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Local multiplier of industrial employment: Brazilian mesoregions (2000-2010)*

Multiplicador local do emprego industrial: mesorregiões brasileiras

GUILHERME MACEDO
LEONARDO MONASTERIO**

RESUMO: Este trabalho estima o multiplicador local de longo prazo da emprego industrial para as mesorregiões brasileiras. A metodologia toma como base os estudos de Moretti (2010) e Moretti e Thulin (2012), que estimaram os multiplicadores locais do emprego para os Estados Unidos e para a Suécia, respectivamente. Foram avaliados os impactos da variação de empregos no setor industrial sobre o emprego no setor de serviços, bem como o impacto da variação de empregos nos setores industriais de alta e de baixa tecnologia sobre o emprego nos setores de serviços. Essas estimativas permitiram avaliar o impacto de mudanças do emprego industrial nas economias locais. Fez-se uso de uma variável instrumental fundamentada no método estrutural-diferencial (shift-share). Foram utilizados dados de emprego da Relação Anual de Informações Sociais (RAIS) de 2000, 2005 e 2010, para 21 subsetores de atividade econômica e 123 mesorregiões. Estimou-se que, no nível mesorregional, para cada emprego gerado nos setores industriais quatro são criados nos setores de serviços, no longo prazo. Também foi calculado que, para cada emprego gerado nos setores industriais de alta intensidade tecnológica, são criados cerca de sete empregos nos setores de serviços, no nível mesorregional, no longo prazo.
PALAVRAS-CHAVE: economia regional; mercado de trabalho; multiplicadores locais; *shift-share*.

ABSTRACT: This paper estimates the local multiplier of manufacturing for Brazil (2000-2010). The method is based on Moretti (2010) and on Moretti and Thulin (2012), who estimated these multipliers for the U.S. and Sweden. The local multiplier of manufacturing estimates the impacts of employment changes in the industrial sectors on employment in the services

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** Respectively, PhD Candidate at Birkbeck, University of London, e-mail: gmmacedo@gmail.com; Professor ata Universidade Católica de Brasilia (UCB) and researcher at Instituto de Pesquisa Econômica Aplicada (IPEA), e-mail: leonardo.monasterio@gmail.com. Submitted: 26/September/2014; Approved: 24/September/2015.

sectors, and the impact of changes in employment in the high-tech and low-tech tradable sectors on employment in the services sectors. These estimates help to assess the importance of industrial employment changes over local economies. We created instrumental variables, based on the shift-share method. The employment data cover 21 economic subsectors and 123 regions in 2000, 2005 and 2010. We have estimated that in the Brazilian mesorregions, for each new job in the tradable sectors, almost four jobs were created locally in the services sectors. Additionally, each job in the high-tech industrial sectors was estimated to create approximately seven jobs in the services sectors over the long term.
KEYWORDS: regional economics; labour market; local multipliers; shift-share.
JEL Classification: J21; J88; R12; R23.

INTRODUCTION

The present and future of the Brazilian manufacturing industry have received the attention of scholars and policy makers[1]. Discussions have focused on the process of early deindustrialisation and its causes. Although consensus on the issue is lacking, the proponents of manufacturing's importance to national development agree that the sector is special. Following a Kaldorian approach, they claim that manufacturing has a very strong multiplier effect on other sectors at the local and national levels (e.g., Lamonica and Feijó, 2011).

To contribute to this debate, this study estimates the local multiplier effect of national industrial employment. This estimate is achieved through a newly developed technique that offers advantages over previous approaches. Isles and Cuthbert (1956) presented a pioneering attempt to adapt the Keynesian multiplier to subnational analysis (Faggian and Biagi, 2003). Later, more sophisticated input-output, computable general equilibrium or simulation models were applied in the estimation of this multiplier. These methods are relevant. However, they require databases at the local level, which are rarely available, and theoretical choices that are not always obvious.

The method proposed by Moretti (2010) is the primary recent contribution to local multiplier estimation. In an article published in the *American Economic Review*, Moretti estimated the employment multiplier at the local level in the U.S. between 1980 and 2000 (Moretti, 2010). The author applied an idea proposed by Bartik (1991) and Blanchard and Katz (1992, p. 49): using the shift-share method to create an instrumental variable that overcomes endogeneity problems. As will be presented below, this method estimates local employment creation as a result of an exogenous increase in the number of jobs in the manufacturing sectors.

This study applies the method of Moretti (2010) to Brazilian mesoregions for a recent period and thus represents an innovative approach to local multiplier estima-

[1] For the contemporary debate on deindustrialization in Brazil, see: Nassif (2008); Bonelli and Pessôa (2010); Oreiro and Feijó (2010); and Squeff (2012).

tion in Brazil, based on instrumental variables. The data source is the Annual Social Information Report (Relação Anual de Informações Sociais – RAIS), and the level of analysis comprises the 21 Brazilian economic subsectors and 123 Brazilian mesoregions. The study period was selected based on the following criteria: quality, data availability and comparability with other studies. Therefore, there are two periods of analysis, 2000-2005 and 2005-2010. In this study, the tradable sector groups represents the manufacturing industry sectors, and the term "industrial" is used as this sector's synonym. In addition, "services" is used instead of "non-tradable".

The importance of assessing the local multiplier is easily justified. In the search for local development, policy makers seek guidance regarding the impact of new ventures. The estimation of the long-term employment multiplier serves as an initial basis for the assessment of public policies for regional development.

The paper is divided in six parts, considering this introduction. In the second part, the method proposed by Moretti (2010) is detailed, in order to present the model that will be used to estimate the Brazilian local multiplier of industrial employment. The third part explains the shift-share method, which is the core for the construction of the instrumental variable used to estimate de model presented in the second part. In section four, the data gathered from RAIS for this study are described and analysed. The fifth part shows the econometric results for estimations of the local multipliers. In the last part, the conclusions are presented.

METHOD

As previously mentioned, Bartik (1991) and Blanchard and Katz (1992) pioneered the use of shift-share methods to construct instrumental variables (IVs) for regional issues. Currently, there are several studies adopting the same research approach: Mardukhi (2010), Blasio and Menon (2011), Beaudry, Green and Sand (2012), Carvalho and Lee (2013), Koster (2013) and Faggio and Overman (2014).

Firstly, the theoretical basis of econometric specifications will be outlined. Subsequently, it will be demonstrated how the shift-share method can generate an appropriate instrument. Each geographical unit is considered to be a competitive economy that uses labour to produce the vector of tradable goods nationally (x1, x2, x3,..., xK), the prices of which are exogenous to the geographical units because they are determined nationally. Labour also generates the vector of non-tradable goods (z1, z2,...,zM), the prices of which are determined locally. Labour is fully mobile among sectors within the same geographical unit (Moretti, 2010).

The local labour supply has a positive slope. The greater the geographical mobility of labour is, the greater the elasticity of the labour supply will be. A limitation of labour mobility is local housing supply. Its elasticity depends on the local geography, the regulations on land use in the region and accessibility.

Moretti (2010) demonstrated the possible causes and effects of the increased labour supply at a given location. The permanent increase in labour demand in tradable sector x1 in location m could be the result of the establishment of a new

industry in the region or the increasing demand for products produced by companies already established in the same region. The direct effect of this shock is an increase in employment in sector x1. However, this shock also directly affects the jobs in other tradable sectors (x2, x3,..., xK) and in all of the non-tradable sectors. The shock must also have general equilibrium effects on local prices, e.g., the increase in wages over the entire location (Mardukhi, 2010) and the rising costs of housing in the location (except in extreme cases of infinitely elastic housing or labour supply).

Regarding the case of the shock effect on the other tradable industries, there is an immediate increase in the labour demand, which causes an increase in wages in the tradable sectors, resulting in the reduced competitiveness of local industries as a whole because the price of tradable goods is defined nationally. Therefore, if the production costs of an industry increase in a particular location, the tendency is for the industry to migrate to another region. This effect is corrected over the medium term by the increased supply of labour through the migration of new workers to the region.

Moretti and Thulin (2012) argued that the estimation by ordinary least squares (OLS) of (1) could provide inconsistent results if the unobserved shocks to non-tradable sector employment at the local level also affect tradable sector employment. Specifically, these shocks could be associated with variation over time in a region's labour supply (e.g., the region's infrastructure, crime, quality of education, local services, local taxes), and they could result in bias in the estimation. For Moretti and Thulin, this bias could be positive or negative, depending on the correlation between the variations in employment in the tradable sector and the shocks (represented by ε residuals), and such a correlation could be positive or negative. Endogeneity requires the creation of an instrumental variable that is correlated with the explanatory variable but is not directly related to the dependent variable. To estimate the local multiplier, Moretti (2010) proposed the construction of an instrumental variable using the shift-share method, as explained in the following section.

THE SHIFT-SHARE METHOD

The shift-share analysis is based on an identity that decomposes the growth of local employment into three effects: national (the national growth effect), structural (the industry mix effect) and differential (the local share effect) components. The national component indicates the proportion of local employment growth that results simply from the total increase in employment in the country. The structural component indicates the change in local employment as a result of its particular production structure. For example, a region with a high rate of expanding sectors performs better than another region with a high rate of declining industries. The differential component indicates the variation in local employment caused by the performance of the sectors in the region relative to the performance of these sectors in the economy as a whole. That is, the differential effect indicates the variation in

employment caused by local specificities. Formalised by Dunn (1960), this analysis is one of the most frequently used tools in the discipline of regional science.[2]

The empirical strategy for the present study is based on calculating the structural component of the regions and using it as an instrument of the variation observed in the tradable sector. Thus, if an industry in the tradable sector increases the labour supply as a result of a national shock in that industry, this instrument will isolate the variation caused by national changes from the variation that results from local changes. These variations associated with each industry affect the regions in different ways because of their different sector structures.

The reason for using the shift-share method merits consideration in terms of the literature on instrumental variables. The structural component is associated with a variation in the employment in the tradable sector, making it a relevant instrument. In addition, the method would only influence the dependent variable by means of the instrumental variable. Therefore, it is an exogenous instrument.[3]

Thus, to estimate the local employment multiplier, the shift-share method will be used as a tool to eliminate potential endogeneity problems in the regression.

Moretti and Thulin (2012) chose to construct the IV based on the same logic as that of the shift-share method. Thus, the term $E^{T}_{m,t} - E^{T}_{m,t-b}$ is represented by instrument $\Sigma^{s}_{j=1} E^{T}_{m,j,t-s}\left(ln\,(E^{T}_{j,t} - E^{T}_{m,j,t}) - ln\,(E^{T}_{j,t-b} - E^{T}_{m,j,t-b})\right)$. This instrument includes the national portion and the shares of each industry. However, it excludes regional variation. In fact, the IV isolates the variation as a result of national changes in sector j from all the variation in employment in sector j in region m. This variation affects the national geographical units differently, depending on the composition of their tradable sectors relative to total employment in the reference year.

DATA SOURCE AND ANALYSIS

In this study, the database used was extracted from *Rais Vínculo* for the 2000, 2005 and 2010 and was grouped into mesoregions and subsectors. Despite certain limitations and necessary adjustments, this database is considered for the present study.

The dispersion of growth rates is essential for the application of the presented method. During the analysed decade, some mesoregions experienced regression in industrial employment, with a decrease of 6%, whereas others grew by more than

[2] The classic study of Haddad *et al.* (1989) discusses the method and its extensions. For applications of the shift-share analysis in Brazil, see: Santos (2000); Martins and Silva (2005); Ilha and Wegner (2005); De Souza and Dos Santos (2011); Gonçalves Junior and Galete (2010); Souza and Rodrigues (2011); and Gonçalves Junior *et al.* (2012).

[3] The national component captures the increase in national employment. Thus, the formalisation and employment growth in the period of 2000-2010 were absorbed by this component and did not bias the analysis.

450%. That is, despite the overall preservation of the industry's regional configuration, the regional trajectories were different.

This study followed the criteria of Cruz and Santos (2011), and mesoregions that presented (according to data from 2000) fewer than 5,000 formal jobs or more than four subsectors with no employment were excluded from the analysis. Fourteen mesoregions satisfied one of the two criteria for the 2000 base period. Thus, of the initial 137 mesoregions, RAIS data for only 123 mesoregions were considered. The subsectors of economic activity available in RAIS represent the highest level of sectorial aggregation used by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE) in the classification of economic activities, precisely because it is one of the oldest classifications of these activities. This level of disaggregation of economic activities into 25 subsectors is sufficient.[4]

Four subsectors were disregarded: Mineral Extraction, Production of Nonmetallic Minerals, Public Administration and Agriculture and Others. The classification used for the subsectors agrees with the approach of Moretti (2010). The first three sectors were excluded because their locational reasons are based on natural resources or political decision, and these factors are not the focus of this study. Moreover, the subsectors of Public Administration and Agriculture are among those with information that is significantly compromised by deficiencies in the RAIS database. Thus, the data for the remaining 21 subsectors of economic activities will be used.

The separation of industry and services will be based on the division suggested by Marconi and Rocha (2011), with the necessary adaptations, because the authors have not worked with IBGE economic activity subsectors. The following subsectors were grouped under industry: Metal industry; Mechanical industry; Electrical and communications; Transport equipment; Wood and furniture; Paper and printing; Rubber, tobacco and leather; Chemical industry; Textiles; Footwear industry; and Food and Beverage. The subsectors considered to be services are Public utilities; Construction; Retail; Wholesales; Financial institutions; Technical and professional administration; Transport and communications; Accommodation and communications; Medical, dental and veterinary; and Education.

Among the 11 industrial subsectors to be grouped by technological intensity, the following groupings are considered:

- Low technology: Metal industry; Wood and furniture; Paper and printing; Rubber, tobacco and leather; Textiles; Footwear and Food and beverage; and
- High technology: Electrical and communications; Transport equipment; Chemical industry and Mechanical industry.

Observing the share of economic activity subsectors that constitute the data-

[4] Cruz and Santos (2011) and Saboia (2013) presented comprehensive views of the evolution of Brazilian industry in recent periods.

base nationwide (Table 1), the subsectors that appear to make up the cluster of services are those with the largest share of employment in the three selected years. The Retail, Professional Technical Administration and Accommodation and Communication subsectors are noteworthy because together they accounted for more than 40% of employment.

TABLE 1: Employment share among selected economic activity subsectors in Brazil (2000, 2005 and 2010)

	2000		2005		2010	
Subsector	Jobs (thousands)	Share (%)	Jobs (thousands)	Share (%)	Jobs (thousands)	Share (%)
Retail	3,556	18,8	5,033	21.1	6,970	21.1
Professional Technical Administration	2,580	13.7	3,148	13.2	4,562	13.8
Accommodation and Communication	2,268	12.0	2,890	12.1	3,696	11.2
Transport and Communications	1,390	7.4	1,669	7.0	2,305	7.0
Construction	1,094	5.8	1,243	5.2	2,498	7.6
Food and Beverage	982	5.2	1,399	5.9	1,749	5.3
Medical, Dental and Veterinary	924	4.9	1,137	4.8	1,473	4.5
Education	918	4.9	1,032	4.3	1,502	4.5
Textiles	70	3.7	832	3.5	1,035	3.1
Wholesale	690	3.7	950	4.0	1,376	4.2
Financial	556	2.9	619	2.6	783	2.4
Chemical Industry	509	2.7	635	2.7	90	2.7
Metal Industry	482	2.6	604	2.5	796	2.4
Wood and Furniture	39	2.1	425	1.8	466	1.4
Paper and Printing	308	1.6	338	1.4	41	1.2
Transport Equipment	297	1.6	411	1.7	584	1.8
Public Utilities	290	1.5	340	1.4	401	1.2
Mechanical Industry	278	1.5	4	1.5	566	1.7
Footwear	240	1.3	30	1.2	345	1.0
Rubber, Tobacco and Leather	221	1.2	278	1.2	327	1.0
Electrical and Communications	192	1.0	225	0.9	282	0.9
Total	**18,871**	**100.0**	**23,873**	**100.0**	**33,022**	**100.0**

Source: Relação Anual de Informações Sociais – RAIS
Prepared by the authors.

The share of the services sectors in total employment has been at least three times greater than the share of the industrial sector (Table 2). Despite the significant increase observed in the number of jobs in the industrial sector, that sector's share in the total employment of the two groups decreased from 24.4% to 22.6%. That

is, in 2000, there were 3.1 jobs in the services sectors for each job in the industrial sectors, whereas in 2010, this ratio increased to 3.4.

With regard to technological intensity, Table 2 shows an increased share of the sectors classified under high technological intensity in the industrial sectors, at 27.7% in 2000 and 31.3% in 2010. Thus, whereas in 2000, there were 2.6 low-tech jobs for each high-tech job, the ratio decreased to 2.2 in 2010.

TABLE 2: Distribution of employment by subsectors grouped in Brazil (2000, 2005 and 2010)

	2000		2005		2010	
Sectorial level	Jobs (thousands)	Share (%)	Jobs (thousands)	Share (%)	Jobs (thousands)	Share (%)
Industry	4,604	24.4	5,811	24.3	7,456	22.6
Services	14,266	75.6	18,061	75.7	25,566	77.4
Technological intensity (industry only)						
Low	3,327	72.3	4,172	71.8	5,123	68.7
High	1,276	27.7	1,638	28.2	2,332	31.3

Source: Relação Anual de Informações Sociais – RAIS
Prepared by the authors.

The generation of industrial and services jobs between 2005 and 2010 increased compared with the first period (Table 3). This acceleration was more intense among the services sectors, in which the variation in the number of jobs between 2005 and 2010 was 41.6%, compared with 26.6% between 2000 and 2005. The increase in the number of jobs in high-tech sectors is also noteworthy: from 28.4% during the first period to 42.3% during the second period.

TABLE 3: Variation in employment by grouped subsectors in Brazil (2000, 2005 and 2010)

Sectorial level	2000-2005 (thousands)	Variation (%)	2005-2010 (thousands)	Variation (%)
Industry	1,206	26.2	1,644	28.3
Services	3,798	26.6	7,504	41.6
Total	**5,001**	**26.5**	**9,149**	**38.3**
Technological intensity (industry only)				
Low	844	25.4	951	22.8
High	362	28.4	693	42.3

Source: Relação Anual de Informações Sociais – RAIS
Prepared by the authors.

A few facts should be noted regarding the distribution among mesoregions. As is known, the number of jobs in the metropolitan mesorregion of São Paulo (Região Metropolitana de São Paulo – RMSP) is more than double that of the mesoregion with the second-highest number of jobs, and in 2010, it corresponded to 19% of the total employment in the subsectors selected among the 123 mesoregions.

ECONOMETRIC RESULTS

Table 4 synthesizes our econometric results. The multiplier of industry jobs on services obtained by OLS was 5.3. That is, for each job created in the industrial sectors, more than five jobs are created in the services sectors. Applying the IV, as presented in the Method section, the multiplier increases to 6.6. Only the first two results presented in Table 4 considered the metropolitan mesorregion of São Paulo (Região Metropolitana de São Paulo – RMSP).

TABLE 4: Synthesis of estimated local multipliers

	Estimated value	Econometric method	RMSP
Industry on services	5.27	OLS	Yes
Industry on services	6.58	IV	Yes
Industry on services	2.88	OLS	No
Industry on services	3.78	IV	No
High-tech on services	6.94	IV	No
Low-tech on services	6.81	IV	No
High-tech on low-tech	0.77	IV	No

Prepared by authors.

Note: All estimators are statistically significant at 1%. Full results are available upon request.

In both of the first two results presented in Table 4, the high value of the multipliers is notable. Surprisingly, similar values were obtained by Moretti and Thulin (2012) when estimating the employment multipliers for Sweden, considering all regions, including Stockholm (Table 5). There, the multipliers of high-tech sectors on the non-tradable sectors were 5.64 by OLS and 6.55 using the instrumental variable. However, after removing Stockholm, the authors obtained a significantly lower multiplier, characterising the strong weight of the capital in generating employment in the country's tradable sector.

TABLE 5: Local employment multipliers of tradable sectors in non-tradable sectors estimated for other countries

	Country analysed	Analysed period	Estimated local multiplier
Moretti (2010)	United States	1980-2000	1.59
Moretti and Thulin (2012)	Sweden (without Stockholm)	1995-2007	0.49
Moretti and Thulin (2012)	Sweden (with Stockholm)	1995-2007	4.02
Moretti and Thulin (2012)	Sweden (with Stockholm and only high-tech sectors)	1995-2007	6.55
Blasio and Menon (2011)	Italy	1991-2001	0.38
Faggio and Overman (2014)	United Kingdom[1]	2003-2007	0.47

Prepared by the authors.
[1]For the U.K., the estimated multiplier was between employment in the public sector and employment in the private non-tradable sector.

Table 5 also shows the local employment multiplier estimated for Italy to be low. Blasio and Menon (2011) attributed the low multiplier of Italy to three factors: a rigid labour market, low variability in wages and obstacles to the mobility of labour. For the U.S., the local multiplier was larger than for Sweden and Italy, indicating, among other factors, greater labour mobility.

Moretti and Thulin (2012) also warned that problems might arise from Stockholm concentrating the same number of jobs as the other four largest regions. Where the employment concentration is high, the local effect is not isolated from the structural effect, given the large share of the city in the total national employment. In the case of Brazilian mesoregions, there is a parallel between Stockholm and the RMSP. Therefore, the RMSP was not included in part of the regressions. These results indicate that when OLS was applied, the multiplier was 2.9 and was significant, whereas the estimated the multiplier using the IV was 3.8 (Table 4). All of the values were statistically significant.[5]

Although the values of the local employment multipliers appear to be of high magnitude, they are in accordance with those reported by other authors using different methods. Fachinelli et al. (2014) found mean employment multipliers of industrial sectors in Brazil (except the South region) of 4.00 and 4.11 for 1999 and 2004, respectively. For the South region, the multipliers exhibited similar mean magnitudes. These researchers used input-output matrices with data from the IBGE National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios – PNAD), estimates of which require the use of more a complex method than that used in this study. Other studies, which also used the input-output matrix but with

[5] In the Swedish case, the decrease of the multiplier was even greater, decreasing to approximately 0.5 in the IV estimation.

a higher level of sectorial disaggregation, found even higher mean multipliers than those found in this study. For example, Guilhoto and Sesso Filho (2010) obtained an estimated mean multiplier of national employment of 18.20 in 2005 in industry and services, considering the direct, indirect and induced effects. Obviously, these results are not directly comparable because they correspond to different spatial units.

Regarding the impact of high- and low-technology sectors on the local employment, unlike the results obtained by Moretti and Thulin (2012) for Sweden, the employment multiplier of the high- and low-technology sectors have high values, even without considering RMSP, 6.94 and 6.81, respectively (Table 4). However, in the same line of estimated multipliers for Sweden, the multiplier of the low-tech sectors, estimated with IV, is lower than that of the high-tech sectors. That is, the generation of jobs in high-tech sectors has a higher multiplier effect on employment in the services sectors than the generation of jobs in low-tech sectors. These results agree with what is expected from the high-technology sectors: these sectors hire more skilled labour and pay higher wages than low-technology sectors. For the same number of jobs, those higher wages imply a greater increase in local demand for services when the mesoregion attracts a high-technology company than when a low-technology company is established.

Finally, the local multipliers estimated within the industrial sectors ware 0.71 by OLS and 0.77 using the IV (Table 4). The impact of variation in employment of high-technology sectors on the low-technology sectors is estimated. The results suggest estimated multipliers much lower than the multipliers on the services. This outcome is likely because such goods can be imported from other mesoregions, unlike what occurs in the services sectors. Thus, for each job created in the high-technology sectors, less than one job is created in the low-technology sectors.

CONCLUSION

This study estimated the local employment multipliers between the industrial and services sectors for Brazilian mesoregions between 2000 and 2010. Empirical evidence was found for an economically important and statistically significant local employment multiplier. A job opening in the industrial sectors of a Brazilian mesoregion results in the creation of approximately four jobs in the services sectors over the long term. When grouped into subsectors of high and low technological intensity, the estimated multipliers on services sectors were 6.94 and 6.81, respectively.

The existence of positive and high multipliers is not, by itself, a necessary or sufficient reason to argue that government incentives should be provided to the industrial sectors. The estimated effects were local; thus, the employment growth of a mesoregion via migration may bring on decreases in other places. Furthermore, even considering only local interests, caution is required for three reasons.

Firstly, each local development experience is different. Studies like this estimate

only *average* impacts. In practice, the multipliers vary according to the sector, the technology and the strategies of the benefited companies. Secondly, one must consider the trade-off between industry-oriented incentives, and other policies aiming job creation or welfare increases. Finally, the local conditions for attracting and retaining companies are decisive for the multiplier effects. Amenities, a favourable business environment, infrastructure and an elastic housing supply are factors that increase the impact of positive employment shocks on the local economy.

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