/PUMA" in 1980 and 2000 for the same city. The resulting adjusted data for both 1980 and 1990 is summarized as well in Table 4.1.

4.3 Empirical method

The empirical method used in this chapter builds on specification 2, as explained in Section 1.4. Let us recall the regression model in Eq. (1.12)

$$\frac{E^{NT}_{c,t+10} - E^{NT}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} = \alpha_2 + \beta_2 \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} + \gamma_2 X_{c,t} + \delta_2 \text{Time}_t + \varepsilon_{c,t}$$

and the instrument used in the regression in Eq. (1.13)

$$\text{IV}_2 = \left(E^{NT}_{c,t} + E^{T}_{c,t}\right)^{-1} \sum_{j \in T} E^{j}_{c,t} \left(\frac{\sum_{c' \in C_t \setminus c} E^{j}_{c',t+10}}{\sum_{c' \in C_t \setminus c} E^{j}_{c',t}} - 1 \right),$$

where $E^{T}_{c,t}$ $\left(E^{NT}_{c,t}\right)$ is the total number of employed workers in the tradable (non-tradable) sector of MSA c at time t. Estimating Eq. (1.12) with a 2SLS approach using Eq. (1.13) as the instrumental variable and total employment regression weights, results in a parameter β_2 that represents the average number of jobs created in the non-tradable sector as a result one new worker in the tradable sector. This is also what I model in Chapter 3, therefore I keep using regression weights as I did in Chapter 1.

I can estimate the effect of the tradable sector on a specific part of the non-tradable sector by changing the LHS of Eq. (1.12)

$$\frac{E^{NT,p,k}_{c,t+10} - E^{NT,p,k}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} = \alpha_{2,p,k} + \beta_{2,p,k} \frac{E^{T}_{c,t+10} - E^{T}_{c,t}}{E^{NT}_{c,t} + E^{T}_{c,t}} + \gamma_{2,p,k} X_{c,t} + \delta_{2,p,k} \text{Time}_t + \varepsilon^{p,k}_{c,t}, \quad (4.1)$$

where $E^{NT,p,k}_{c,t}$ is the total number of employed workers in part $p \in \{H, L\}, k \in \{C, M\}$ of the non-tradable sector. Here H and L represent high- and low-skilled workers respectively. C and M represent current inhabitants of the MSA and recent movers respectively. For example, $E^{NT,H,C}_{c,t}$ counts only the high-skilled current inhabitant of MSA c at time t. Regardless of p and k, the instrument is the same in each estimation

as none of the independent variables change. The parameter $\beta_{2,p,k}$ can be interpreted as the Moretti multiplier and $1+\beta_{2,p,k}$ can be interpreted as an input-output multiplier.

4.3.1 Unemployment

In the model in the previous chapter I determined that the size of the local employment multiplier depends on the local unemployment rate, but I showed in Eq. (3.28) that this relationship is not linear. The predicted relationship between β and the unemployment rate is given by

$$\beta(u) = \frac{\lambda}{1-\lambda}\frac{q}{\bar{e}}\frac{u}{b+ur}. \tag{4.2}$$

I will not impose this structural relation on the data, but instead I will estimate the non-parametric relationship between the unemployment rate and the local employment multiplier. I use the Nadaraya-Watson kernel regression (Nadaraya, 1965; Watson, 1964) to estimate β as a function of the unemployment rate

$$\hat{\beta}(u) = \arg\min_{\alpha,\beta} \sum_{t=1}^{T}\sum_{c=1}^{C}\left\{\left(\frac{E_{c,t+10}^{NT,p}-E_{c,t}^{NT,p}}{E_{c,t}^{NT}+E_{c,t}^{T}} - \alpha_{2,p} - \beta_{2,p}\frac{E_{c,t+10}^{T}-E_{c,t}^{T}}{E_{c,t}^{NT}+E_{c,t}^{T}} - \gamma_{2,p}X_{c,t} - \delta_{2,p}\text{Time}_t\right)K\left(\frac{u_{c,t}-u}{h}\right)\right\} \tag{4.3}$$

with the uniform kernel.

In effect, this is equivalent to estimating Eq. (1.12) many times. Each time for a sub-sample of cities that has an unemployment rate within a distance $h/2$ of u. The application of the instrumental variable is straightforward. For each value of u both the first- and second-stage are estimated using the same subset of cities, with an unemployment rate within a distance $h/2$ of u.

4.4 Results and discussion

The starting point for this analysis is the average multiplier between employment in the tradable and the non-tradable sector in the USA as estimated in Table 1.2 of Chapter 1. I found that for 100 new jobs in the tradable sector, 158 additional jobs are created in the non-tradable sector of the same MSA. In this section I will show how many of these workers were skilled and/or moved from outside the city to get their job.

Following this analysis of how multipliers differ within an MSA, I will estimate how multipliers differ between MSAs. I estimate how the local unemployment rate affects the size of the local employment multiplier with a non-parametric analysis. I focus on unemployment because my model in Chapter 3 predicts that the size of the local multiplier will be larger in cities with a higher unemployment rate, and I will use a non-parametric approach because the model predicts this effect is non-linear.

4.4.1 Differences within the MSA

Table 4.2 shows the OLS estimates of the average number of jobs created in (parts of) the non-tradable sector for each new worker in the tradable sector of an MSA. These results are biased as discussed in Chapter 1, therefore I use an industry-mix shift-share instrumental variable. The IV results are shown in Table 4.3 and will form the basis of my discussion.

The total effect of 1.58, as shown in Column (1), is the same result as shown in Table 1.2 of Chapter 1. Now I categorize each non-tradable sector worker in two ways:

- Either as a current inhabitant of the MSA he works in, or as a recent mover from outside of the MSA;
- Either as a worker that is high skilled, or as a worker that is low skilled.

Table 4.2: *OLS estimates for the effect of a shock to employment in the tradable sector on different parts of the non-tradable sector in U.S. MSAs between 1980 and 2000*

Migration	All			Current inhabitants			Recent movers		
Skill	All	High	Low	All	High	Low	All	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Contribution tradable	2.69***	1.46***	1.23***	1.95***	0.99***	0.97***	0.73***	0.47***	0.26***
	(0.23)	(0.14)	(0.11)	(0.16)	(0.09)	(0.08)	(0.08)	(0.06)	(0.04)
ln(initial population)	-0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Share '3+ years of college'	-0.79***	-0.01	-0.79***	-0.72***	-0.08	-0.64***	-0.07	0.07	-0.15***
	(0.29)	(0.16)	(0.15)	(0.22)	(0.11)	(0.12)	(0.11)	(0.07)	(0.05)
Share 'grade 12 - 2 years of college'	0.04	0.20*	-0.16	0.05	0.17**	-0.13	-0.01	0.03	-0.04
	(0.22)	(0.11)	(0.13)	(0.17)	(0.08)	(0.10)	(0.10)	(0.06)	(0.05)
Initial unemployment rate	-0.27	-0.16	-0.11	-0.24	-0.08	-0.16	-0.03	-0.08	0.05
	(0.39)	(0.22)	(0.23)	(0.29)	(0.14)	(0.19)	(0.19)	(0.12)	(0.09)
Constant	0.34***	0.24***	0.10**	0.27***	0.19***	0.08**	0.07*	0.05**	0.02
	(0.08)	(0.04)	(0.04)	(0.06)	(0.03)	(0.04)	(0.04)	(0.02)	(0.02)
Observations	464	464	464	464	464	464	464	464	464
Adjusted R-squared	0.63	0.85	0.79	0.63	0.86	0.81	0.41	0.65	0.47

Note: Clustered standard errors in parentheses.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Table 4.3: *IV estimates for the effect of a shock to employment in the tradable sector on different parts of the non-tradable sector in U.S. MSAs between 1980 and 2000*

Migration	All			Current inhabitants			Recent movers		
Skill	All	High	Low	All	High	Low	All	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Contribution tradable	1.58***	1.06***	0.52**	1.05***	0.63***	0.43***	0.53***	0.43***	0.09
	(0.31)	(0.20)	(0.22)	(0.25)	(0.14)	(0.14)	(0.12)	(0.12)	(0.11)
ln(initial population)	-0.01***	-0.01	-0.01***	-0.01***	-0.00	-0.01***	-0.00	-0.00	-0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Share '3+ years of college'	-0.31	0.16	-0.48***	-0.33	0.07	-0.41***	0.02	0.09	-0.07
	(0.29)	(0.17)	(0.18)	(0.23)	(0.12)	(0.13)	(0.11)	(0.08)	(0.06)
Share 'grade 12 - 2 years of college'	0.09	0.22*	-0.13	0.09	0.19**	-0.10	-0.00	0.03	-0.03
	(0.24)	(0.12)	(0.14)	(0.18)	(0.08)	(0.11)	(0.10)	(0.06)	(0.05)
Initial unemployment rate	-0.71*	-0.31	-0.39*	-0.59*	-0.22	-0.37**	-0.11	-0.09	-0.02
	(0.41)	(0.23)	(0.23)	(0.32)	(0.16)	(0.19)	(0.20)	(0.12)	(0.10)
Constant	0.24***	0.21***	0.04	0.19***	0.16***	0.03	0.05	0.05*	0.01
	(0.09)	(0.04)	(0.05)	(0.07)	(0.03)	(0.04)	(0.04)	(0.02)	(0.02)
Observations	464	464	464	464	464	464	464	464	464
Adjusted R-squared	0.54	0.83	0.72	0.52	0.84	0.75	0.38	0.64	0.41
First-stage statistic	49	49	49	49	49	49	49	49	49

Note: Clustered standard errors in parentheses.
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

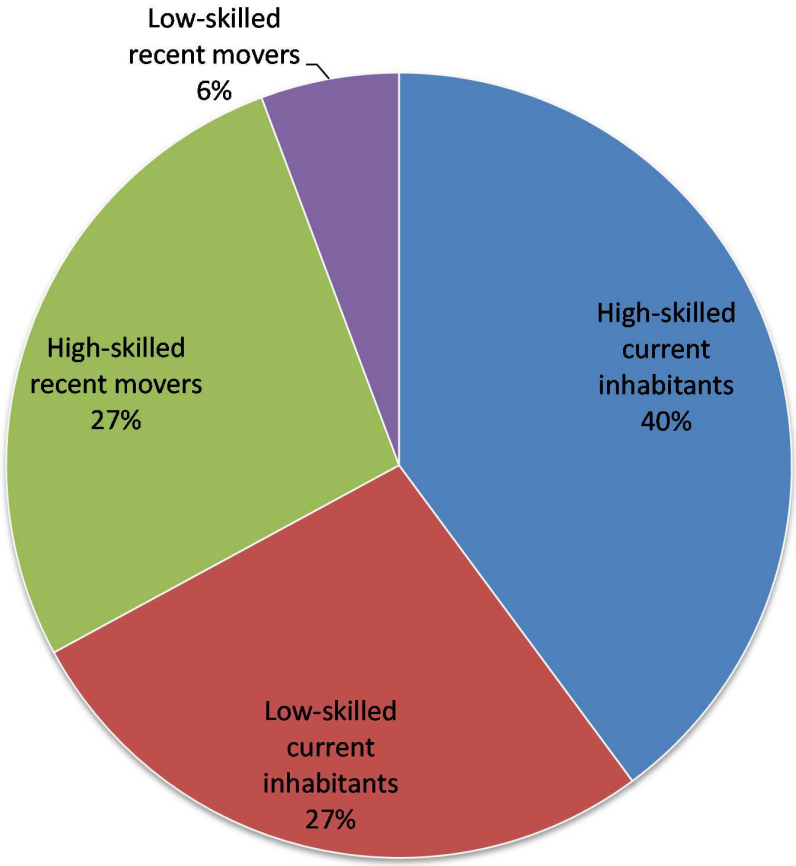
Combining these two categories creates four parts of the non-tradable sector. The effect of a shock to the tradable sector on each part is shown in Columns (5), (6), (8) and (9). The independent variables and the instrumental variable are exactly the same as in Column (1) in each case: only the dependent variable changes. Therefore the first-stage estimation is also the same for each regression and can be found in Table 1.3. By construction the estimates in Columns (5), (6), (8) and (9) add up to the total effect in Column (1). These results can be interpreted as follows: the average effect of 100 new jobs to the tradable sector is the employment of 63 high-skilled and 43 low-skilled current inhabitants as well as 43 high-skilled and 9 low-skilled workers that move from outside the MSA. The effect on low-skilled movers is not significant.

The effect on all current inhabitants / movers or the effect on all high-skilled or low-skilled workers can be estimated as shown in Columns (2) - (4) and (7), but the size of each effect can also be determined by adding up its two component parts from Columns (5), (6), (8) and (9). As shown in Figure 4.2, current inhabitants and high-skilled workers have an advantage. Two-thirds of all new non-tradable sector jobs are fulfilled by high-skilled workers and two-thirds are fulfilled by current inhabitants. This makes intuitive sense, high-skilled workers are more wanted on the labour market and workers that are living outside the city have an information disadvantage relative to unemployment workers already living close-by. In the next section I will show how the absolute and relative sizes of these parts, as well as their sum, will change with the unemployment rate.

4.4.2 Local unemployment

The effect of the unemployment rate on the total number of additional jobs created in the non-tradable sector for each new tradable sector job is shown in Figure 4.3. The effect increases from 1.2 to 2.0 as the unemployment rate increases from 4.3% to 7.7%. I limit myself to this unemployment range, because all other observations have

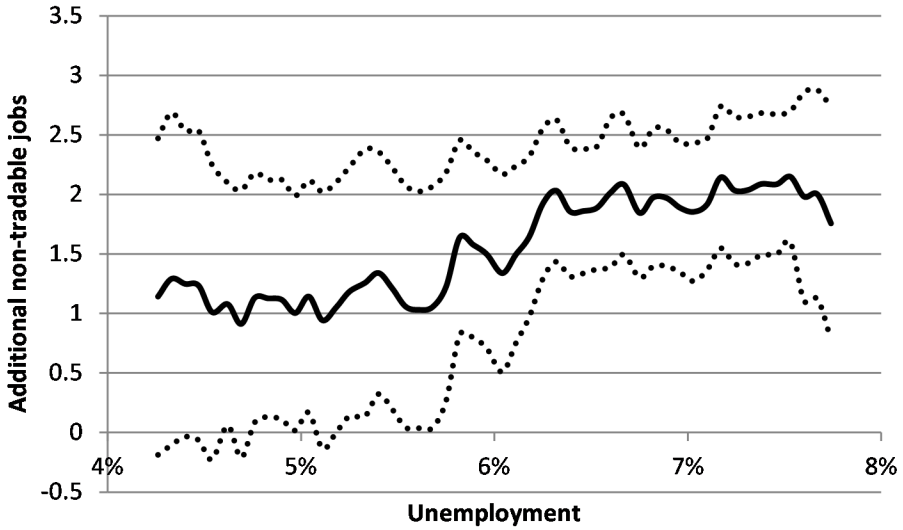
Figure 4.2: *Distribution of the multiplier effect across four parts of the non-tradable sector*



a weak first-stage estimation result ($F < 20$). The transition from a low multiplier to a high multiplier seems to occur between 5.5% and 6.5% unemployment. Full employment in the USA lies between 4% and 6.4% (OECD, 2000), therefore it seems that the multiplier increases as unemployment moves beyond this level. It is not possible to reject the null-hypothesis that the effect does not change with the multiplier, but in corroboration with the model, the increase seems convincing. Especially when one also considers the difference between current inhabitants and recent movers discussed later on. I have also tried to include a standard interaction regression, but this was not possible due to a weak first-stage estimation result.

The multiplier model in the previous chapter uses a simpler specification of the

Figure 4.3: *Non-parametric plot of the number of additional non-tradable jobs created for each new tradable job as a function of the unemployment rate with 95% confidence bands*

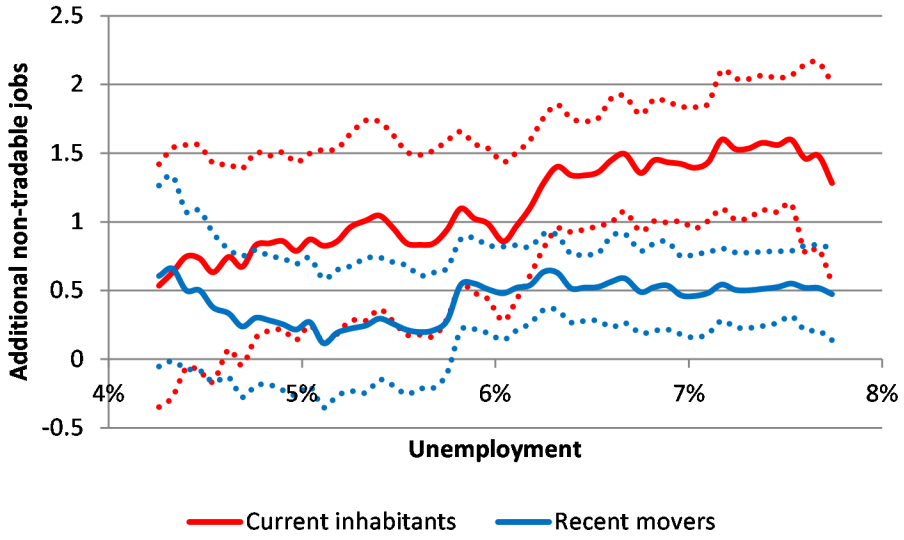


labour market, with full employment at 0% unemployment, therefore the model does not predict the relatively flat relationship between unemployment rate and the multiplier for very low unemployment rates. But the subsequent sharp increase and flattening of the curve shown in Figure 4.3 *is* predicted by the model.

The model makes a separate prediction about current inhabitants and recent movers to the MSA. Therefore I make a non-parametric estimation for both as shown in Figure 4.4. I see that the increase in the local employment multiplier with the unemployment rate is indeed driven by the effect on current inhabitants and I see no effect, or perhaps even a small decrease at low levels of unemployment, for those workers that recently moved to the MSA. Both these results are predicted by the model in the previous chapter.

Although it is not possible to test this, I also want to include a richer explanation outside of the scope of the model. When the unemployment rate in a city is higher, there are more workers available to fulfil new jobs in the non-tradable sector and the skill set of these available workers is more diverse. When the unemployment rate is

Figure 4.4: *Non-parametric plot of the number of additional non-tradable jobs for current inhabitants and recent movers created for each new tradable job as a function of the unemployment rate with 95% confidence bands*

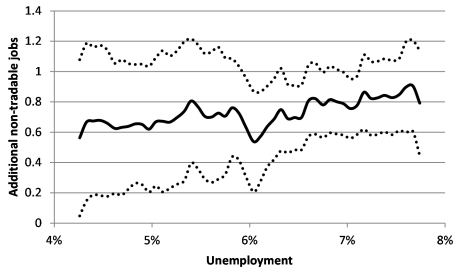


low, only few workers are left to respond and these are likely to be unable or unwilling. This could explain the larger impact of a shock to tradable sector employment on employment in the non-tradable sector in cities with a higher unemployment rate. It also explains why this positive effect is only observed for current inhabitants. The composition of available workers outside of the city does not change with the local unemployment rate within the city.

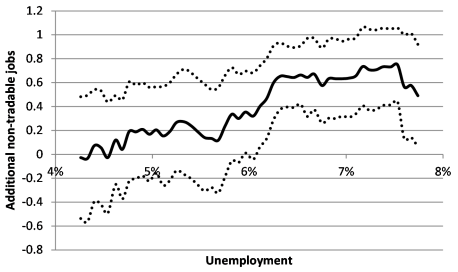
It is possible to split the non-tradable sector into four parts as well; the result for each part is shown in Figure 4.5. The results for high-skilled and low-skilled current inhabitants reflect the trend observed for current inhabitants overall. This could be explained by a greater availability of high-skilled workers with higher unemployment rates, and perhaps the availability of better workers within the low-skilled group as well. The results for high-skilled movers reflect the trend for all movers and the results for low-skilled movers are never significant.

Figure 4.5: *Non-parametric plots of the number of additional jobs created in different parts of the non-tradable sector for each new tradable job as a function of the unemployment rate with 95% confidence bands*

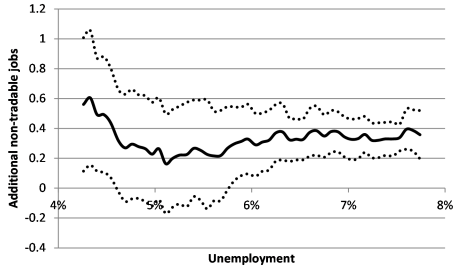
(a) *High-skilled current inhabitants*



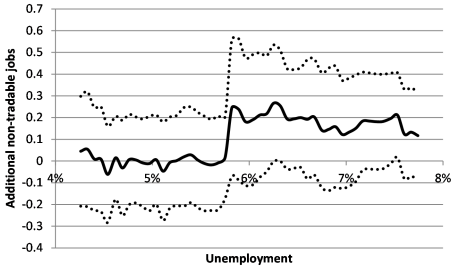
(b) *Low-skilled current inhabitants*



(c) *High-skilled recent movers*



(d) *Low-skilled recent movers*



4.5 Conclusion

The model in Chapter 3 and empirical results in this chapter support a large local employment multiplier between the tradable sector and the non-tradable sector. This is consistent with the existing literature. Policy makers in (local) governments use this multiplier as an argument to attract tradable firms to their cities, for example by giving tax cuts or investing in certain industries.

This chapter extends the existing literature by showing that the impact of attracting jobs in the tradable sector depends on the unemployment rate. An increase in employment in the tradable sector in a city with a higher unemployment rate will have a greater multiplier effect on the non-tradable sector than the same increase in a city with a lower unemployment rate. Therefore policy makers can increase the regional impact of tradable employment and decrease the disparity between regions

by stimulating tradable firms to expand in regions or cities with more unemployment.

The unemployment rate influences the local employment multiplier for current inhabitants differently from workers outside the MSA. As a result the share of jobs created in the non-tradable sector that is fulfilled by current inhabitants increases with the unemployment rate. In other words, in MSAs where the policy of attracting tradable jobs is most effective, the policy maker's constituents will relatively benefit the most. This could make attracting tradable jobs even more desirable for these policy makers.

Chapter 5

Local multipliers of European regions

5.1 Introduction

A crucial part of the European Union Cohesion Policy is to shift the focus from maximizing the total economic growth in the EU to reducing the disparities between different regions in the union by promoting growth in low growth regions. This chapter shows that creating jobs in tradable industries has the biggest positive impact on the regional employment in cities with a high unemployment rate.[1] These are generally the low growth regions, therefore this result allows us to maximize total employment growth as well as reducing the backwardness of the least-favoured regions.

By, for example, investing in innovation or by changing regulations to make an area more hospitable, policy makers can stimulate firms in the tradable sector within Europe to build new or expand current plants in European regions with a high unemployment rate. As a result employment and output increases in these regions and disparities between different regions in the union are reduced. In this chapter, I show

[1] I define the tradable sector as all firms that produce goods and/or services that can be traded with other cities and/or countries. Examples of firms in the tradable sector are a car manufacturer such as Audi or an electronics firm such as Philips.

that this approach also creates the largest local employment multiplier between the tradable and the non-tradable sector.[2] Total employment across Europe is maximized when I apply this type of cohesion policy.

This local multiplier effect has been shown for cities in the USA (Moretti, 2010; Van Dijk, 2016), but the reaction to employment shocks differs between Europe and the USA (Decressin and Fatás, 1995). In Europe, multipliers have been estimated for tradable sector and public sector jobs in France (Malgouyres, 2013), Spain (Gerolimetto and Magrini, 2014; Jofre-Monseny et al., 2016), Italy (de Blasio and Menon, 2011) and the United Kingdom (Faggio and Overman, 2014), with mixed results. For example, no significant multipliers were found in Italy and the United Kingdom. These results beg the question whether significant local multipliers are in fact a purely American phenomenon like muscle cars and cheesesteak and should not be sought after with European policy.

Even though several countries in Europe have already been studied using a method based on Moretti (2010), every paper made different changes to the specification of their analysis. Therefore it is hard to compare the multipliers found across these studies. Additionally there is no published result that analyses Europe in its entirety or provides an overview of Europe and its part. This chapter attempts to provide this analysis and overview, using the same method and specification within Europe and a method very similar to the method used with U.S. data, allowing for reliable comparisons.

I show that, for Territorial Level 3 (TL3) regions in Europe, an additional 100 jobs in the tradable sector will increase employment in the non-tradable sector by 110 jobs.[3] This impact is measured over a period of 5 years. When I split Europe into the United Kingdom and Ireland, North and West, South, and East, I find the largest multi-

[2]Goods and/or services that are (mostly) consumed within the city that they are produced in. For example bread or a haircut at a barbershop.

[3]TL3 regions as defined by the OECD correspond to the NUTS3 regions as defined by the EU.

pliers in Northern and Western Europe and Southern Europe. I also find a significant, but smaller, multiplier in the East of Europe. I do not find a significant multiplier in the United Kingdom and Ireland. Finally, depending on the unemployment rate within a region, the average size of the local employment multiplier ranges from 0.3 in a region with 2% unemployment to 3.0 in a region with 8% unemployment.

5.2 Theoretical framework

I use the same framework as in Chapters 1 and 2, hence I will only provide a brief outline here.

Each region is a competitive economy where tradable and non-tradable goods are produced. Non-tradable 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. 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 most services such as barbers, restaurants and dry cleaners are non-tradable.

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 non-tradable 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-tradable goods are demanded and their respective technologies, there will be an increase in labour demand in the non-tradable sector. Assuming the elasticity of the local labour supply is neither zero nor infinite, the increased demand for labour in the non-tradable sector will increase both wages and employment in the non-tradable sector. The latter is the local employment multiplier effect of jobs in the tradable sector on jobs in the non-tradable sector.

5.3 Data

For my estimation of the local employment multiplier in European TL3 regions I use OECD Regions and Cities data. The OECD has classified two levels of geographic units within each member country. The higher level, Territorial level 2 (TL2), consists of 362 larger regions and the lower level, Territorial level 3 (TL3), is composed of 1794 smaller regions. All the territorial units are defined within national borders and in most of the cases correspond to administrative regions. Regions at the lower level (TL3) are contained within the higher level (TL2).

The Regions and Cities dataset provides yearly data on employment at the place of work between 1995 and 2013. The years for which data is available differs for each region and virtually no region has data on every year. I am interested in long-term local employment multipliers in Europe, where I define long-term as five to ten years and local as within a TL3 region. The two years, at least five years apart, that have the highest number of TL3 regions in common are 2001 and 2006, therefore I will focus my analysis on the interval 2001-2006.

I observe employment in the tradable and the non-tradable sector in 2001 and 2006 for 802 TL3 regions across 22 countries in Europe. I will control for other variations between regions, such as population size and degree of urbanisation[4] in

[4]This is based on the OECD regional typology. I convert this into a dummy variable where

2001. These controls are available for 754 of the regions.

5.4 Empirical method

The empirical strategy used to determine the causal effect of employment in the tradable industry on employment in the non-tradable industry relies on an industry-mix shift-share instrument as used by, for example, Bartik (1991). The approach in this chapter is based upon an adaptation of this method used by Faggio and Overman (2014).

The central equation that is estimated for every region, c, is

$$\frac{N^{NT}_{c,t} - N^{NT}_{c,t-s}}{N^{NT}_{c,t-s} + N^{T}_{c,t-s}} = \alpha + \beta \frac{N^{T}_{c,t} - N^{T}_{c,t-s}}{N^{NT}_{c,t-s} + N^{T}_{c,t-s}} + \gamma X_{c,t-s} + \varepsilon_{c,t}, \tag{5.1}$$

where $\left(N^{NT}_{c,t} - N^{NT}_{c,t-s}\right) / \left(N^{NT}_{c,t-s} + N^{T}_{c,t-s}\right)$ is the contribution of employment in the non-tradable sector to total employment growth between period $t-s$ and t; and $\left(N^{T}_{c,t} - N^{T}_{c,t-s}\right) / \left(N^{NT}_{c,t-s} + N^{T}_{c,t-s}\right)$ is the contribution of employment in the tradable sector. The vector $X_{c,t-s}$ is a set of city specific characteristics that affect employment growth in the non-tradable sector and $\varepsilon_{c,t}$ is the error term.

The parameter β indicates the effect of employment in the tradable sector on employment in the non-tradable sector. If $\beta = 0$ they are not related, otherwise β indicates the number of additional jobs that are created in the non-tradable sector for each new job in the tradable sector.

The parameter β can capture three types of co-movement: the causal effect of extra jobs in the tradable sector on employment in the non-tradable sector; the effect of employment in the non-tradable sector on the tradable sector; and effects due to omitted variables, for example effective local government can increase employment in both sectors.

intermediate/rural=0 and urban=1.

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 non-tradable sector I need a way to filter out the other two unwanted co-movements captured by β. To achieve this I will use an instrumental variable derived from the well-established shift-share approach.

This instrument uses the initial share of the tradable sector within the city and the national growth of this sector to predict the contribution of the tradable sector to employment growth in region c.

$$\frac{N^T_{c,t-s}}{N^{NT}_{c,t-s}+N^T_{c,t-s}} \times \left(\frac{\sum_{c \in C} N^T_{c,t}}{\sum_{c \in C} N^T_{c,t-s}} - 1 \right), \tag{5.2}$$

where C contains all TL3 regions in the country that c is a part of (excluding c itself).

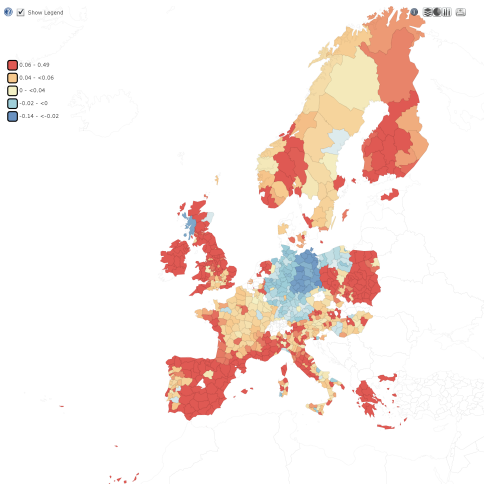
As a robustness check I can also calculate an alternative instrument that depends on more detailed sub-sector data for TL2 regions. See Faggio and Overman (2014) or Moretti (2010) for more details on the shift-share approach.

5.5 Results

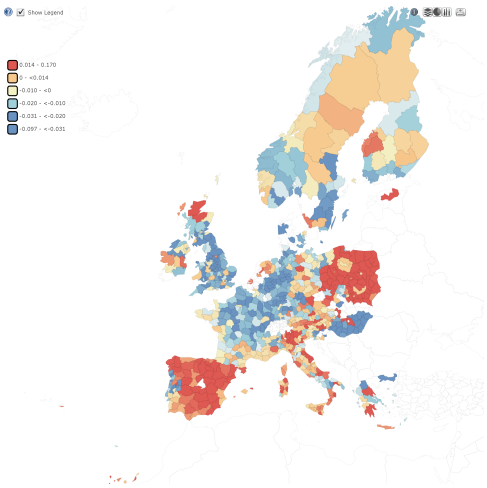
I estimated the average local employment multiplier between employment in the tradable and the non-tradable sector within European TL3 regions from 2001 till 2006 using OECD data. The dependent variable is the change in employment in the service sector between 2001 and 2006 divided by total employment in 2001 (the contribution of service sector employment) as defined in Eq. (5.1). My main regressor, defined in a similar way, is the contribution of tradable sector employment over the same period. An overview of this contribution of the non-tradable and tradable sector to total employment growth is shown for all TL3 regions in Figure 5.1a and 5.1b respectively. In all estimations I control for the total number of employed workers in each region and whether a region is urbanised. I exclude any region that contains more than 10% of all jobs in the country it is a part of.

Figure 5.1: *Contribution to total employment growth between 2001 and 2006 for TL3 regions. Created with OECD Data explorer*

(a) *Contribution of services to total employment growth*



(b) *Contribution of industry to total employment growth*



The left-hand column of Table 5.1 reports OLS estimates. The right-hand column reports instrumental variable estimates where I use the shift-share instrument defined in Eq. (5.2). As becomes clear from the Table, there is a significant local multiplier effect and the OLS estimate is biased downwards. The Instrumental Variable estimate of this multiplier is 1.1; this implies that for each additional 100 tradable sector jobs in a TL3 region increases employment in the non-tradable sector by 110.

These results are robust for different time periods or controlling for unemployment. Using a more detailed instrument based on TL2 regions which is available for only a third of the regions shows at worst my estimate is on the conservative side. More details about these robustness checks are available from the author upon request.

5.5.1 Differences across Europe

In order to investigate differences across Europe I will split the continent into four parts. The British and Irish Islands, the Northern and Western parts of continental

Table 5.1: *Estimates of the Effect of Tradable Employment on Services Employment between 2001 and 2006.*

	OLS	IV
$\text{Contribution}_{2001\text{-}2006}$ (tradable)	0.7^{***}	1.1^{***}
	(0.1)	(0.2)
$\text{Total employment}_{2001}$	-0.008	-0.009
	(0.005)	(0.005)
$\text{Urbanisation}_{2001}$	0.016^{**}	0.021^{***}
	(0.007)	(0.007)
Constant	0.16^{**}	0.16^{***}
	(0.06)	(0.06)
Observations	754	754
Adjusted R^2	0.07	0.06
First-stage statistic[a]		166

Note: Robust standard errors clustered by TL2 region are reported in parentheses. Data is from the OECD Regions and Cities database. The dependent variable is the contribution of service sector employment to total employment growth between 2001 and 2006. $\text{Contribution}_{2001\text{-}2006}$ (tradable) denotes the contribution of tradable sector employment to total employment growth. The instrumental variable is equal to the 2001 share in tradable sector employment for a given region multiplied by the 2001-2006 increase in tradable sector employment for the country as a whole (excluding own region).
[a] The Kleibergen-Paap rk Wald F statistic
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

Europe, Eastern Europe, and Southern Europe, as shown in Figure 5.2. The descriptive statistics in Table 5.2 show clear differences between these parts. For example the United Kingdom and Ireland consist of far more urbanised regions; the unemployment rate and share of employment in the tradable sector is relatively high in Eastern Europe; and employment in TL3 regions is growing much faster on average in the United Kingdom, Ireland and Eastern Europe. The non-tradable sector is growing in the average TL3 region for all parts of Europe, but employment in the tradable sector is decreasing in the United Kingdom, Ireland and the Northern and Western parts of continental Europe.

Figure 5.2: *Division of Europe into four parts. The British and Irish Islands are dark blue, the Northern and Western parts of continental Europe are red, Eastern Europe is light blue and Southern Europe is yellow. Data is missing in the white areas. Created with OECD Data explorer.*

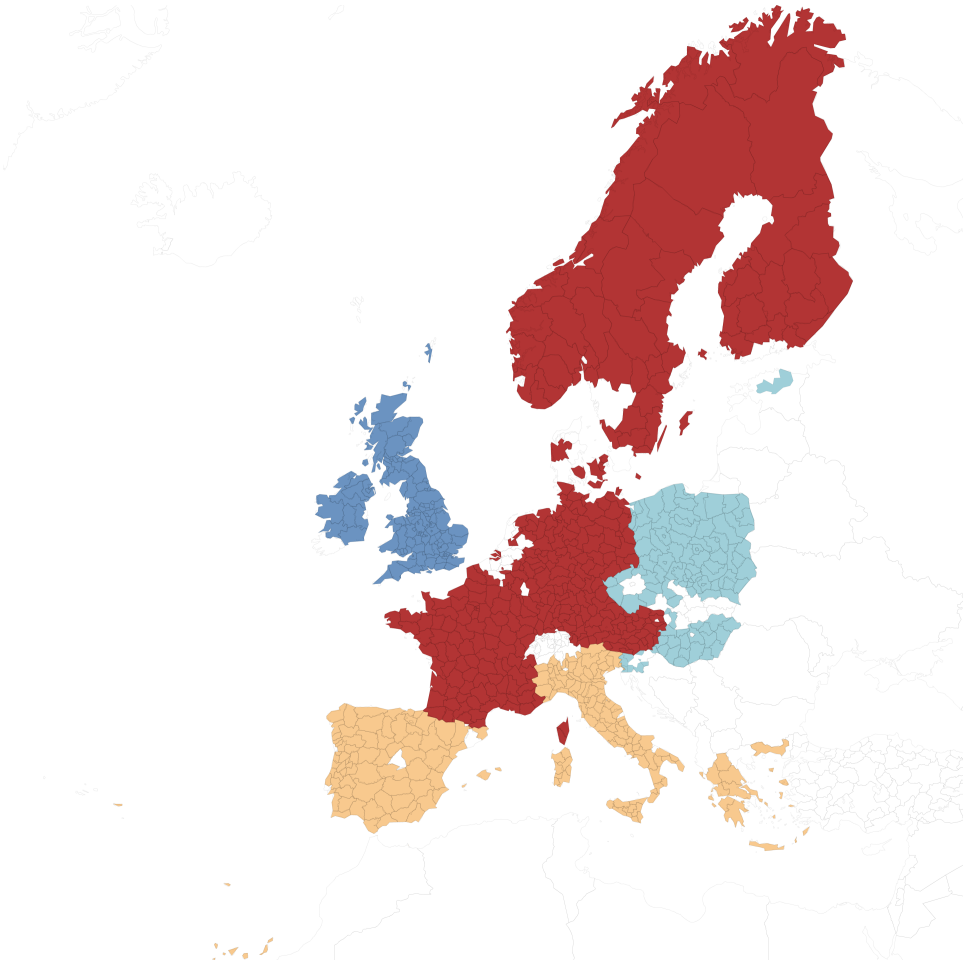


Table 5.2: *Descriptive Statistics of Employment in European TL3 regions.*

	Europe		British and Irish		North and West		South		East	
	Mean	Std. dv.	Mean	Std. dv.	Mean	Std. dv.	Mean	Std. dv.	Mean	Std. dv.
Dependent variable										
Contribution non-tradable 2001-2006	5%	7%	8%	6%	2%	6%	9%	8%	5%	5%
Main regressor										
Contribution tradable 2001-2006	-1%	3%	-3%	2%	-2%	2%	0%	2%	1%	4%
Control variables										
Total employment 2001($\times$1000)	191	191	193	160	206	201	185	227	158	106
Urbanised regions 2001	27%	44%	60%	49%	19%	39%	24%	43%	11%	32%
Unemployment rate 2001	8%	6%	5%	2%	8%	5%	9%	6%	14%	7%
Other Descriptives										
Share tradable 2001	23%	9%	18%	5%	23%	9%	21%	10%	33%	7%
Total employment growth 2001-2006	4%	8%	5%	6%	0%	6%	0%	9%	6%	8%
Tradable growth 2001-2006	-4%	11%	-13%	12%	-6%	6%	2%	10%	3%	13%
Non-tradable growth 2001-2006	7%	9%	10%	7%	2%	7%	11%	9%	8%	7%
Number of TL3 regions observed	754		145		300		203		106	
Number of TL2 regions observed	250		14		155		49		32	
Number of countries observed	21		2		9		4		6	
Number of TL3 regions too large	48		2		21		6		19	

Table 5.3 reports the local employment multiplier for all four parts of Europe. I find the largest multipliers in Northern and Western Europe, and Southern Europe, with local employment multipliers of 2.3 and 1.9 respectively. The local employment multipliers in Eastern Europe, and the United Kingdom and Ireland are significantly smaller, with a local employment multiplier of 0.6 and 0.3 respectively, where the estimated multiplier for the latter is not statistically significant.

Table 5.3: *Estimates of the Effect of Tradable on Services Employment over five years for different parts of Europe.*

	British and Irish	North and West	South	East
$\text{Contribution}_{\text{2001-2006}}$ (tradable)	0.3	2.3^{***}	1.9^{***}	0.6^{***}
	(0.6)	(0.4)	(0.6)	(0.2)
Observations	145	300	203	106
Adjusted R^2	0.04	-	0.06	0.27
First-stage statistic[a]	31	68	189	36

Note: Robust standard errors clustered by TL2 region are reported in parentheses. The dependent variable is the contribution of service sector employment to total employment growth. $\text{Contribution}_{\text{2001-2006}}$ (tradable) denotes the contribution of tradable sector employment to total employment growth. The instrumental variable is equal to the 2001 share in tradable sector employment for a given region multiplied by the 2001-2006 increase in tradable sector employment for the country as a whole (excluding the own region). The total employment in 2001 and a dummy variable for urbanisation are included as controls.

[a] The Kleibergen-Paap rk Wald F statistic

* Significance at the 10% level.

** Significance at the 5% level.

*** Significance at the 1% level.

Northern and Western Europe, and Southern Europe have a similar share of tradable employment and comparable unemployment and urbanisation rates. But employment growth is a lot smaller in Northern and Western Europe than in Southern Europe. This is most extreme in the tradable sector, which is shrinking in Northern and Western Europe, but growing in Southern Europe.

Eastern Europe, and the UK and Ireland are very different. The share of workers employed in the tradable sector is much higher in Eastern Europe. The tradable sector is growing in Eastern Europe, whilst it is rapidly declining in the UK and Ireland. The UK and Ireland are far more urbanised and have a much lower unemployment rate.

The direction of the shock to employment in the tradable sector could influence the size of the local multiplier. To control for this I include a dummy variable that is one when the first-stage estimate of the contribution of the tradable sector to total employment is positive and zero otherwise. Table 5.4 shows that the direction of the shock does not have a significant effect on the size of the local employment multiplier.

5.5.2 Unemployment

Finally I estimate the effect of the unemployment rate within a TL3 region on the size of the local employment multiplier across Europe. For each region the unemployment rate is shown in Figure 5.3. I use a non-parametric regression that allows the size of the multiplier to vary with the unemployment rate. This method is explained in Chapter 4. The result of this regression is shown in Figure 5.4. The solid line shows that the local employment multiplier increases with the unemployment rate and the dashed line is the estimate of the local multiplier when I assume it is independent of the unemployment rate.

Figure 5.3: *Unemployment rate in 2001 across TL3 regions in Europe. Created with OECD Data explorer.*

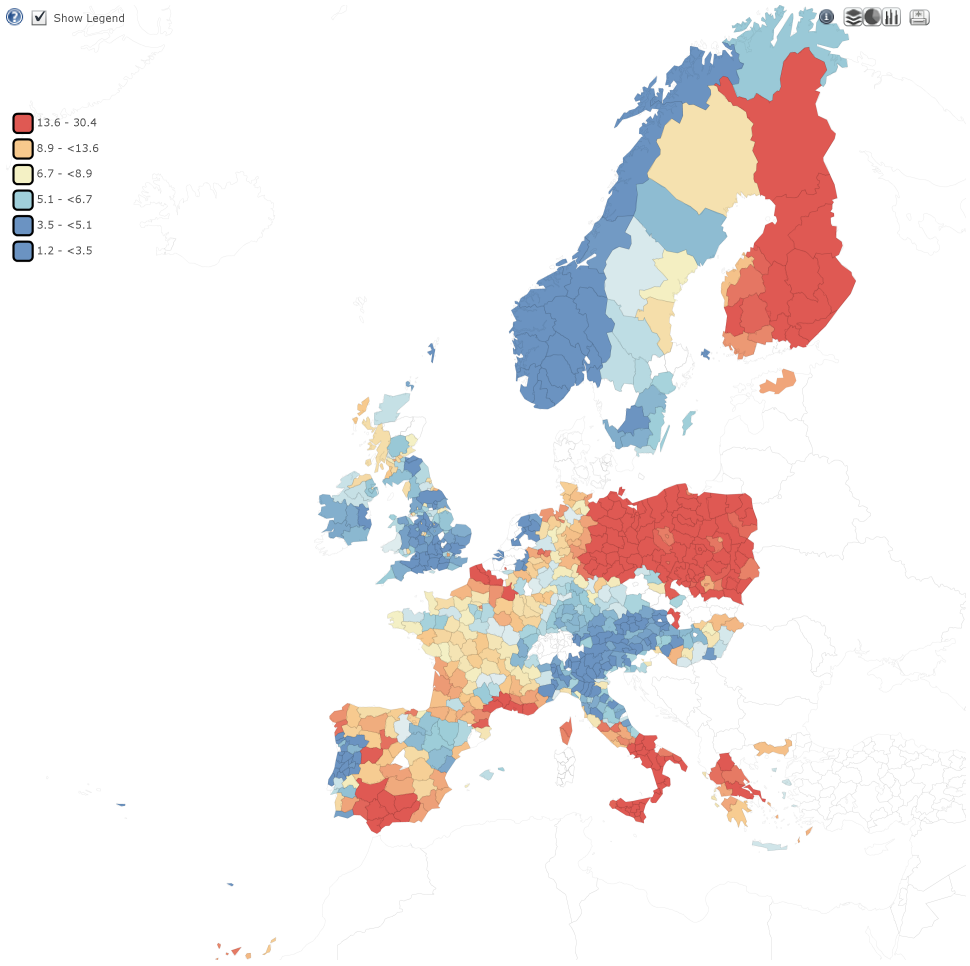


Figure 5.4: *Non-parametric effect of unemployment on the local employment multiplier*

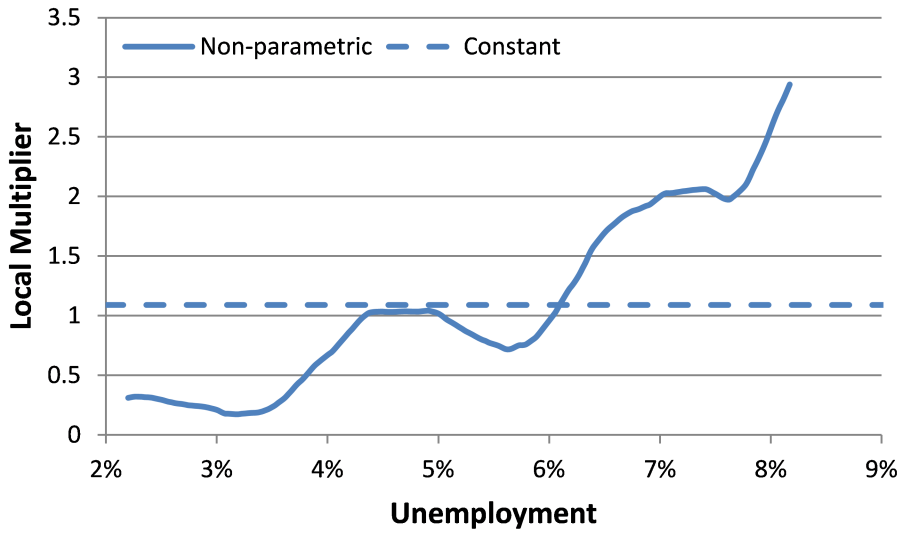


Table 5.4: *Estimates of the Effect of Tradable Employment on Services Employment between 2001 and 2006, allowing the multiplier size to differ between positive and negative shocks.*

	OLS	IV
$\text{Contribution}_{2001\text{-}2006}$ (tradable)	0.6^{***}	1.2^{***}
	(0.2)	(0.4)
$\text{Positive contribution}_{2001\text{-}2006}$ (tradable)	0.4	-0.3
	(0.3)	(0.7)
$\text{Total employment}_{2001}$	-0.008	-0.009
	(0.005)	(0.005)
$\text{Urbanisation}_{2001}$	0.015^{**}	0.021^{***}
	(0.007)	(0.008)
Constant	0.15^{**}	0.16^{**}
	(0.06)	(0.06)
Observations	754	754
Adjusted R^2	0.08	0.05
First-stage statistic[a]		18

Note: Robust standard errors clustered by TL2 region are reported in parentheses. The dependent variable is the contribution of service sector employment to total employment growth between 2001 and 2006. $\text{Contribution}_{2001\text{-}2006}$ (tradable) denotes the contribution of tradable sector employment to total employment growth. The instrumental variable is equal to the 2001 share in tradable sector employment for a given region multiplied by the 2001-2006 increase in tradable sector employment for the country as a whole (excluding own region).
[a] The Kleibergen-Paap rk Wald F statistic
* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

5.6 Discussion and conclusion

I can now relate the empirical results in this chapter to the existing literature. I find a significant local employment multiplier for TL3 regions in Europe; for each additional 100 jobs in the tradable sector of a TL3 region there are 110 jobs created in the non-tradable sector of the same region.

The size of the local employment multiplier for cities in the USA over a ten year period is 1.6 (Van Dijk, 2016). This suggests that the magnitude of the local multiplier effect is a bit smaller in Europe than in the USA. There are some caveats

to this comparison. First of all, there was not enough city data available for Europe. Therefore the European multipliers are based on TL3 regions instead of cities. The average TL3 region has 569 thousand inhabitants, making them comparable in size to MSAs. But by their nature, they are less dense than MSAs.We also expect Europeans to be less mobile in response to labour demand shocks (Decressin and Fatás, 1995). Both of these will affect the size of the local multiplier.

The local multiplier for municipalities in Sweden over a period of six years found by Moretti and Thulin (2013) is 0.5, but both the method and unit of analysis were different in the Swedish study.

When I separate out Europe into the North and West, the United Kingdom and Ireland, South, and East I find the largest multiplier in North- and West-Europe. I grouped these two parts of Europe together because they have very similar economical climates. I also find a large multiplier for Southern Europe even though many conditions there are very different from those in Northern and Western Europe. The local employment multipliers in Eastern Europe, and the United Kingdom and Ireland are significantly smaller, with local employment multipliers of 0.6 and 0.3 respectively, where the estimated multiplier for the latter is not statistically significant.

Across TL3 regions in Europe the size of the local employment multiplier increases with the unemployment rate, therefore policy makers can increase the regional impact of tradable employment and decrease the disparity between regions by stimulating tradable firms to expand in regions or cities with more unemployment.

I find that regions with an unemployment rate of 2% have an average multiplier of just 0.3, whilst regions with an unemployment rate of 8% have a multiplier of almost 3.0. This is good news: the bigger the problem is, the more effective the solution. The incentives for local officials; policy makers who want to reduce disparities between regions; and policy makers who want to increase overall employment are aligned. Policy makers should stimulate the tradable sector in regions with a high

unemployment rate.

It is unlikely that the predicted increase in the local employment multiplier will sustain for much higher unemployment rates, because frictions in the local labour market are likely to become dominant. This could also explain why Eastern Europe has smaller multipliers even though the average unemployment rate of a TL3 region there was 14%.

These results are affected by the identification of the tradable sector. This chapter estimates the size of the tradable sector as accurately as possible given the data that is available, but using the combination of mining, manufacturing and energy as the tradable sector has some limitations. It is likely that parts of the energy sector and even the manufacturing sector are actually non-tradable, and this specification does not allow for tradable services. Another limitation of this chapter is the lack of sub-sector information within the tradable sector of TL3 regions. More detailed TL2 data shows that my estimates hold up, but this is no replacement for the actual detailed data.

My results show that policies that create jobs in the tradable sector can be very successful to stimulate local economic growth because of the local employment multiplier effect. The European Union could simulate firms to locate or expand in low-growth regions as part of their Cohesion Policy. Future research should determine which tradable sub-sector have the greatest multiplier, such that these industries can be targeted by the smart specialisation innovation policy of the European Union.

Conclusions

A permanent shock to employment in the tradable sector of a region has a significant and important effect on employment in the non-tradable sector of the same region. This is a robust result that holds for several methods of analysis, multiple combinations of control variables, different definitions of tradable employment and many regional units of analysis. When employment in the tradable sector of an average MSA in the USA increases by 100 workers, an additional 109 jobs are created in the non-tradable sector of the same MSA. If I consider the impact of the average tradable sector worker instead of the average MSA, this result increases to between 158 and 169 jobs. All these results are based on U.S. Censuses between 1980 and 2000 and rely on 2SLS estimates, employing an instrument that uses a shift-share approach. I also found a significant local employment multiplier for TL3 regions in Europe: for each additional 100 jobs in the tradable sector of a TL3 region there are 110 jobs created in the non-tradable sector of the same region.

There is no significant local employment multiplier for tradable jobs that pay below the median wage, but the local employment multiplier for jobs that pay above the median wage lies between 3.0 and 3.3 and *is* significant.[5] When I distinguish between jobs created for skilled and unskilled workers I find that a shock to skilled employment in the tradable sector has a local employment multiplier of 3.1; for each 100 new skilled jobs in the tradable sector, 89 skilled and 116 unskilled additional

[5]Reported as 2.0-2.3 in Chapter 1, because it uses a slightly different definition of the local employment multiplier.

jobs are created in the non-tradable sector. The local employment multiplier for unskilled jobs in the tradable sector is not significant. Two-thirds of all new jobs in the non-tradable sector are fulfilled by current inhabitants of the MSA, only one third is fulfilled by workers that move in from outside the MSA.

Although the empirical methods in Chapters 1 and 2 are both rooted in Moretti (2010), they diverge to the extent that they provide seemingly conflicting results. In Chapter 2, I include MSA fixed effects, I rely on the MSA of work instead of the MSA of residence and I do not include regression weights. I even use two different definitions of the local employment multiplier, where I need to add one to the multiplier in Chapter 1 in order to compare it to the multiplier in Chapter 2. I would argue that all these changes are improvements, as the resulting estimates provide a robust lower bound for the size of the local employment multiplier; and the changes allow for a better comparison of the results to more traditional multiplier estimates, such as those from the input-output literature. Yet, there is still value - apart from the merit of comparing different empirical approaches - in the estimates from Chapter 1. They allow for a more extensive analysis, such as the study of the effect of unemployment in Chapter 4.

I build a theoretical foundation for the workings of these local employment multipliers by developing an efficiency wage model with rural-urban migration for the non-tradable sector. To incentivise workers not to shirk, wages are too high; as a result there is unemployment in the city (Shapiro and Stiglitz, 1984). Workers move to the city from the surrounding hinterlands up to the point where the expected utility in the city is equal to their utility in the rural area (Harris and Todaro, 1970). I then consider the impact of a shock to employment in the tradable sector in the city and find a positive multiplier effect. The size of this multiplier increases with the local unemployment rate. In cities with a higher unemployment rate more jobs are created for current inhabitants of the city as a result of a shock to the tradable sector; the

multiplier for workers who move from outside the city decreases, but the former effect dominates. These predictions are all consistent with my empirical findings.

An increase in employment in the tradable sector in an MSA with a higher unemployment rate will have a greater multiplier effect on the non-tradable sector than the same increase in an MSA with a lower unemployment rate. When the unemployment rate lies around 5.2% the MSA is approximately at full employment and the effect of 100 new jobs in the tradable sector is 120 additional jobs in the non-tradable sector. As the unemployment rate increases the number of additional jobs in the non-tradable sector increases as well, to 200 at an unemployment rate of 7.7%. The unemployment rate influences the local employment multiplier for current inhabitants differently than for workers outside the MSA. As a result the share of jobs created in the non-tradable sector that is fulfilled by current inhabitants increases with the unemployment rate.

When I separate out Europe into the North and West, the United Kingdom and Ireland, South, and East I find the largest multiplier in North- and West-Europe. I also find a large multiplier for Southern Europe even though many conditions are very different here from Northern and Western Europe. The local employment multipliers in Eastern Europe, and the United Kingdom and Ireland are significantly smaller, with local employment multipliers of 0.6 and 0.3 respectively, where the estimated multiplier for the latter is not statistically significant. Across TL3 regions in Europe the size of the local employment multiplier also increases with the unemployment rate. Regions with an unemployment rate of 2% have an average multiplier of just 0.3, whilst regions with an unemployment rate of 8% have a multiplier of almost 3.0.

The results discussed above show a clear incentive for policy makers to focus on *skilled* jobs if they want to attract jobs to the tradable sector. More importantly, policies that try to increase growth in less favoured regions by stimulating tradable firms to locate in areas with high unemployment, will both reduce disparities between

cities *and* efficiently reduce unemployment across the board. And in MSAs where the policy of attracting tradable jobs is most effective, the policy maker's constituents will relatively benefit the most. This could make attracting tradable jobs even more desirable for these policy makers.

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