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The producer service sector in Italy:
Long-term growth and its local determinants

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THE PRODUCER SERVICE SECTOR IN ITALY: LONG-TERM GROWTH AND ITS LOCAL DETERMINANTS

by Valter Di Giacinto ^{*} and Giacinto Micucci ^{**}

Abstract

This paper analyses the local determinants of producer service growth in Italy, focusing on agglomeration economies, and taking into account the particular features of this sector with respect to manufacturing. Using an OECD classification, we estimate a dynamic specification allowing for transitory dynamics around the long-run employment path derived from a model in which both demand and supply factors are considered. Compared with the prevailing modelling approach, the spatial scope of externalities is extended to include possible interactions across different urban areas. Our main findings are the following. Long-run employment growth is positively affected by Marshall-Arrow-Romer externalities, with a minor role played by urbanization externalities, a result similar to that obtained by more recent research on the Italian manufacturing sector and its industrial districts. Among the remaining supply factors, human capital exerts a positive influence on the long-run employment level in producer services industry; among demand factors, the size of the local market appears to be important, given the still incomplete tradability of service output. Significant interactions across urban areas are shown to occur; in particular, positive knowledge externalities on local productivity appear to be induced by location in urban areas contiguous to cities specializing in producer services.

JEL classification: L80, R10, R12.

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1. Introduction¹

In recent years employment growth in developed countries has been driven mainly by the expansion of service activities, in particular those whose output is mainly employed as an intermediate input by other firms (producer services). Accordingly, economic researchers have been paying more and more attention to the service economy.

In the Baumol (1967) model, employment growth in the service industry was related to its stagnant productivity, in contrast to the continuously rising manufacturing sector's productivity. While still convincing for some specific activities,² this hypothesis can hardly be extended to the entire service sector, and namely to producer services. Indeed, Oulton (1999) underlines how the overall efficiency of the economy can be boosted by an increasing utilization of services as inputs. At the same time, Van Ark *et al.* (2002) trace the more rapid productivity in the US to the better performance of some service subsectors, including traditional activities such as retail and wholesale trade included.

Moving from this background, the paper aims to provide an empirical assessment of the structural factors that promote or hinder productivity and employment growth in producer services at the local level. The empirical analysis is based on theoretical arguments mainly derived from the rich urban growth literature. After the seminal contribution of Glaeser *et al.* (1992), this literature has focused on the relationship between agglomeration of economic activity and growth, assuming that the geographical clustering of firms promotes TFP growth, and hence local labour demand, by inducing external economies. The latter are then traced back to the local availability of specialized suppliers and of a specifically trained labour force and to knowledge spillovers across the nearest agents. In order to better reconcile the TFP growth patterns and the employment dynamics, urban

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² Baumol's famous example refers to a concert performed by a musical ensemble, where any attempt to reduce the execution time would clearly result in a lowering of the quality of the output.

growth models have been extended more recently to include an analysis of the local labour supply (Cingano and Schivardi, 2004).

So far, the empirical tests for agglomeration have mainly been performed on manufacturing subsector data. This pattern reflects the assumption that, since the output of the service industry is eminently intangible, non-tradable and technically impossible to separate in the two phases of production and consumption, the geographical location of service firms closely reflects the spatial pattern of overall economic activity, without any reasonable scope for the local clustering of suppliers. However, this assumption is rapidly becoming outdated, as recent technological advancements, chiefly in the ICT field, are making it increasingly possible to outsource some services remotely.³ Gaspar and Glaeser (1996) and Venables (2001) preview that complex, knowledge-intensive activities, requiring frequent face-to-face interactions – as do some services – will probably tend to concentrate within the largest cities in the most developed nations. Consequently, studies on growth and agglomeration economies including the service sector have recently appeared in the empirical literature (Combes, 2000; Blien *et al.*, 2006; Paci and Usai, 2006).

An analysis of the spatial distribution of producer services, following the previous literature on urban growth and agglomeration, is clearly warranted. However, since most of the output is still sold on the local market, an examination of the role of local demand in determining the evolution of services within each urban area is required as well. From a methodological point of view, we innovate on previous empirical literature on the following four issues:

- i. local service demand is explicitly modelled;
- ii. the impact of local human capital endowment on service-sector employment is analyzed;
- iii. a dynamic specification of the model allowing for both transitory and long-run dynamics is introduced, by assuming an error correction structure;
- iv. the existence of spatial interactions across different urban areas is dealt with.

³ Bhagwati (1984), de Vaal and van den Berg (1999), Micucci (2003).

The remainder of the paper is organized as follows. In Section 2 a brief review of previous literature on agglomeration and growth is presented. In Section 3 a descriptive analysis of the regional employment dynamics and distribution based on the Eighth General Italian Census data for the period 1991-2001 is performed, using an industry classification recently proposed by the OECD. A simple theoretical model of local supply and demand for both output and labour markets is introduced in Section 4. In Section 5 two possible extensions of this model are made, allowing for the existence of market and non-market interactions across urban areas. Section 6 introduces the dynamic specification that forms the basis of the subsequent empirical analysis. Section 7 details the indicators selected as proxies of the explanatory variables suggested by the theory. The results of the econometric analysis are discussed in Section 8. Section 9 concludes with a brief summary of the main findings.

2. Literature review

After the contribution of Glaeser et al. (1992), many empirical analyses have tried to measure the influence of agglomeration externalities on total factor productivity (TFP) and, with some caveats, on employment. Within the abundant literature on agglomeration, three different strands can be identified, referring to hypotheses respectively advanced by Marshall, Arrow and Romer (MAR), Porter and Jacobs.

MAR externalities⁴ are essentially related to knowledge spillovers among firms operating in the same industry (localization economies): by promoting knowledge diffusion, sectoral specialization is thus assumed to foster growth.⁵ According to Porter (1990), the favourable effects of a high concentration of firms belonging to the same sector are further increased by local competition among suppliers, which encourages innovative activity.⁶ Jacobs (1969), differently from the MAR approach, assumes information spillovers not to be

⁴ The seminal contributions of Marshall (1890), Arrow (1962) and Romer (1986) are usually acknowledged.

⁵ In what follows the terms “localization economies” and “specialization economies” will be treated as synonyms.

⁶ According to MAR theory, on the contrary, a local monopoly would support growth by facilitating the appropriation of the externalities generated by technological innovations, and hence promoting investment in R&D.

generated within each single industry, the technological knowledge being equally transmittable across different industries. Moreover, the larger the number of sectors operating in a given area, the greater the likelihood that successful innovations in a given industry will be imitated in other industries.

Under this hypothesis, economic development is promoted by the overall agglomeration of economic activity (urbanization economies⁷), rather than by specialization.

Among the few studies that have tested the above hypotheses on service sector data, Combes (2000) finds a positive effect of Jacobs external economies and a negative effect of specialization for France; the results are the opposite for manufacturing. For Italy, Paci and Usai (2006) find that specialization hinders growth for both manufacturing and services.

With reference to West Germany, using dynamic panel techniques, Blien et al. (2006) find that diversity has a positive but transitory effect on service employment growth. The contribution of specialization is also positive, but it is not strong enough to affect growth permanently. Somewhat surprisingly, a positive effect of education is only found in manufacturing.⁸ Finally, a large share of small firms depresses employment growth.

Desmet and Fafchamps (2005) analyse how the spatial distribution of employment changed in United States between 1972 and 2000. Whereas non-service employment spread out, service jobs clustered in the main cities, at the cost of service employment in the hinterland. According to the authors, the different behaviour of non-service and service sectors is consistent with a number of different explanations, such as falling transport costs, an increasing need to be close to specialized workers, a different land intensity of production (Glaeser and Kahn, 2001). Acs and Armington (2004a) provide more evidence that urbanization economies foster service sector growth by promoting the establishment of new firms, the overall effect being enhanced by a greater availability of local human capital.

Moving to a cross-country analysis, Messina (2004) assesses the role of structural factors and institutions in explaining service employment patterns in OECD countries,

⁷ Also referred as “density economies”.

⁸ However, as the authors note, this need not imply that human capital spillovers are absent in advanced services, because they test the impact on employment, not on productivity

finding a positive effect of urbanization as well as a negative role played by more stringent regulations in the product and labour markets.

Summing up, even if the findings vary with the countries and periods under consideration, in general the positive impact of the specialization economies is not detected. As we argue better in the remainder of the paper, these results may be affected by the chosen econometric framework.

Lacking properly disaggregated figures on TFP, the empirical analysis of the impact of agglomeration on service sector growth will subsequently be carried out using employment as a proxy variable (agglomeration economies, by raising TFP, increase local labour demand and thus, *ceteris paribus*, employment). However, Cingano and Schivardi (2004) show that employment is no longer a good proxy of productivity when labour supply reacts adversely to local conditions that are expected to enhance TFP. In this case it is recommended to integrate the usual analysis with a simultaneous treatment of both local labour demand and supply.

3. Descriptive analysis

Initially identified as a residual class, the service sector includes a set of highly heterogeneous activities. However, because of the long-term rise in the workforce engaged in services, an increasing number of contributions has sought to provide more accurate definitions. In particular, OECD (2000) provides a useful classification system.

In the OECD approach, economic activities are divided into nine sectors, four of which relate to services: 1) producer services; 2) distributive services; 3) personal services; and 4) social services (see Table 1). Each of the four sectors is further split into four activities, yielding a total of sixteen. In particular, the producer service sector – on which our analysis is focused – is composed of business and professional services, financial services, insurance services, and real-estate services. The taxonomy of the service sectors and activities is based on three criteria: i) the economic function performed by the services; ii) whether business or households are the primary users; and iii) whether market or non-market provision predominates.

According to the Eighth General Italian Census data, in 2001 overall employment in Italy was 8.0 per cent higher than in 1991, the largest contribution to employment growth coming from services (8.9 percentage points; Table 2), while manufacturing subtracted 1.8 percentage points. However, the aggregate national pattern hides conspicuous differences across the areas of the country. In the North-West the service sector has provided the greatest impulse to employment of the four macro-regions (10.6 percentage points; 12.4 in the region of Lombardy), more than balancing out the sharp decline in the manufacturing sector (-4.6 per cent; see Table 2). Also in the North-East, the service sector's performance was better than the national average (9.5 points). In the Centre, employment dynamics have been roughly in line with the national trend; in this area, the rise was concentrated in Lazio, the region where the capital (Rome) is located. In the South, the contribution of the service sector was the lowest across the macro-regions (5.2 points); at the same time manufacturing subtracted half a point from overall employment growth.

The positive performance of the Italian tertiary sector is largely due to producer services (6.1 percentage points), a smaller contribution coming from social (2.1 points) and personal (0.8 points) services, and a negative one from the distributive sector (-0.2 points). Within producer services, about 5/6 of the contribution to employment growth came from business and professional activities; a positive impulse came from real-estate services (0.8 points), while employment was stable in financial and insurance services. Among the different regions, the contribution of business and professional activities to employment growth was higher than the average in Lombardy (6.5 points) and, in particular, Lazio (8.0 points); these results are basically due to the performances of Milan and Rome, the largest Italian cities.

The geographical concentration of supply is particularly high for producer services, for which Herfindahl indexes, computed with reference to the regional distribution of employment across the local labour market areas, attain the maximum values among the nine sectors of the OECD taxonomy.⁹ A value of the index three times higher than the level

⁹ Micucci (2000) provides an evaluation of the role of scale, agglomeration and co-agglomeration economies in explaining the spatial distribution of economic activity in Italy. Although based on a slightly different industry classification, his empirical findings confirm a high level of spatial concentration in producer services, differently from the remaining services.

measured for manufacturing is observed for the whole country. Higher concentration levels are recorded in the North-West and in the Centre, while in the North-East and in the South the concentration of producer services is only slightly greater than observed for manufacturing.

Moreover, while in the period 1991-2001 the spatial concentration of the demand for producer services, expressed by the distribution of manufacturing employment, decreased, the geographical concentration of supply increased as a consequence of the evolution in the subsector of business and professional services.

In 2001, the largest metropolitan areas seemed to specialize in the supply of producer services according to the ratio employment/population. This evidence is confirmed by the value of the correlation between local employment and population shares, equal to 0.66 in the case of producer services; this value is the highest across all the industries, and more than double that of manufacturing employment (0.28).

4. The static model

In this section we introduce a static partial equilibrium model that considers jointly the local labour and producer service markets. The model follows the approach set out in Glaeser *et al.* (1992) and extended by Cingano and Schivardi (2004) with labour supply effects. We enrich the analysis by including an explicit treatment of the local output demand and introducing human capital in the production function.

For manufacturing industries producing internationally traded goods, the inclusion of the output demand function can be neglected, since all firms can be expected to face approximately the same demand curve. This situation clearly does not extend to the service sector, for which a substantial share of output is locally traded and where wide differences in market potential can be observed between close urban areas, making an explicit analysis of local demand necessary for a proper comprehension of employment dynamics.

The model considers two markets, for labour and services, and has four endogenous variables: the output of the service industry (Y), the corresponding labour input (L), the price of the output (p) and the wage rate (w).

In the i -th location service production is carried out by a single representative firm that obtains its output by employing a single variable input, human capital augmented labour, with Cobb-Douglas technology:

$$Y_i = A_i(L_i H_i)^\alpha$$

where H_i denotes the average human capital of the labour force in the location i . Due to the existence of a fixed factor (land), the production process is denoted by decreasing returns to scale ($0 < \alpha < 1$).

At this stage of the analysis we assume that services are non-tradable. As a consequence, markets are completely spatially segmented and the output price varies across locations to balance internal supply (Y_i^s) and demand (Y_i^d).

Assuming that the local service demand curve is a multiplicative function of price, a scale variable (S_i) measuring the size of the local market, and a set of exogenous variables (X_i) qualifying relevant structural features of local demand, we obtain:

$$Y_i^d = f^d(p_i, S_i, X_i) = p_i^{-\sigma} S_i^\gamma \prod_{r=1}^R X_{ri}^{k_R}$$

Following Cingano and Schivardi (2004), we assume that the labour force can move across locations by facing mobility costs that are increasing with the distance between locations. Individuals will set their dwelling by maximizing the utility they derive from residing in a given city, which depends on the local wage level and on a set of local features, increasing (*amenities*) or reducing (*disamenities*) individual welfare. With this assumption labour supply in the location i can be given by the following expression:

$$L_i^s = \frac{1}{M_i} w_i^\delta \prod_{q=1}^Q Z_{qi}^{n_q}$$

where δ measures the wage elasticity of labour supply, M denotes the average distance of the pool of workers from the i -th market and $Z = [Z_1, \dots, Z_Q]$ is a set of Q urban characteristics.

In Appendix B it is shown how, under equilibrium conditions on both labour and output markets, the following log-linear reduced-form expression for employment level ensues:

$$l_i = \beta_0 + \beta_1 a_i + \beta_2 h_i + \beta_3 s_i + \beta_4' x_i + \beta_5' z_i + \beta_6 m_i \quad (1)$$

where lower case letters denote logarithms of the corresponding variables, and where $x_i = [x_{1i}, x_{2i}, \dots, x_{Ri}]'$, $z_i = [z_{1i}, z_{2i}, \dots, z_{Qi}]'$, $\beta_4 = [\beta_{41}, \beta_{42}, \dots, \beta_{4R}]'$ and $\beta_5 = [\beta_{51}, \beta_{52}, \dots, \beta_{5Q}]'$.

Reduced form coefficients in (1) are linked to the underlying structural parameters by the following set of equations:

$$\begin{aligned} \beta_0 &= \rho\sigma \frac{\delta}{\delta + \rho\sigma} \\ \beta_1 &= \theta \frac{\delta}{\delta + \rho\sigma} \\ \beta_2 &= \alpha\theta \frac{\delta}{\delta + \rho\sigma} \\ \beta_3 &= \rho\gamma \frac{\delta}{\delta + \rho\sigma} \\ \beta_{4r} &= \rho\kappa_r \frac{\delta}{\delta + \rho\sigma} \quad r = 1, 2, \dots, R \\ \beta_{5q} &= \frac{\eta_q \rho\sigma}{\delta + \rho\sigma} \quad q = 1, 2, \dots, Q \\ \beta_6 &= -\frac{\rho\sigma}{\delta + \rho\sigma} \end{aligned}$$

where

$$\begin{aligned} \rho &= \frac{1}{[\sigma(1-\alpha) + \alpha]} \\ \theta &= \frac{\sigma(1-\alpha) + \alpha - 1}{[\sigma(1-\alpha) + \alpha](1-\alpha)} \end{aligned}$$

allowing us to qualify their expected signs on the basis of the properties of the theoretical model.

In particular, the assumption of decreasing returns to scale and non-negativity of σ (the absolute values of the price elasticity of service demand) jointly imply $\rho > 0$.

In order to have also $\theta > 0$, the condition $\sigma > 1$ must be satisfied. Given that the wage elasticity of labour supply (δ) is positive, a price elasticity of the demand for local services greater than 1 in absolute value represents a sufficient condition to yield a positive, and increasing with δ , value of the elasticity of equilibrium employment to TFP (coefficient β_1), a result in line with those presented in Combes *et al.* (2004).

Elasticity to human capital (β_2) is simply proportional to elasticity to TFP and, as such, will share the same sign.

Expressions of coefficients β_3 and β_4 indicate that both types of demand shocks in the output market translate equilibrium employment in the same direction of the demand shift, if wage elasticity of labour supply is non-zero. In particular, when the elasticity of local service demand to market size (γ) is positive, an increase in the scale of the local market will result in higher equilibrium employment ($\beta_3 > 0$).

Finally, the expected signs for the coefficients of variables shifting labour supply (β_5) are positive for amenities and negative for disamenities, while the elasticity of local employment in the relative location with respect to the total labour force (β_6) is expected to be negative (peripherality tends to depress economic activity).

5. Introducing spatial interactions

In this section two different extensions of the model are introduced by allowing urban areas to interact with each other. The first generalization removes the assumption of spatially segmented output markets, while the second deals with the possible transmission of

knowledge across urban areas.¹⁰ In both cases, as above, only the static equilibrium is analysed at this stage.

5.1 – Output exchange across local markets

We start by considering the case in which service firms located at site i can sell their output to customers located in a set of N different areas, by facing transport costs that can be expressed by means of a set of coefficients c_{ij} , $0 \leq c_{ij} < 1$, $i, j=1, 2, \dots, N$, measuring the reduction in the price actually collected with respect to the level prevailing on the j -th market. To complete the specification of transport costs we assume, moreover, that $c_{ii} = 1$ and that c_{ij} approaches zero as the distance between locations i and j increases.

In this setting the representative firm located in i will have to solve N partial optimum problems by equating marginal cost to marginal revenue for each local market, given wage level in location i and given output price on all the accessible markets.

The labour demand schedule, derived in the Appendix B, can be shown to be directly related to: *a)* the size and structural features of output demand in the remaining markets; *b)* the external wage level, whose increment makes suppliers located outside the local market less competitive. At the same time local labour demand shows an inverse relationship with respect to factors, such as TFP and human capital, increasing the productivity of outside competitors. All spatial interaction effects are discounted by the distance separating individual markets.

In this case, the complicated expression of the labour demand function does not allow us to derive an analytically tractable formulation for the reduced form of the employment level in the local service industry. In general, the equilibrium employment level will depend on both the local values of the exogenous factors and a weighted sum of the values of the same variables observed in remaining locations. For the purpose of the empirical analysis, a workable approximation is devised by augmenting expression (1) with the spatially lagged

¹⁰ Pagnini (2004) provides some empirical evidence of the relevance of inter-city information spillovers for the Italian manufacturing sector.

values of the exogenous variables in the model, yielding the following log-linear specification:

$$l_{it} = \beta_0 + \beta_1 a_i + \beta_2 h_i + \beta_3 s_i + \beta_4' x_i + \beta_5' z_i + \beta_6 m_i + \bar{\beta}_1 \mathbf{L}a_i + \bar{\beta}_2 \mathbf{L}h_i + \bar{\beta}_3 \mathbf{L}s_i + \bar{\beta}_4' \mathbf{L}x_i + \bar{\beta}_5' \mathbf{L}z_i + \bar{\beta}_6 \mathbf{L}m_i \quad (2)$$

where $\mathbf{L}x_i = [\mathbf{L}x_{1i}, \mathbf{L}x_{2i}, \dots, \mathbf{L}x_{Ri}]'$, $\mathbf{L}z_i = [\mathbf{L}z_{1i}, \mathbf{L}z_{2i}, \dots, \mathbf{L}z_{Qi}]'$, $\bar{\beta}_4 = [\bar{\beta}_{41}, \bar{\beta}_{42}, \dots, \bar{\beta}_{4R}]'$, $\bar{\beta}_5 = [\bar{\beta}_{51}, \bar{\beta}_{52}, \dots, \bar{\beta}_{5Q}]'$ and where \mathbf{L} denotes the spatial lag operator defined, for a generic variable x , by the relation

$$\mathbf{L}x_i = \sum_{j=1}^M \omega_{ij} x_j$$

in which the non-negative coefficients ω_{ij} (also referred to as spatial weights) are decreasing with geographical distance and identically set equal to 0 when $i=j$.

The above qualitative discussion of the impact of external exogenous factors on the local level of labour demand allows us to provide some indications on the expected signs of the coefficients measuring spatial interaction effects in equation (2). More specifically, $\bar{\beta}_1$ and $\bar{\beta}_2$ have negative expected signs, since an increase in the productivity of external competitors shifts local labour demand to the left. The expected sign of $\bar{\beta}_3$ is positive, as is the case for β_3 (an increase in local market potential shifts labour demand to the right) and the same situation extends to elasticities $\bar{\beta}_4$ to local demand shifters, sharing the same sign as the corresponding ones in β_4 .

The sign of the variables affecting the local labour supply can be ascertained by analysing their effect on the wage level. For example, factors shifting labour supply to the right outside the local market will cause a reduction in wages paid by the competitors, with a negative feedback on production and labour demand of local firms. In general terms, the signs of $\bar{\beta}_5$ and $\bar{\beta}_6$ will be the opposite of the signs of β_5 and β_6 , implying, in particular, $\bar{\beta}_6 > 0$.

5.2 – Information spillovers across local markets

Maintaining the assumption of spatially segmented output markets, a second possible extension of the model can be derived by letting local shocks to TFP produce effects also on firms located outside a given urban area, via information spillovers. More specifically, we assume that new technological knowledge is not codified and is transferred across space through face-to-face interactions among individuals (Gaspar and Glaeser, 1996; Venables, 2001), an assumption that we translate formally by adopting the following specification for the local TFP level

$$A_i = U_i \prod_{j=1}^M U_j^{\psi \omega_{ij}}, \quad \psi \geq 0$$

assumed to be the product of the local knowledge stock (U_i) and of a geometric combination of knowledge available in remaining areas; spatial weights ω_{ij} , as above, decline with geographical distance between markets and ψ is a non-negative parameter measuring the overall intensity of spatial interactions. After a logarithmic transformation the above expression becomes:

$$a_i = u_i + \psi \mathbf{L}u_i$$

defining a spatial moving average model (SMA: Haining, 1978, Anselin, 2003). Substituting the above expression in (1) yields the following reduced-form expression for the equilibrium level of employment in a given location:

$$l_{it} = \beta_0 + \beta_1 u_i + \bar{\beta}_1 \mathbf{L}u_i + \beta_2 h_{it} + \beta_3 s_{it} + \beta_4' x_{it} + \beta_5' z_{it} + \beta_6 m_{it} \quad (3)$$

where $\bar{\beta}_1 = \psi \beta_1$. In presence of information spillovers between cities, local employment is thus a function of the value of TFP recorded in neighbouring areas, a result already obtained under the hypothesis of output exchange across cities. In this case, however, the coefficients of the spatially lagged exogenous variables, given the non-negativity of ψ , take the same

sign as the corresponding coefficients for non-lagged variables, an opposite result to the one obtained under the market interaction hypothesis.

6. The dynamic specification

Starting from the initial contribution of Glaeser *et al.* (1992) the dynamic specification of urban growth models has raised a number of issues, involving the presence or lack of mean reversion and the problem of parameter identification and interpretation when the lagged dependent variable is included among regressors (Combes, 1999). In our view, some of the drawbacks encountered with dynamic urban growth specifications are likely to derive from the lack of a proper distinction of long-run (trend) growth versus transitory process evolutions. Building on this consideration, in this section we proceed to introduce time dynamics in our model, addressing the two aspects separately.

6.1 – Long-run dynamics

In the model of Glaeser *et al.* (1992), trend growth is determined by long-run multifactor productivity growth, which is assumed to be fostered by dynamic agglomeration externalities. The authors argue that, while a high local employment level in a given city-industry can be explained by the existence of static externalities due, for instance, to better access to natural resources, long-run employment growth can only be sustained by dynamic externalities, which they relate essentially to the intensity of knowledge spillovers and to the local degree of market competition.

Letting ξ denote the vector collecting the logs of the structural factors promoting knowledge externalities, urban growth models postulate the following log-linear relationship between TFP growth and ξ (see, e.g., Cingano and Schivardi, 2004):

$$\Delta a_{it} = a_{it} - a_{it-1} = \lambda' \xi_{it} \quad (4)$$

By taking time differences of the reduced-form employment level equation and substituting the above expression for TFP growth, we obtain the following dynamic relationship

$$\Delta l_{it} = \beta_1 \lambda' \xi_{it} + \beta_2 \Delta h_{it} + \beta_3 \Delta s_{it} + \beta_4' \Delta x_{it} + \beta_5' \Delta z_{it} + \beta_6 \Delta m_{it} \quad (5)$$

relating employment growth to its local determinants along the long-run equilibrium path. Assuming, at this stage, that all variables on the right-hand side of (5), except local TFP determinants, are either fixed over time or constant over space, the following simplified equation can be derived from (5)

$$\Delta l_{it} = const + \tilde{\beta}_1' \xi_{it-1} \quad (6)$$

where $\tilde{\beta}_1 = \beta_1 \lambda$ and where, following the standard approach, initial values of TFP determinants are substituted for current values to avoid simultaneity issues, under the assumption that such factors represent structural features that are approximately constant over time. Equation (6), with the addition of the initial level of the dependent variable, introduced as a statistical control to test the dynamic behaviour of the model, provides the empirical estimating equation initially proposed by Glaeser *et al.* (1992):

$$\Delta l_{it} = const + c l_{it-1} + \tilde{\beta}_1' \xi_{it-1} \quad (7)$$

Since growth is measured along the long-run trend, to reduce the impact of business cycle fluctuations on parameter estimates, the model is usually estimated considering a long time span between initial and final periods, usually of one or more decades.

As is well-known from the literature on economic growth and convergence (see, e.g., Islam, 2003), a negative value of the c coefficient implies mean reversion, i.e. the tendency of each local economy to converge to a stable long-run level. In particular, in this case,

conditional convergence would be observed when at least one of the elements of $\tilde{\beta}_1$ is non-zero, each city achieving a different steady-state employment level in the given industry.

In urban economics jargon, conditional convergence would thus imply the presence of static agglomeration externalities, while the existence of dynamic externalities, i.e. of different long-run growth rates, would be demonstrated by the absence of mean reversion.

6.2 – *Transitory dynamics*

Following the initial contribution of Glaeser *et al.* (1992), most empirical analyses have based their inferences on the existence of agglomeration externalities on the estimation of a specification exclusively based on the long-run equilibrium dynamics of the process analogous to (7). However, when adjustment costs or nominal rigidities in output or labour markets exist, the transition to a new equilibrium employment level along the trend marked by TFP growth will not be instantaneous.

Moreover, if the speed of adjustment to equilibrium is slow, the observed medium-term evolution of the process may still be significantly influenced by transitory dynamics.

Assuming that the equilibrium level is eventually attained in the long run, employment dynamics in the city-industry can be modelled by means of an error correction specification (ECM), a dynamic specification that can be motivated by economic theory (see, e.g., Kozicky and Tinsley, 1999) and that is well-known to provide a high degree of flexibility, being equally valid for both stationary and co-integrated systems, while imposing milder restrictions on transitory dynamics with respect to alternative specifications (see Hendry *et al.*, 1984).

Recently, Blien *et al.* (2006), considering the need for a more flexible dynamic specification of urban growth models with respect to the standard growth-equation approach, adopt a panel autoregressive distributed lags (ADL) model.

The ECM model, while being essentially a reparametrization of the ADL model, allows for a straightforward separation of transitory and permanent dynamics which, as shown below, can provide useful information for the evaluation of the nature of agglomeration externalities (static versus dynamic).

We start by stating the error correction formulation corresponding to the equilibrium relation given by (1), which, considering a lag order equal to 1, reads as:

$$\begin{aligned} \Delta l_{it} = & \gamma_1 \Delta a_{it} + \gamma_2 \Delta h_{it} + \gamma_3 \Delta s_{it} + \gamma_4' \Delta x_{it} + \gamma_5' \Delta z_{it} + \gamma_6 \Delta m_{it} + \\ & + c \{ l_{it-1} - \beta_0 - \beta_1 a_{it-1} - \beta_2 h_{it-1} - \beta_3 s_{it-1} - \beta_4' x_{it-1} - \beta_5' z_{it-1} - \beta_6 m_{it-1} \} + \varepsilon_{it} \end{aligned} \quad (8)$$

where ε_{it} is a white-noise uncorrelated both over time and across space, which is introduced to allow for the possible transitory influence of unobservable idiosyncratic shocks on employment dynamics.

Two alternative ECM specifications can be derived from (8), conditional on the assumption of static or dynamic agglomeration externalities. Under the first hypothesis agglomeration impacts only on the TFP level and, maintaining a simple log-linear specification, this amounts to setting:

$$a_{it} = \lambda' \xi_{it}. \quad (9)$$

Substitution of (9) in (1) and (8) then yields the following expressions for the long-run employment level and for the corresponding ECM formulation:

$$l_{it} = \beta_0 + \tilde{\beta}_1' \xi_{it} + \beta_2 h_{it} + \beta_3 s_{it} + \beta_4' x_{it} + \beta_5' z_{it} + \beta_6 m_{it} \quad (10)$$

$$\begin{aligned} \Delta l_{it} = & \tilde{\gamma}_1' \Delta \xi_{it} + \gamma_2 \Delta h_{it} + \gamma_3 \Delta s_{it} + \gamma_4' \Delta x_{it} + \gamma_5' \Delta z_{it} + \gamma_6 \Delta m_{it} + \\ & + c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1 \lambda' \xi_{it-1} - \beta_2 h_{it-1} - \beta_3 s_{it-1} - \beta_4' x_{it-1} - \beta_5' z_{it-1} - \beta_6 m_{it-1} \} + \varepsilon_{it} \end{aligned} \quad (11)$$

where we set $\tilde{\gamma}_1 = \gamma_1 \lambda$.

From expression (10) it is immediately apparent to notice that if both the TFP determinants and all the remaining variables on the right-hand side are stationary, the employment process does not exhibit long-run growth.

If agglomeration externalities are assumed to be of a dynamic nature, i.e. when equation (4) is supposed to hold instead of (9) the TFP level at time t , conditional on the hypothesis that the process started at time 1, becomes:

$$a_{it} = \sum_{h=0}^{t-1} \lambda^h \xi_{it-h} \quad (12)$$

showing how, when local TFP-fostering factors are assumed to be constant over time, i.e. if

$$\lambda^h \xi_{it} = \lambda^h \xi_i = \lambda_i^*$$

TFP grows over time at a constant rate, the level of the variable increasing according to the simple exponential trend:

$$a_{it} = \lambda_i^* t. \quad (13)$$

When local TFP determinants are allowed to change over time, long-run TFP dynamics become slightly more complicated, still showing an exponential growth path, but with a time-varying growth rate.

Substituting expression (12) in (1) yields:

$$l_{it} = \beta_0 + \tilde{\beta}_1' \sum_{h=0}^{t-1} \xi_{it-h} + \beta_2 h_{it} + \beta_3 s_{it} + \beta_4' x_{it} + \beta_5' z_{it} + \beta_6 m_{it} \quad (14)$$

showing how, in this case, city-industry employment in equilibrium grows, holding constant the remaining explanatory factors, at a rate proportional to that of TFP growth.

Using expressions (2) and (14) the ECM model can be written as:

$$\begin{aligned} \Delta l_{it} = & \tilde{\gamma}_1' \xi_{it} + \gamma_2 \Delta h_{it} + \gamma_3 \Delta s_{it} + \gamma_4' \Delta x_{it} + \gamma_5' \Delta z_{it} + \gamma_6 \Delta m_{it} + \\ & + c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1' \sum_{h=1}^{t-1} \xi_{it-h} - \beta_2 h_{it-1} - \beta_3 s_{it-1} - \beta_4' x_{it-1} - \beta_5' z_{it-1} - \beta_6 m_{it-1} \} + \varepsilon_{it} \end{aligned} \quad (15)$$

which, since the current level is included on the right-hand side, instead of the current change of ξ , does not represent a standard ECM model. However, it can be immediately converted to the standard form by considering the following reparametrization:

$$\begin{aligned} \Delta l_{it} = & \tilde{\gamma}_1' \Delta \xi_{it} + \gamma_2 \Delta h_{it} + \gamma_3 \Delta s_{it} + \gamma_4' \Delta x_{it} + \gamma_5' \Delta z_{it} + \gamma_6 \Delta m_{it} + \\ & + c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1' \xi_{it-1} - \tilde{\beta}_1' \sum_{h=2}^{t-1} \xi_{it-h} - \beta_2 h_{it-1} - \beta_3 s_{it-1} - \beta_4' x_{it-1} - \beta_5' z_{it-1} - \beta_6 m_{it-1} \} + \varepsilon_{it} \end{aligned} \quad (16)$$

with $\tilde{\beta}_1 = \tilde{\beta}_1 - \frac{\tilde{\gamma}_1}{c} = \left(\beta_1 - \frac{1}{c} \gamma_1 \right) \lambda$.

A comparison of expressions (11) and (16) demonstrates how the two models essentially differ only for the presence in the latter of the cumulative sum of the lagged values of TFP determinants in the long-run equilibrium relation.

The existence of dynamic agglomeration externalities in the ECM approach set out above is thus shown by dependence of the current employment level not only on the current values but also on the past values of the TFP-fostering factors.

Differently from the growth-equation approach, dynamic externalities are hence assessed from the level of the process, rather than from its long-run growth rate.

As such, inference on dynamic externalities does not require the absence of mean reversion. In fact, when $c=0$, implying the existence of a unit autoregressive root, expression (15) reduces to (5), and consequently inference on dynamic externalities reduces to the estimation of the usual growth equation, possibly augmented to include the current variation of the other variables affecting employment in the city-industry, should these display significant changes across time and sufficient variance across space.

At the same time, when $c<0$, i.e. when the process is mean reverting, inference on dynamic externalities can be based on information from the level of the process.

What reveals the presence of dynamic agglomeration externalities is, thus, the evidence that the city-industry employment level is an upward trending variable. When the mean reversion hypothesis is rejected the process will behave like a random walk with drift, while when the opposite is true, the level series will be stationary around an exponential time trend. In both cases, inferences on trend slope can be validly gathered from estimated ECM parameters.

Basing inferences on the existence of dynamic agglomeration externalities on the presence of unit autoregressive roots, a procedure set out in some recent contributions (Combes *et al.* 2004; Blien *et al.* 2006), does not appear to provide a valid empirical strategy, at least within the ECM analytical environment implemented in this paper, since

mean reversion affects only the stochastic behaviour of the process around the long-run trend, providing no evidence on the actual existence of that trend.

6.3 – Identification issues

A widely used proxy of the existence of MAR externalities is provided by the ratio of employment in a given city-industry to overall city employment, a measure of the specialization of the local economy in producing a given category of goods or services.

The pitfalls of dynamic specifications that include both the lagged levels of the dependent variable and of specialization have been analysed in Combes (1999), who also discusses the identification problem arising when the lagged value of total employment (or employment density) is included among the regressors as well, to control for urbanization externalities or local market size effects.

This under-identification problem extends to the ECM framework described above when static agglomeration externalities are assumed. To illustrate the issue, letting \bar{l}_{it} denote the log of total employment in city i at time t and let $spec_{it} = (l_{it} - \bar{l}_{it})$, and considering a simplified version of (11) where non-relevant explanatory variables are dropped for clarity of exposition, we obtain:

$$\begin{aligned} \Delta l_{it} &= c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1 spec_{it-1} - \beta_2 \bar{l}_{it-1} \} + \varepsilon_{it} = \\ &= c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1 (l_{it-1} - \bar{l}_{it-1}) - \beta_2 \bar{l}_{it-1} \} + \varepsilon_{it} = \\ &= c(1 - \tilde{\beta}_1) \left\{ l_{it-1} - \frac{\beta_0}{1 - \tilde{\beta}_1} - \frac{(\beta_2 + \tilde{\beta}_1)}{1 - \tilde{\beta}_1} \bar{l}_{it-1} \right\} + \varepsilon_{it} \end{aligned}$$

showing how the coefficients of (log-)specialization and total employment are not separately identified.

On the contrary, when dynamic externalities exist, the dependence of the current level of the dependent variable on past levels of specialization identifies the effect of the variable also when total city employment is included among regressors. In this case, in fact, we have:

$$\begin{aligned}\Delta l_{it} &= c \{ l_{it-1} - \beta_0 - \tilde{\beta}_1 \text{spec}_{it-1} - \tilde{\beta}_1 \sum_{h=2}^{t-1} \text{spec}_{it-h} - \beta_3 \bar{l}_{it-1} \} + \varepsilon_{it} = \\ &= c(1 - \tilde{\beta}_1) \left\{ l_{it-1} - \frac{\beta_0}{1 - \tilde{\beta}_1} - \frac{\tilde{\beta}_1}{1 - \tilde{\beta}_1} \sum_{h=2}^{t-1} \text{spec}_{it-h} - \frac{(\beta_2 + \tilde{\beta}_1)}{1 - \tilde{\beta}_1} \bar{l}_{it-1} \right\} + \varepsilon_{it}\end{aligned}$$

showing how, conditional on the identification of $\tilde{\gamma}_1$ ¹¹ (that enters in the definition of $\tilde{\beta}_1$), both $\tilde{\beta}_1$ and β_2 are identified. Note that identification hinges strictly on the assumption that specialization displays some variation over time. This condition, however, does not appear to be severely binding, provided a sufficiently long time series for the indicator is available.

7. The empirical specification

Expression (16) provides the baseline specification for our empirical analysis, and in this section we detail its empirical implementation, illustrating the indicators used as proxies of the variables entering the theoretical model.

The selected indicators, which are subsequently all expressed in logs when the model is estimated, are the following:

endogenous variable

- it is measured by the number of workers (E) of the Italian local labour market areas¹² employed in local productive units belonging to the producer service sector, as resulting from census data of Istat (the Italian national statistical institute);

¹¹ The identification of $\tilde{\gamma}_1$ and remaining model parameters is discussed in Appendix C.

¹² Italian local labour market areas (LLMAs), identified by Istat (on the basis of the 1991 population census) as self-contained areas with respect to daily commuting flows, provide a geographical partition of Italy at an intermediate spatial scale with respect to administrative municipalities and provinces.

variables affecting services demand

- considering that the producer service sector mainly sells its output to the business sector, the total number of workers employed (TE) in the LLMA is preferred to population as a measure of the scale of local service demand;
- structural features of local demand are assessed by means of two indicators: 1) the incidence of employment in hi-tech sectors on overall manufacturing employment (HITECH); 2) the average size, measured by the number of workers, of manufacturing establishments (SIZE). Under the hypothesis that more advanced industries use a greater proportion of innovative services as intermediate inputs with respect to more traditional activities, the first variable has a positive expected influence. At the same time, the sign associated with the second indicator depends on two factors: the share of services on production output and the outsourcing intensity of such inputs; while the former is plausibly increasing with firm size, the latter is likely to show an opposite pattern, since larger firms are likely to produce internally a higher share of the required services (administration, logistics, marketing, etc.); the sign of SIZE will thus depend on which of the two opposite effects prevails; both variables are measured with respect to the manufacturing sector to avoid possible simultaneity issues;

variables affecting service supply

- local human capital endowment is proxied by the average years of education of the resident population (HUMCAP);
- following the empirical urban growth literature, three candidate determinants of long-run TFP growth are considered:
 - a. the intensity of Jacobs (urbanization) economies, measured by two indicators: an index of the sectoral diversity (DIV) of the productive system, given by the opposite of the Herfindahl index computed on the local distribution of workers across industries; the ratio of the total number of workers to the surface extension of the LLMA, as a proxy of

the density of economic activity (DENS); the expected signs are both positive;

- b. the degree of competition among local service suppliers, measured by the inverse of the Herfindahl index for the distribution of employment across establishments operating in the producer service sector (COMP). The expected sign is ambiguous (negative according to the MAR theory and positive in Porter's view);
- c. MAR localization economies, proxied by the ratio (SPEC) of the number of workers employed in the producer service sector to the total number of workers in the LLMA.

variables affecting labour supply

- the relative location of the LLMA with respect to the total labour force is measured by the average distance (DIST) between the local market and all remaining Italian LLMAs, weighted by population,¹³
- the attractiveness of the urban area for household residence is captured by a proxy (AMENIT), defined as the per capita tickets sold for theatre and cinema, and measured, due to data limitations, at the geographical scale defined by administrative provinces.¹⁴

By substituting the above indicators in expression (14) and considering that $SPEC_{it} = E_{it} - ET_{it}$ we obtain:

¹³ Geographical distance is measured by the length of the shortest arc connecting two sites over the earth's surface. The unavailability of data for the entire period analysed, forced us to use population as weight, instead of labour force. However, in 2001, when both are available, the two series appears to be highly correlated (about 0.99).

¹⁴ Note that the size of the urban area could itself represent a valuable proxy of the local amenities for households residing there (a larger urban scale generally implies a greater availability of recreational facilities). Since the model specification already includes a variable (TE) that is closely correlated to urban size, such effect is already taken into account.

$$\begin{aligned}
E_{it} = & \frac{1}{1 - \tilde{\beta}_{14}} \{ \beta_0 + \tilde{\beta}_{11} DIV_{it} + \tilde{\beta}_{12} DENS_{it} + \tilde{\beta}_{13} COMP_{it} + \\
& + \sum_{h=0}^{t-1} (\tilde{\beta}_{11} DIV_{it-h} + \tilde{\beta}_{12} DENS_{it-h} + \tilde{\beta}_{13} COMP_{it-h} + \tilde{\beta}_{14} SPEC_{it-h}) + \quad (17) \\
& + \beta_2 HUMCAP_{it} + (\beta_3 - \tilde{\beta}_{14}) ET_{it} + \beta_{41} HITECH_{it} + \beta_{42} SIZE_{it} + \\
& + \beta_5 AMENIT_{it} + \beta_6 DIST_{it} \}
\end{aligned}$$

While, in principle, all the past history of TFP determinants should enter on the right-hand side of (17), the pre-sample TFP level can be treated as a fixed local market effect, i.e. we can set :

$$a_{it-1} = \sum_{h=0}^{t-1} (\tilde{\beta}_{11} DIV_{it-h} + \tilde{\beta}_{12} DENS_{it-h} + \tilde{\beta}_{13} COMP_{it-h} + \tilde{\beta}_{14} SPEC_{it-h}) = \delta_i \cdot (18)$$

However, such parametrization, given that our empirical specification includes both the lagged levels of E_i and TE_i , would cause parameter $\tilde{\beta}_{14}$, measuring the elasticity of long-run employment growth to specialization, to remain unidentified. To achieve the identification of such a crucial parameter, we thus include explicitly the pre-sample value of $SPEC$ among the explanatory variables (i.e. we do not subsume it under the geographical fixed effect), obtaining the following ECM specification where, in line with the actual application of the model subsequently carried out, a time series with observations for only two periods (t and $t+1$) is considered:

$$\begin{aligned}
\Delta E_{it+1} = & \tilde{\gamma}_1 \Delta DIV_{it+1} + \tilde{\gamma}_2 \Delta DENS_{it+1} + \tilde{\gamma}_3 \Delta COMP_{it+1} + \tilde{\gamma}_4 \Delta SPEC_{it+1} + \gamma_2 \Delta HUMCAP_{it+1} + \\
& + \gamma_3 \Delta TE_{it+1} + \gamma_4 \Delta HITECH_{it+1} + \gamma_5 \Delta SIZE_{it+1} + \gamma_6 \Delta AMENIT_{it+1} + \gamma_7 \Delta DIST_{it+1} \\
& + c \{ E_{it} - \tilde{\delta}_i - \frac{1}{1 - \tilde{\beta}_{14}} (\tilde{\beta}_{11} DIV_{it} + \tilde{\beta}_{12} DENS_{it} + \tilde{\beta}_{13} COMP_{it} + \tilde{\beta}_{14} SPEC_{it-1}) + \\
& + \beta_2 HUMCAP_{it} + \tilde{\beta}_3 TE_{it} + \beta_{41} HITECH_{it} + \beta_{42} SIZE_{it} + \beta_5 AMENIT_{it} + \beta_6 DIST_{it} \} + \varepsilon_{it-1} \quad (19)
\end{aligned}$$

where $\tilde{\beta}_3 = (\beta_3 - \tilde{\beta}_{14})$ and $\tilde{\delta}_i = (\delta_i - \tilde{\beta}_{14} SPEC_{it-1}) / (1 - \tilde{\beta}_{14})$.

Eliminating the current change of SPEC, which is a linear function of ΔE and ΔTE , the above expression yields the specification that is actually estimated from the data:

$$\begin{aligned} \Delta E_{it+1} = & \tilde{\delta}_i + g_1 \Delta DIV_{it+1} + g_2 \Delta COMP_{it+1} + g_3 \Delta TE_{it+1} + g_4 \Delta HUMCAP_{it+1} + \\ & + g_5 \Delta INTECN_{it+1} + g_6 \Delta DIMIND_{it+1} + g_7 \Delta AMENIT_{it+1} + \\ & + b_0 E_{it} + b_1 DIV_{it} + b_2 DENS_{it} + b_3 COMP_{it} + b_4 SPEC_{it-1} + b_5 HUMCAP_{it} + \\ & + b_6 TE_{it} + b_7 INTECN_{it} + b_8 DIMIND_{it} + b_9 AMENIT_{it} + b_{10} DIST_{it} + \varepsilon_{it} \end{aligned} \quad (20)$$

Note that, while the theoretical specification should include the current change of the DENS indicator, in practice this variable was dropped from the empirical model. In fact, since the surface of the local markets is constant over time, this variable is highly collinear to the change in total employment. The current change of DIST was similarly dropped, considering that the variable displays negligible variation over the time period considered.

While the coefficients of expression (20) can be directly estimated from the data, they do not represent the parameters of interest in the present context, which are given by the elasticities of long run employment growth to TFP determinants (in (19) coefficients $\tilde{\beta}_{11}$ to $\tilde{\beta}_{14}$), the elasticities of long-run employment level to remaining explanatory variables (coefficients β_2 to β_6) and the coefficient measuring the speed of adjustment to equilibrium (c).

However, considering that parameters of interest are linked to estimable coefficients by a one-to-one relationship, indirect inferences on the former can be based on preliminary estimation results for equation (7) coefficients according to the procedure described in Appendix C.

8. The econometric analysis

Econometric estimates of model parameters were based on data for the 784 Italian local labour market areas (LLMAs) defined by Istat on the basis of the 1991 population

census. The time period analysed is limited to the decade 1991-2001, since data from previous industry and service censuses were collected using a different industry breakdown that does not allow for a proper identification of the producer service sector as defined by the OECD according to the current classification of economic activities. To provide a reference point, we first present empirical findings obtained by fitting a benchmark specification to our data, implementing a common approach in the urban growth literature. Estimation results for our basis ECM specification and for an extended version allowing for spatial interactions across local markets are subsequently described in a separate subsection.

8.1 – Econometric results for the benchmark specification

Following Glaeser *et al.* (1992) we ran a regression of the growth rate of producer service employment over the period 1991-2001 on the initial values of the proxies of dynamic agglomeration externalities and of the dependent variable. Pooled data for the four producer service subsectors were used for this purpose, allowing for heterogeneous intercepts across subsectors.¹⁵

Estimation results, displayed in Table 5, appear in line with the ones initially collected by Glaeser *et al.* and proved to apply to the Italian economy in Cingano and Schivardi (2004) and Paci and Usai (2006). In particular, a strong negative influence of specialization on growth is found, while a positive and significant impact is estimated for urbanization economies and local competition. The coefficient of the initial level of the dependent variable is negative but not significantly different from zero, providing evidence of dynamic agglomeration externalities.

Following the suggestion given in Combes (1999), we subsequently estimated a modified growth equation, where the initial level of total LLMA employment replaces the lagged level of the dependent variable. Since we enter specialization, as all remaining variables, in logarithms, this modified growth equation is barely a reparametrization of the former, leaving the overall fit of the model and most estimation results unchanged. The

¹⁵ By using a within-group estimator, we implicitly take deviations of all model variables from the national sectoral averages, a standardization commonly employed in the related empirical literature.

elasticity to initial specialization is only marginally affected by the reparametrization, still showing a strong negative impact on long-run growth.

As shown by expression (5), the omission of the current changes of other factors affecting employment in equilibrium is likely to result in biased elasticity estimates when the hypothesis that omitted variables are constant over time or over space is not supported by the data. Since descriptive evidence appears to be in contrast with this assumption, we estimated an extended version of the benchmark specification, including the current growth rates of human capital and other local demand and supply factors. To cope with simultaneity issues, current changes to human capital, location amenity and local market size proxies were instrumented using as instruments lagged growth rates, the current growth rate for sectors other than the producer services sector and the lagged levels of AMENIT and DENS.

2SLS estimates, displayed in column (c) of Table 5, show how current changes in local market size and in service demand shifters are highly significant. A comparison with the estimation results obtained for the baseline growth equation shows a marked reduction of the importance of urbanization economies for local service sector growth. The elasticity to urban diversity drops, in fact, from .13 to .04, being no longer statistically significant; analogously, elasticity to urban density halves in absolute value and is not significant at the 5 per cent level. Other findings remain essentially unchanged, providing evidence that the negative estimated impact of specialization was not due to estimation bias induced by the omission of current growth rates of the relevant explanatory factors.

8.2 – *Estimation results for the baseline ECM*

Econometric estimates of our baseline ECM specification are given on Table 6, where, to improve readability, and considering that our analysis focuses on long-run dynamics, estimation results are reported only for the levels component of the model. As already done in the case of the extended benchmark model, since most of our explanatory variables are clearly endogenous when moving from a partial to a general equilibrium setting, econometric estimates were obtained by the 2SLS method. Both current growth rates and initial levels of potentially endogenous explanatory factors were instrumented, mostly employing lagged values based on Istat's censuses for the years 1981 and 1971 as

instrumental variables (Table 3 details the list of instrumented variables and corresponding instruments).

Apart from industry controls, the empirical specification includes a set of geographical dummies to allow for initial TFP level differentials. However, while the analytical specification provided by (16) involves fixed effects at the level of the single local market, this approach was not feasible in our case, since the estimation had to be carried out on a single cross-section. Instead of LLMA dummies, fixed effects for the slightly wider geographical areas given by administrative provinces were used (in 1991 each Italian province included about 8 LLMA, on average). Since we explicitly control for the pre-sample level of specialization and for a number of other urban structural features, we are confident that this approximation should allow for sufficiently accurate estimates of model parameters.

The first column of Table 6 displays 2SLS estimation results. Differently from the benchmark regression, specialization is now found to affect positively long-run growth, with an elasticity of about 0.08. A comparable elasticity value is estimated for urban diversity (0.09), while the impact of urban density, although positive, is small (about 0.01) and not statistically significant. Local competition is estimated to affect adversely long-run growth, with an elasticity of about 0.1.

Among the variables impacting on the long-run level of the dependent variable, human capital stands out as the most important factor, with an elasticity slightly above unity. In steady state, producer service employment is also positively related to the size of the local market, but with a rather moderate value of elasticity (about 0.15).

Regarding the structural features of the demand for local producer services, SIZE's coefficient has a negative sign with a significant impact, suggesting that smaller firms buy a larger share of services used in the production process. This occurrence can be motivated by the existence of a minimal scale below which it is not efficient to produce such inputs internally.

The other demand shifter (HITECH) is also estimated to be inversely related to the development of the local producer service industry, with a statistically significant effect.

As regards the two variables affecting labour supply, DIST enters with the expected negative sign, while AMENIT does not.

The coefficient of the initial level of the dependent variable is negative, and highly significant. Differently from the evidence collected for the benchmark model, in this case the process thus appears to be mean reverting along the long-run trend driven by TFP increase. The value of the coefficient provides evidence of substantial inertia, showing how only slightly more than 1/3 of the initial disequilibrium is corrected in a time span of ten years.

To check the validity of the empirical specification, mainly with respect to the possible omission of relevant explanatory variables, a test of absence of residual spatial autocorrelation was performed at this stage. For this purpose, considering that the regressors include endogenous variables, the procedure proposed in Anselin and Kelejian (1997) was implemented. The two authors study the asymptotic distribution of the Moran index when the statistic is computed on the residuals of a regression model including endogenous variables on the right-hand side, both in the form of spatial *lags* of the dependent variable or other variables that are simultaneously determined with it. When, as in the present case, only the second kind of simultaneity is involved, Anselin and Kelejian (1997) show that the squared Moran index has the same asymptotic distribution as the Burridge (1980) *LM* test, converging in distribution to a χ^2 with 1 degree of freedom as the sample size increases.

The highly significant value of the test statistic leads us to reject the null hypothesis of spatially uncorrelated errors.

While, in principle, such evidence could be dictated by the existence of spatially correlated responses to a set of common shocks impacting on the local markets, if we assume that LLMAAs located within a given province show similar responses to macro disturbances, the effect of common shocks should be broadly captured by the geographical control dummies included in the empirical specification of the model.

Building on this consideration we thus proceeded to test for the existence of possible spatial interaction effects. In Section 5 we have shown that, under the assumptions of both output exchange and information spillovers across local markets, the equilibrium level of employment is affected by the value of model explanatory factors observed in neighbouring

areas. To allow for such spatial interaction effects we estimated an extended ECM specification, augmented with the spatial lags of regressors.¹⁶

8.3 – The model with spatial lags of the explanatory variables

An operative definition of spatial neighbours is necessary to implement the extended model. By referencing a common approach in spatial econometrics (see e.g. Anselin, 1988, Chapter 3), spatially lagged variables were computed as simple averages of the observations on geographically close LLMAAs, considering two markets to be connected when the distance between the respective central locations is less than the 5th percentile of the distribution of the distance across all Italian LLMAAs (about 80 kilometres).

Consistently with the ECM approach, spatial lags were included both in levels and growth rates, and the model thus respecified was estimated by 2SLS, using as instruments for spatial lags of endogenous variables the spatial lags of the instrumental variables considered in the previous step.

Estimation results for the specification including spatial lags of regressors are given in column (b) of Table 6. When comparing results with the baseline ECM, the main findings appear essentially confirmed, albeit with some noticeable differences. In particular, the long-run elasticity of employment to human capital increases by about 70 per cent, and a considerably higher value of the elasticity to the market scale variable (TE) is found as well (about 0.7). Among the two proxies of urbanization externalities, diversity appears to lose importance in favour of urban density. The coefficient of the amenity indicator now takes the expected positive sign, but with a negligible absolute value. The estimated fraction of adjustment to equilibrium rises significantly, to about 0.5.

As regards the spatially lagged regressors, specialization in neighbouring urban areas appears to exert a positive effect on growth, providing some evidence in support of the existence of information spillovers across contiguous markets (learning from neighbours). Among the spatial lags of the remaining TFP determinants, a reversal of sign of the

¹⁶ Only the non-deterministic variables showing sufficient spatial variation were considered. In particular, the lag of the DIST indicator was not included, as it is highly collinear with the original variable.

estimated coefficients with respect to the case of non-lagged variables is observed, evidence consistent with the existence of competition among service suppliers located in contiguous cities. However, the large value of the elasticity to lagged DENS (-0.2), coupled with the equally negative impact of market size in neighbouring areas (contrary to expectations based on the existence of inter-city service exchange), suggest an alternative explanation. Both variables could be, in fact, acting as proxies of urban amenity. In this case an increase in the size or density in neighbouring urban centres may produce two opposite effects. On one hand, there will be an increase in demand for locally based firms that fosters local employment growth; on the other hand, a contemporaneous shift of local labour supply to the left, since workers, attracted by higher living standards in neighbouring cities will require, *ceteris paribus*, higher wages to compensate for utility loss. The estimated sign will eventually reflect which of the two forces prevails in the observed sample, and in our case it could be signalling that the labour supply effect has a stronger impact with respect to increased market potential.

8.4 – Allowing for spatially autocorrelated errors

The LM statistic checking for residual spatial autocorrelation, while reducing substantially in absolute value, remains highly statistically significant also when spatial lags of regressors are included in the model. This evidence may be due either to the spatial spillover of unobservable local shocks or to some remaining specification problems. At this stage, having specified a highly detailed regression function, we chose not to extend it further, but to re-estimate the model assuming the following spatially autoregressive structure for the error process:

$$\varepsilon_{ist} = \rho \mathbf{L} \varepsilon_{ist} + u_{ist} \quad (21)$$

where \mathbf{L} denotes, as above, the spatial *lag* operator and ρ is an unknown coefficient measuring the intensity of interactions across local markets.

To cope with the presence of endogenous regressors, parameter estimations for the extended specification were carried out by means of the Generalized Spatial 2 Stage Least

Squares method of Kelejian and Prucha (1998), instead of the usual maximum likelihood approach.

The estimated value of ρ is rather low, about 0.2,¹⁷ showing that after spatial lags of regressors have been introduced, the model actually accounts for most of the spatial dependence in the observed data. Controlling for remaining residual autocorrelation, nonetheless, allows for more precise inferences on model coefficients and for unbiased estimation of the corresponding standard errors.

Estimation results, displayed in column c of Table 6, essentially confirm those obtained with the preceding specification. Elasticity to human capital decreases to about 1.5, and elasticity to AMENIT increases to 0.04, while remaining not statistically significant. The coefficients of spatially lagged variables show a general decrease, but inferences on the sign and statistical significance remain unaffected.

9. Conclusions

In Italy, between 1991 and 2001, employment in the producer service sector expanded at a rapid rate, providing the largest contribution to overall employment growth. Disaggregated spatial analysis evidences an unequal pace of growth across urban areas, leading to a higher geographical concentration of the industry.

In this paper, starting from a proper classification of the highly heterogeneous activities included in the service sector, we aimed to provide an assessment of the structural factors underlying the observed spatial pattern of employment growth in producer services.

To this purpose, we first introduced a simple theoretical model of local demand and supply in the output and labour markets, extending the specification commonly employed in the empirical urban growth literature by introducing an explicit treatment of local demand for service output and by allowing for spatial differentials in the per capita human capital stock. Two subsequent generalizations, introducing interactions across agents located in different markets, were then proposed, the first removing the hypothesis of spatially

¹⁷ The maximum admissible value corresponding to the adopted spatial lag specification is equal to 1.

segmented output markets and the second allowing for information spillovers across different urban areas. In both cases it has been shown that the reduced form of the equation for employment level includes spatially lagged values of exogenous variables on the right-hand side.

Specific attention was devoted to modelling time dynamics around the equilibrium path of the process. In line with some recent contributions, more flexibility with respect to benchmark urban growth models was obtained by allowing for both transitory dynamics and long-run TFP-driven growth within the unified analytical environment provided by the error correction model. We also considered the inclusion of spatially lagged regressors and of a spatially autocorrelated error term.

Our main findings are the following.

Differently from the evidence collected from a benchmark urban growth regression, long-run employment growth in the producer service sector appears to be fostered mainly by dynamic MAR agglomeration externalities, with a minor role for urbanization externalities of the Jacobs type. At the same time, local competition among suppliers is estimated to affect negatively long-run growth. Such findings appear to be consistent with the results shown in Cingano and Schivardi (2004) for the Italian manufacturing sector and its industrial districts.

On the supply side, local human capital endowment appears to exert a positive and substantial influence on the long-run employment level in the producer service sector, a result confirming the evidence collected by Armington and Acs (2004 a and b) for the US.

On the demand side, while the size of the local market remains crucial, because of the still incomplete tradability of many service activities, the average size of potential customers appears to be important as well, smaller firms appearing to rely more on the external provision of services; a similarly negative effect, but of smaller size, is estimated for the technological level of the local manufacturing industry.

Significant interactions across urban areas appear to exist: at the present stage, we are not able to identify separately the sources of such externalities (market effects versus technological spillovers); sometimes the signs of estimated coefficients seem to support the

output tradability hypothesis, while information spillovers appear to be prevalent in other cases. However, such effects are important and future research to investigate the different mechanisms of spatial interaction appears to be warranted.

Appendix A: Tables

Table 1

DEFINITION OF SECTORS USED IN EMPIRICAL ANALYSIS

OECD Classification	NACE Rev. 1 code ⁽¹⁾
Agriculture	0111-0502
Mining and quarrying	1010-1450
Manufacturing	1511-3720
Electricity, gas and water supply	4010-4100
Construction	4511-4550
Producer services	
Business and professional services	7110-7134 and 7210-7484
Financial services	6511-6523 and 6711-6713
Insurance	6601-6603 and 6720
Real estate	7011-7032
Distributive services	
Wholesale trade	5010, 5030-5050 and 5211-5263
Retail trade	5111-5170
Transportation	6010-6340
Communication	6411-6420
Personal services	
Hotels and restaurants	5511-5552
Recreational and cultural services	9211-9272
Domestic services	9500
Other personal services	5020,5271-5274,7140 and 9301-9305
Social services	
Government proper	7511-7530 and 9900
Health services	8511-8520
Educational services	8010-8042
Miscellaneous social services	8531-9133

Fonte: OECD (2000)

(1) The European Union's General Industrial Classification of Economic Activities within the European Communities [EUROSTAT (1996)].

Table 2

SECTORAL CONTRIBUTIONS TO EMPLOYMENT GROWTH (1991-2001), BY GEOGRAPHICAL AREA
(percentage values)

Regions	Agriculture	Mining and quarrying	Manufacturing	Electricity gas and water supply	Construction	Services of which:	Producer services	Distributive services	Personal services	Social services	Total
Piedmont	0.0	0.0	-5.4	-0.3	1.3	9.0	6.3	-0.4	0.9	2.2	4.5
Valle d'Aosta	0.1	0.0	-1.1	-0.7	0.9	7.1	5.4	-1.1	0.5	2.4	6.3
Lombardy	0.0	-0.1	-4.5	-0.2	0.9	12.4	7.9	1.2	1.0	2.2	8.5
Trentino A. A.	0.4	-0.2	0.4	0.0	2.0	11.9	5.9	1.2	-0.4	5.2	14.3
Veneto	0.2	0.0	0.9	-0.2	1.3	11.0	6.1	1.4	1.3	2.3	13.3
Friuli Venezia G.	-0.1	-0.1	1.8	-0.1	-0.2	5.3	5.3	-1.4	0.2	1.3	6.6
Liguria	0.2	0.0	-3.9	-0.3	0.8	3.5	4.8	-3.0	0.2	1.5	0.3
Emilia Romagna	0.0	0.0	0.4	-0.1	1.4	8.5	6.5	-0.1	0.8	1.3	10.2
Tuscany	-0.2	-0.1	-2.3	-0.2	1.2	6.3	5.0	-0.6	0.9	1.0	4.7
Umbria	-0.2	0.0	-1.0	-0.3	2.2	9.8	5.8	0.8	1.9	1.4	10.5
Le Marche	-0.3	0.0	2.7	-0.1	0.9	7.4	5.0	-0.1	1.2	1.3	10.7
Lazio	0.0	0.0	-2.8	-0.4	1.7	13.9	8.8	-0.2	2.1	3.2	12.4
Abruzzo	0.0	-0.1	1.8	-0.2	0.3	5.3	4.3	-0.2	0.6	0.6	7.2
Molise	-0.3	-0.2	3.9	-0.2	-1.4	3.7	3.6	-1.2	0.5	0.9	5.5
Campania	0.0	0.0	-1.1	-0.3	1.0	7.7	5.1	-0.5	0.0	3.1	7.3
Puglia	0.2	0.0	-1.3	-0.1	2.2	5.3	4.9	-1.2	0.4	1.2	6.3
Basilicata	0.0	0.1	6.4	-0.5	-3.1	3.5	3.6	-0.4	0.1	0.2	6.4
Calabria	2.3	0.0	-0.2	0.0	1.1	1.5	4.5	-2.5	-0.6	0.1	4.8
Sicily	0.5	-0.1	-1.2	-0.3	0.2	3.4	2.8	-2.8	-0.5	3.9	2.5
Sardinia	0.2	-0.4	-1.6	-0.3	0.1	6.9	3.7	-1.2	0.6	3.8	5.0
<i>North-West</i>	<i>0.0</i>	<i>-0.1</i>	<i>-4.6</i>	<i>-0.2</i>	<i>1.0</i>	<i>10.6</i>	<i>7.2</i>	<i>0.3</i>	<i>0.9</i>	<i>2.2</i>	<i>6.6</i>
<i>North-East</i>	<i>0.1</i>	<i>0.0</i>	<i>0.8</i>	<i>-0.1</i>	<i>1.3</i>	<i>9.5</i>	<i>6.1</i>	<i>0.5</i>	<i>0.9</i>	<i>2.0</i>	<i>11.5</i>
<i>Centre</i>	<i>-0.1</i>	<i>-0.1</i>	<i>-1.7</i>	<i>-0.3</i>	<i>1.5</i>	<i>10.0</i>	<i>6.7</i>	<i>-0.3</i>	<i>1.6</i>	<i>2.0</i>	<i>9.3</i>
<i>South and Islands</i>	<i>0.4</i>	<i>-0.1</i>	<i>-0.5</i>	<i>-0.2</i>	<i>0.7</i>	<i>5.2</i>	<i>4.2</i>	<i>-1.4</i>	<i>0.0</i>	<i>2.4</i>	<i>5.5</i>
Italy	0.1	-0.1	-1.8	-0.2	1.1	8.9	6.1	-0.2	0.8	2.1	8.0

Source: our calculations based on "Istat, 8° Censimento dell'industria e dei servizi".

ENDOGENOUS VARIABLES AND CORRESPONDING INSTRUMENTS

Variables	Instruments
∇-TE	Contemporaneous employment change in the LLMA for all sectors except production services
∇-HUMCAP	Lagged value: change over the period 1981-1991
∇-COMP	Lagged value: change over the period 1981-1991
∇-AMENIT	Lagged value: change over the period 1981-1991
TE	Employment level in the LLMA for all sectors except production services
HUMCAP	Lagged value: level in 1971
COMP	Number of establishments and corresponding average size in 1971 for the sector most closely matching the actual definition of producer services based on the former industry taxonomy (lagged Herfindhal non-computable due to the lack of data on plant size)
AMENIT	Population density (residents/surface) on 1971 and incidence of employment in cultural and recreational activities, also measured on 1971

Table 4

REGIONAL AVERAGES OF THE EXPLANATORY VARIABLES (1)*(index numbers: Italy=100)*

Regions	HUMCAP	COMP	AMENIT	SIZE	DIV	HITECH	DIST	DENS	SPEC
Piedmont	101.8	32.9	86.5	95.2	86.5	56.2	118.2	7.3	97.9
Valle d'Aosta	101.6	118.7	94.6	150.4	104.9	149.8	106.0	122.6	106.9
Lombardy	105.3	208.4	102.3	128.9	115.6	127.8	94.8	247.6	119.9
Trentino A.A.	104.2	29.2	217.2	102.4	96.5	78.3	102.5	22.1	92.4
Veneto	100.4	82.4	81.4	113.9	116.1	84.3	89.6	64.8	105.5
Friuli V.G.	104.9	107.5	127.0	109.3	114.6	89.3	101.4	73.4	115.2
Liguria	107.0	100.8	115.3	98.0	99.0	119.9	92.1	77.2	122.5
Emilia Romagna	102.1	88.4	140.9	104.9	118.6	112.4	79.5	56.8	122.0
Tuscany	99.6	101.5	125.9	83.8	101.9	70.4	76.9	48.6	112.7
Umbria	99.7	37.3	112.1	102.2	99.6	66.3	76.0	21.0	62.1
Le Marche	98.5	41.2	93.2	100.1	97.3	57.5	79.7	54.8	82.6
Lazio	108.2	131.0	170.5	94.3	96.2	131.9	81.3	92.9	128.3
Abruzzo	97.4	48.3	86.2	106.2	99.4	82.5	84.0	39.3	57.7
Molise	86.5	17.2	36.0	80.1	77.4	87.8	96.2	7.0	42.0
Campania	95.7	64.5	69.5	85.4	93.4	102.3	94.4	184.8	81.3
Puglia	92.1	78.1	51.5	88.1	88.9	72.9	121.8	28.6	71.0
Basilicata	90.0	16.8	47.5	67.2	74.8	63.9	116.2	8.6	42.3
Calabria	91.6	24.5	40.8	45.6	68.4	53.8	137.8	18.8	60.9
Sicily	92.4	50.2	68.2	61.3	79.1	70.3	147.4	47.7	85.5
Sardinia	95.3	45.9	83.8	81.8	86.9	77.4	120.0	18.1	75.4
Italy	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(1) All indicators refer to 1991, except SPEC, measured on 1981.

ESTIMATION RESULTS FOR BENCHMARK SPECIFICATIONS (1)

Explanatory variables and statistics	(a)		(b)		(c)	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
DIV	0.128	0.000	0.128	0.000	0.042	0.276
DENS	0.043	0.000	0.043	0.000	0.022	0.072
COMP	0.104	0.000	0.104	0.000	0.107	0.000
SPEC	-0.300	0.000	-0.311	0.000	-0.314	0.000
E	-0.011	0.380			-0.013	0.415
TE			-0.011	0.380		
∇-TE					0.827	0.000
∇-HUMCAP					0.087	0.477
∇-HITECH					-0.019	0.007
∇-SIZE					-0.138	0.001
∇-AMENIT					-0.778	0.088
Estimation method	OLS		OLS		2SLS	
Observations	2,498		2,498		2,498	
R^2	0.547		0.547		0.577	
$adj.-R^2$	0.545		0.545		0.575	

(1) Explanatory variables include a full set of sectoral dummies.

ECM ESTIMATION RESULTS (1) (2)

Explanatory variables and statistics	(a)		(b)		(c)	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
DIV	0.091	0.060	0.016	0.155	0.000	0.248
DENS	0.007	0.204	0.027	0.078	0.024	0.072
COMP	-0.097	0.045	-0.090	0.033	-0.150	0.001
SPEC	0.082	0.000	0.082	0.000	0.070	0.000
E	-0.376	0.000	-0.497	0.000	-0.469	0.000
TE	0.145	0.000	0.677	0.000	0.425	0.000
HUMCAP	1.053	0.001	1.767	0.000	1.499	0.000
HITECH	-0.021	0.099	-0.019	0.078	-0.017	0.074
SIZE	-0.090	0.014	-0.125	0.001	-0.105	0.001
AMENIT	-0.146	0.148	0.008	0.242	0.043	0.200
DIST	-0.628	0.132	-0.252	0.103	-0.264	0.082
L-DIV			-0.096	0.152	-0.026	0.218
L-DENS			-0.201	0.001	-0.159	0.002
L-COMP			0.312	0.000	0.248	0.000
L-SPEC			0.142	0.000	0.113	0.001
L-TE			-0.058	0.129	-0.079	0.078
L-HUMCAP			0.183	0.192	0.184	0.182
L-HITECH			-0.047	0.108	-0.042	0.107
L-SIZE			0.137	0.067	0.105	0.081
L-AMENIT			-0.225	0.060	-0.175	0.070
Estimation method	2SLS		2SLS		GS2SLS	
Observations	2,498		2,498		2,498	
R^2	0.641		0.661		0.594 (3)	
\bar{R}^2	0.622		0.641		0.570 (3)	
LM test for residual						
Spatial autocorrelation	259.9	<0.001	66.7	<0.001		
ρ coefficient					0.183	

(1) Explanatory variables also include a full set of sectoral dummies. (2) Estimation results for coefficients relating to the transitory part of the ECM not reported. (3) Values are not comparable to those in column (c), since the estimation is carried out on transformed variables.

Appendix B: Derivation of the reduced-form equation for the local employment level

The profit maximization problem faced by the representative firm operating on market i is the following:

$$\max_{L_i} \Pi_i = \max_{L_i} (Y_i p_i - L_i w_i) = \max_{L_i} (A_i L_i^\alpha H_i^\alpha p_i - L_i w_i).$$

From the first order condition

$$\frac{\partial \Pi_i}{\partial L_i} = \alpha p_i A_i H_i^\alpha L_i^{\alpha-1} - w_i = 0$$

the following expression for the labour demand schedule ensues:

$$L_i^d = \left(\frac{\alpha H_i^\alpha p_i A_i}{w_i} \right)^{\frac{1}{1-\alpha}}$$

The local service supply schedule derives from the profit maximization conditions of the representative firm

$$Y_i^s = A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha p_i H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}}$$

The following expression for the equilibrium price is obtained by equating supply and demand in the local market for services:

$$\begin{aligned}
p_i^{-\sigma} S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_r} &= A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha p_i H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}} \\
S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_r} &= A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}} p_i^{\frac{\sigma(1-\alpha)+\alpha}{1-\alpha}} \\
p_i &= \left\{ \frac{S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_r}}{A_i^{\frac{1}{1-\alpha}} (\alpha H_i)^{\frac{\alpha}{1-\alpha}}} \right\}^{\frac{1-\alpha}{\sigma(1-\alpha)+\alpha}}
\end{aligned}$$

Substituting the above expression in the labour demand equation we have:

$$L_i^d = \left(\frac{\alpha H_i^\alpha A_i}{w_i} \left\{ \frac{S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_r}}{A_i^{\frac{1}{1-\alpha}} (\alpha H_i)^{\frac{\alpha}{1-\alpha}}} \right\}^{\frac{1-\alpha}{\sigma(1-\alpha)+\alpha}} \right)^{\frac{1}{1-\alpha}}$$

which can be more compactly written as:

$$L_i^d = \alpha^{\rho\sigma} w_i^{-\rho\sigma} A_i^\theta H_i^{\alpha\theta} S_i^{\rho\gamma} \prod_{r=1}^R X_{ri}^{\rho\kappa_r} .$$

Deriving the wage rate expression from the labour supply equation, and substituting it in the labour demand equation. Holding the market equilibrium conditions ($L_i^s = L_i^d = L_i$), we obtain:

$$L_i = \alpha^{\rho\sigma} \left(M_i L_i \prod_{q=1}^Q Z_{qi}^{-\eta_q} \right)^{-\rho\sigma} A_i^\theta H_i^{\alpha\theta} S_i^{\rho\gamma} \prod_{r=1}^R X_{ri}^{\rho\kappa_r}$$

which, upon log-linearization, yields the reduced-form expression for the level of employment corresponding to the simultaneous equilibrium of both output and labour local markets.

Now let us consider the case in which firms located in the site i can sell their output to customers located in a set of N different areas by facing transport costs that can be expressed by means of a set of coefficients c_{ij} , $0 \leq c_{ij} < 1$, $i, j = 1, 2, \dots, N$, measuring the reduction in the price actually collected with respect to the level observed in the j -th location. To complete the specification of transport costs we assume, moreover, that $c_{ii} = 1$ and that c_{ij} approaches zero as the distance between locations i and j increases.

The representative firm in i , in this setting, will have to solve N partial optimum problems by equating marginal cost to marginal revenue on each of the local markets, for a given wage level in location i and a given output price in all the markets. The firm will thus select the optimum quantity of labour demanded to serve each local market.

The set of profit maximization problems to be solved is the following:

$$\begin{aligned} \max_{L_{ij}} \Pi_{ij} &= \max_L [Y_{ij} p_j c_{ij} - L_{ij} w_i] = \\ &= \max_{L_{ij}} [A_i L_{ij}^\alpha H_i^\alpha p_j c_{ij} - L_{ij} w_i], \quad j = 1, 2, \dots, N \end{aligned}$$

with first order conditions:

$$\frac{\partial \Pi_{ij}}{\partial L_{ij}} = \alpha p_j c_{ij} A_i H_i^\alpha L_{ij}^{\alpha-1} - w_i = 0, \quad j = 1, 2, \dots, N$$

whose solutions yield the following partial labour demand schedules:

$$L_{ij}^d = \left(\frac{\alpha H_i^\alpha p_j c_{ij} A_i}{w_i} \right)^{\frac{1}{1-\alpha}}, \quad j = 1, 2, \dots, N.$$

Total labour demand of the representative firm located in i will thus be

$$L_i^d = \sum_{j=1}^N L_{ij}^d$$

and equilibrium output price on market j , $j=1, \dots, N$, will be given by the intersection between the local demand curve and total supply:

$$Y_j^s = \sum_{i=1}^N Y_{ij}^s = \sum_{i=1}^N A_i (L_{ij}^d H_i)^\alpha = p_j^{\frac{\alpha}{1-\alpha}} \sum_{i=1}^N A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha c_{ij} H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}}$$

Using the same specification for local services demand as above and equating output demand and supply in the j -th market, we obtain the following expression for the equilibrium price:

$$p_j^{-\sigma} S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_R} = p_j^{\frac{\alpha}{1-\alpha}} \sum_{i=1}^N A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha c_{ij} H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}}$$

$$S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_R} = p_j^{\frac{\sigma(1-\alpha)+\alpha}{1-\alpha}} \sum_{i=1}^N A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha c_{ij} H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}}$$

$$p_j = \left\{ \frac{S_i^\gamma \prod_{r=1}^R X_{ri}^{\kappa_R}}{\sum_{i=1}^N A_i^{\frac{1}{1-\alpha}} \left(\frac{\alpha c_{ij} H_i}{w_i} \right)^{\frac{\alpha}{1-\alpha}}} \right\}^{\frac{1-\alpha}{\sigma(1-\alpha)+\alpha}}$$

which, once substituted in the total labour demand of the representative firm located in i , yields the following expression:

$$L_i^d = \left(\frac{\alpha H_i^\alpha A_i}{w_i} \right)^{\frac{1}{1-\alpha}} \sum_{j=1}^N c_{ij}^{\frac{1}{1-\alpha}} S_j^{\rho\gamma} \prod_{r=1}^R X_{rj}^{\kappa_R} \left\{ \sum_{g=1}^N c_{gj}^{\frac{\alpha}{1-\alpha}} A_g^{\frac{1}{1-\alpha}} \left(\frac{\alpha H_g}{w_g} \right)^{\frac{\alpha}{1-\alpha}} \right\}^{-\frac{1}{\sigma(1-\alpha)+\alpha}}$$

allowing us to analyse spatial interaction effects on labour demand, and hence on local employment in the service sector.

Appendix C: Structural parameters identification

The set of mathematical relations between parameters of interest and the coefficients of the estimating equations form the following systems of 18 non-linear equations and 19 variables, given by the parameters listed on the left-hand side with the addition of parameter $\tilde{\gamma}_{14}$, (note that $\tilde{\beta}_{14}$ is a function of $\tilde{\beta}_{14}$, $\tilde{\gamma}_{14}$ and c):

$$\begin{aligned}
\tilde{\gamma}_{11} &= (1 - \tilde{\gamma}_{14})g_1 \\
\tilde{\gamma}_{13} &= (1 - \tilde{\gamma}_{14})g_2 \\
\gamma_3 &= (1 - \tilde{\gamma}_{14})g_3 - \tilde{\gamma}_{14} \\
\gamma_2 &= (1 - \tilde{\gamma}_{14})g_4 \\
\gamma_{41} &= (1 - \tilde{\gamma}_{14})g_5 \\
\gamma_{42} &= (1 - \tilde{\gamma}_{14})g_6 \\
\gamma_5 &= (1 - \tilde{\gamma}_{14})g_7 \\
c &= (1 - \tilde{\gamma}_{14})b_0 \\
\tilde{\beta}_{11} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_1 + c^{-1}\tilde{\gamma}_{11} \\
\tilde{\beta}_{12} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_2 \\
\tilde{\beta}_{13} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_3 + c^{-1}\tilde{\gamma}_{13} \\
\tilde{\beta}_{14} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_4 \\
\beta_2 &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_5 \\
\beta_3 &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_6 - \tilde{\beta}_{14} \\
\beta_{41} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_7 \\
\beta_{42} &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_8 \\
\beta_5 &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_9 \\
\beta_6 &= -c^{-1}(1 - \tilde{\gamma}_{14})(1 - \tilde{\beta}_{14})b_{10}
\end{aligned} \tag{A.1}$$

The existence of parameter constraints

$$\tilde{\gamma}_1 = \gamma_1 \lambda$$

$$\tilde{\beta}_1 = \beta_1 \lambda$$

(A.2)

$$\tilde{\beta}_1 = \tilde{\beta}_1 - \frac{\tilde{\gamma}_1}{c} = \left(\beta_1 - \frac{1}{c} \gamma_1 \right) \lambda$$

allows, under given additional conditions, a (locally) unique solution for the system, and hence structural parameter identification. In particular, once the above restrictions are applied, it is possible to extract from system A.1 the following subsystem composed of 8 equations in the 8 unknowns $\{c, \gamma_1, \gamma_3, \beta_1, \lambda_1, \lambda_2, \lambda_3, \lambda_4\}$:

$$\begin{aligned} \gamma_1 \lambda_1 &= (1 - \gamma_1 \lambda_4) g_1 \\ \gamma_1 \lambda_3 &= (1 - \gamma_1 \lambda_4) g_2 \\ \gamma_3 &= (1 - \gamma_1 \lambda_4) g_3 - \gamma_1 \lambda_4 \\ c &= (1 - \gamma_1 \lambda_4) b_0 \\ \beta_1 \lambda_1 &= -c^{-1} (1 - \gamma_1 \lambda_4) (1 - \{\beta_1 - \gamma_1 / c\} \lambda_4) b_1 + c^{-1} \gamma_1 \lambda_1 \\ \beta_1 \lambda_2 &= -c^{-1} (1 - \gamma_1 \lambda_4) (1 - \{\beta_1 - \gamma_1 / c\} \lambda_4) b_2 \\ \beta_1 \lambda_3 &= -c^{-1} (1 - \gamma_1 \lambda_4) (1 - \{\beta_1 - \gamma_1 / c\} \lambda_4) b_3 + c^{-1} \gamma_1 \lambda_3 \\ \beta_1 \lambda_4 &= -c^{-1} (1 - \gamma_1 \lambda_4) (1 - \{\beta_1 - \gamma_1 / c\} \lambda_4) b_4 \end{aligned} \tag{A.3}$$

Letting $\{c^*, \gamma_1^*, \gamma_3^*, \beta_1^*, \lambda_1^*, \lambda_2^*, \lambda_3^*, \lambda_4^*\}$ denote a solution of system A.3, using these values it is possible to compute $\tilde{\gamma}_{14}^* = \gamma_1^* \lambda_4^*$ and $\tilde{\beta}_{14}^* = \beta_1^* \lambda_4^* - \frac{\tilde{\gamma}_{14}^*}{c^*}$, whose values, once substituted in (A.1) allow the recursive computation of the remaining solutions.

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