Does decentralization foster agglomeration?

Massimo Del Gatto

"G.d'Annunzio" University, Pescara, Italy

Carmelo Petraglia

University of Basilicata, Potenza, Italy

Salvatore Ercolano[1]

ISSM-CNR, Naples, Italy

ABSTRACT

Agglomeration can be higher when spatial policy is set out locally. We show this result in a system of cities in which agglomeration and dispersion forces are both affected by the extent of decentralization (towards lower tiers of government) of the authority to decide on the spatial distribution of population and economic activities. The empirical analysis confirms this positive relationship for process of fiscal devolution that took place in Italy in the 2000s.

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[1] Corresponding Author Salvatore Ercolano, ercolano@issm.cnr.it, Istituto di studi sulle società del Mediterraneo, Via Guglielmo Sanfelice, 8 - 80134 Napoli (Italy)

1 Introduction

We study whether and how agglomeration at the local level is related to the territorial structure of institutions, with particular reference to the tier of government at which the bulk of policy measures affecting, either directly or indirectly, the spatial distribution of economic activities and population (i.e., "spatial policy") is defined. We claim that the concentration of population and economic activities can be higher when the spatial policy is set out locally.

Different veins of literature provide inputs to thinking about such relationship. On the one hand, the agglomeration process has received increasing attention in the last decades (Fujita et al., 1999; Baldwin et al., 2003; Brackman et al., 2001), with the economic geography literature paying particular attention to the tension between agglomeration and dispersion forces in the face of the integration process (Krugman, 1991; Krugman and Venables, 1995; Venables, 1996). On the other hand, the issue of governance re-scaling is often dealt with from a "spatial" perspective (see e.g. Gualini, 2006), although using different terminologies. For instance, Morrill (1999) focuses on whether there is an optimum, or appropriate, "level of decision-making" across "geographical scales", while Giordano and Roller (2003) highlight the "relations between the city and the regional scale of governance". Alesina et al. (2000) study the relationship between economic integration and political disintegration. A number of expressions have been coined in the nineteens, aimed at summing up the idea of a tension between the local and the global sphere: "global-local interplay" (Dunford and Kafkalas, 1992), "local-global nexus" (Peck and Tickell, 1994), "glocalization" (Swyngedouw, 1992,1997), "glurbanization" (Jessop, 1998).

Our contribution lies at the intersection between those veins of literature. We adopt a very simple analytical framework describing a system of cities in which the agglomeration and dispersion forces are both affected by the degree of decentralization, towards lower tiers of government, of the authority to decide on the spatial distribution of population and economic activities (referred to as "Territorial

Authority", hereinafter TA). By solving the model in terms of the equilibrium concentration levels associated to the cases of fully centralized TA and TA decentralization towards local authorities, we derive a positive relationship between decentralization and agglomeration.

This theoretical prediction is then brought to the data using Italy as a case study, taking advantage of the generalized process of decentralization that took place in Italy during the 1990s and 2000s. To quantify this process, we focus on one of the fields in which it has been more evident: fiscal decentralization from regions to sub-regional tiers of government (i.e., provinces and municipalities). The cross-time and cross-regional variability of such aspect can be expressed in terms of the ratio of local to regional (fiscal) revenues. The econometric analysis suggests that, when the degree of fiscal decentralization is higher, the regional population tends to agglomerate in a smaller number of cities, rather than uniformly spread out across the cities.

The remainder of the paper unfolds as follows. Section 2 presents the model, Section 3 discusses the empirical application, and Section 4 concludes.

2 Model

The economy consists of a urban system whose basic units, called "sites", are grouped in "cities". Sites include an exogenously given number of identical "individuals", so that a city's population is a multiple of the number of sites therein. The economy as a whole is composed of an infinite number of potential sites, but only a certain number W of them is actually developed, giving rise to a number of N of cities. In symbols, city k consists of S_k sites, with $0 < S_k \leq W$, and site i occupies an area equal to L_i units of land.

Individuals and sites are equidistant and spatially immobile, with the overall geography consisting of a

space of dimension $W-1$.[2] In such a world, concentration varies positively with the size of cities and negatively with their number. We thus refer to the size to number of cities ratio (i.e., S/N) as the "concentration index", with the terms "agglomeration" and "dispersion" referring to increasing or decreasing S/N, respectively.

Two goods, both produced under perfect competition, are considered: a homogeneous final good Y, and an intermediate, horizontally differentiated good X. The former is produced and consumed by each site and is not traded. The latter is used by all sites as an input in the production of Y. Each site produces one unit of X using an inexhaustible natural resource. Hence, W is the number of sites and intermediate goods in the system (i.e. *overall variety*) and S_k represents the number of sites and intermediate goods in city k (i.e. *within-city variety*). With X not consumed and Y not traded, the utility U_i of individuals in site i depends on the amount Y produced therein. For the sake of simplicity, we assume $U_i = Y_i$. As a consequence, maximizing production Y is equivalent to maximizing utility (i.e. consumption) and site i's production-utility function is defined as follows:

$$U_i = Y_i = A_{k(i)} X_{\cdot i}^{\alpha} L_i^{1-\alpha} \qquad \text{with} \quad i \in S_{k(i)} \qquad (1)$$

where $0 < \alpha < 1$ denotes the "degree of substitutability" among inputs; subscript $k(i)$ identifies the city in which site i is located and $X_{\cdot i}$ is the total amount of intermediate goods used by site i, which is defined as

$$X_{\cdot i} = \left(\sum_{j=1}^{W} X_{ji}^{1-\frac{1}{\sigma}} \right)^{\frac{1}{1-\frac{1}{\sigma}}} \qquad (2)$$

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[2] This spatial structure is equivalent to a system of circular cities in a space assumed large enough to avoid overlapping (Abdel-Rahman, 1996).

with $i \in S_{k(i)}$; $j \in S_k; k = 1, \dots, k(i), \dots, N$

where X_{ji} is the amount of intermediate good produced in site j and used in site i. $\sigma = 1/(1-\alpha) > 1$ is the elasticity of substitution among inputs. Thus, in line with Rivera-Batiz (1988), Abdel-Rahman (1988) and Fujita (1988), the number of inputs positively effects production (and utility).

The term $A_{k(i)}$ is used to introduce technological effects (i.e., external effects taking place at the level of the production-utility function) by assuming that a site's production-utility is inflenced by density (of economic activity and, as a consequence, of population) in the city. Density is defined in terms of production-utility per unit of land (see, e.g., Ciccone and Hall, 1996):

$$A_{k(i)} = \Lambda_{k(i)} \left(\frac{\sum_i Y_i}{\sum_i L_i}\right)^{\frac{\lambda-1}{\lambda}} \qquad \text{with} \quad i \in S_{k(i)} \qquad (3)$$

with $\lambda > 1$, Equation (4) states that the larger $\Lambda_{k(i)}$, the larger are the benefits associated to a higher density. Given the generality of the model, $\Lambda_{k(i)}$ can be thought of as capturing "fundamentals" at the city level making the cities more or less productive at given levels of X and L, or either as capturing a higher utility (i.e., urban premium) associated to consuming the same amount and type of goods in high-density cities.

We also assume the presence of pecuniary externalities (i.e., external effects taking place through the price mechanism), occuring through inter-city trade. We assume that inputs are traded both within and between cities. Trade costs take the form of iceberg transport costs *à la* Samuelson (1952): a fraction $(1-\tau)$ of one unit of good transported gets destination if trade takes place within a city (within-city trade), while a

fraction $(1-\beta)$ reaches destination if trade involves sites located in different cities (inter-city trade). All sites belonging to city $k(i)$ demand the same amount Z_{ii} of intermediate good i, produced within the city, and the same amount of intermediate good Z_{ij} of goods produced in other cities. The amounts received are $(1-\tau)Z_{ii}$ and $(1-\beta)Z_{ji}$ in the two cases, respectively. With no price discrimination, the price of input i has to be the same wherever it is sold. When $\tau < \beta$, an increase in the number of sites within the city where site i is located ($S_{k(i)}$) renders a larger number of inputs available at lower transport costs (we assume that city k(i) is small (enough) respect to the system). This fosters concentration. To save notation and deal with a measure of proximity, rather than separation, we use $\theta_I \equiv (1-\tau)^{\frac{\alpha}{1-\alpha}}$ and $\theta_E \equiv (1-\beta)^{\frac{\alpha}{1-\alpha}}$.

With each site subject to the following resource constraint:

$$\sum_i Z_{ii} + \sum_{k'} \sum_j Z_{ij} = R_i \qquad (4)$$

with $i \in S_{k(i)}; j \in S_{k'}; k = 1, \dots, k(i), \dots, N; k' = \{k | k \neq k(i)\}$,

and assuming[3]

$$L_i = 1 \quad \forall i = 1, \dots, W \qquad \text{and} \qquad \Lambda_k = \Lambda \quad \forall k = 1, \dots, N, \qquad (5)$$

marginal cost pricing yields the following formulation for the production-utility function of site i (see Appendix A):

[3] Although keeping Λ_k city-specific would allow for a system of heterogeneous cities, assuming symmetry in technology enables us to isolate the effects of decentralization.

$$Y_i = \Lambda^{\lambda}\{\theta_I \frac{S_{k(i)}}{[\theta_I S_{k(i)} + \theta_E \sum_{k'} S_{k'}]^{\alpha}} + \theta_E \sum_{k'} \frac{S_{k'}}{[\theta_I S_{k'} + \theta_E \sum_{k''} S_{k''} + \theta_E S_{k(i)}]^{\alpha}}\}^{\lambda} \qquad (6)$$

with $i \in S_{k(i)};\ j \in S_{k'}; q \in S_{k''}; k = 1, \dots, k(i), \dots, N; k' = \{k | k \neq k(i)\}; k'' = \{k | k \neq k(i), k(j)\}$

Equation (6) can be used to determine the agglomeration outcome in the two cases of centralization (section 2.1) and decentralization (section 2.2). Numerical experiments provides us with values of S, N and W, which enables us to derive results in terms of the equilibrium level of concentration in the two cases.

2.1 The centralized solution

This section presents the equilibrium under the hypothesis that a Central Planner (CP) has the authority to set the agglomeration level by setting S, N and W(centralized TA). This is done by maximizing the following (Benthamian) welfare function:

$$V^{CP} = Y^{CP} - VC^{CP} \qquad (7)$$

where $Y^{CP} = \sum_{i=1}^{W} Y_i$ and VC^{CP} denotes variety costs. We assume variety to be costly for two orders of reasons (Alesina and Spolaore, 1997; Alesina et al., 2000). First, because of a fixed cost ψ associated to developing a new variety (i.e. a new site). Second, because of congestion costs at the level of the city and the whole system.[4] We assume the following structure:

[4] Given the generality of the model, the city-level and economy-level costs of variety can be thought of both in terms of negative effects on the production of Y and negative effects associated to individuals' preferences. The latter interpretation is associated to the fact that the larger the city (i.e., in terms of sites and, as a consequence, in terms of population) the less likely is that individual preferences are exactly matched by the CP's policies. An analytical treatment of this framework can be found in Alesina and Spolaore (1997), who provide a model in which a group of heterogeneous citizens, uniformly distributed along

$$VC^{CP} = \Psi W^{\frac{\rho}{1-\rho}} + \left(\sum_k \Upsilon S_k^{\frac{\mu}{1-\mu}}\right) N + \psi W \qquad \text{with} \quad k = 1, \dots, N. \tag{8}$$

where ψW is the fixed cost (i.e., Site Cost) associated with the creation of each site; $\sum_k \Upsilon S_k^{\frac{\mu}{1-\mu}}$ are within-city heterogeneity costs (expressed in units of the final good), which are increasing and convex in city size ($\mu > 0.5$ is identical across cities). $\Psi W^{\frac{\rho}{1-\rho}}$ (with $\rho > 0.5$) captures the heterogeneity costs throughout the system, which are increasing and convex in the total size of the system W.

Under this specification, the CP's problem is described by a system of N equations (as many as the cities) and N unknowns (the optimum size S_k^* of each city). However, with N being itself unknown, the system could be solved only by setting ex-ante the number of cities. In order to endogenously determine both size and number of cities, we exploit the following property of the model:

Proposition 1 *Let $S \in (1, W]$ be the set of the possible city sizes. Under conditions (4) and (5), the CP chooses the size of cities symmetrically: $S_k = S \;\; \forall k$.*

(Proof: see Appendix B).

Proposition 1 allows us to write site i's production-utility function as

$$Y = \Lambda^{\lambda}[(\theta_I - \theta_E)S + \theta_E W]^{\lambda(1-\alpha)}. \tag{9}$$

so that the CP's problem becomes:

an ideological segment, have to agree on a set of common policies. In their framework, the average distance between the adopted policy and each individual's preferred policy increases with country size.

$$\max_{S,W} V^{CP} = W\Lambda^{\lambda}[(\theta_I - \theta_E)S + \theta_E W]^{\lambda(1-\alpha)} - \Psi W^{\frac{\rho}{1-\rho}} - \left(\Upsilon S^{\frac{\mu}{1-\mu}}\right)\frac{W}{S} - \psi W \qquad (10)$$

where we use the fact that $N = W/S$, with W assumed larger than S throughout the paper. Equation (10) is represented in Figure 1.

<< FIGURE 1 ABOUT HERE >>

2.2 The decentralized solution

In this section we study the agglomeration outcome under the hypotehesis that the TA is completely assigned to Local Planners (LPs): the LP in city k (referred to as LP_k) has the authority to set the size of the city (i.e., S_k). As in the previous case, we adopt a Benthamian welfare function:

$$V^{LP_{k(i)}} = Y^{LP_{k(i)}} - VC^{LP_{k(i)}} \qquad (11)$$

where $Y^{LP_{k(i)}} = \sum_{i=1}^{S_{k(i)}} Y_i$ and $VC^{LP_{k(i)}}$ follows the structure in (8), with the difference that the LP cares only about the effect on the variety costs in its city, taking as given those associated with the size of the other cities ($S_{k\prime}$).

The problem of maximizing (15) respect to $S_{k(i)}$ can be written as:

$$\max_{S_{k(i)},\bar{S}_{k\prime}} V^{LP_{k(i)}} = S_{k(i)}\Lambda^{\lambda}\{\theta_I \frac{S_{k(i)}}{[S_{k(i)}\theta_I + \sum_{k\prime} S_{k\prime}\theta_E]^{\alpha}} + \sum_{k\prime} \theta_E \frac{S_{k\prime}}{[S_{k\prime}\theta_I + S_{k(i)}\theta_E + \sum_{k\prime\prime} S_{k\prime\prime}\theta_E]^{\alpha}}\}^{\lambda} -$$

$$-\Psi\left(S_{k(i)} + \sum_{k\prime} S_{k\prime}\right)^{\frac{\rho}{1-\rho}} - \Upsilon S_{k(i)}^{\frac{\mu}{1-\mu}} - \psi S_{k(i)} \qquad (12)$$

with $i \in S_{k(i)}; j \in S_{k'}; \; q \in S_{k''}; \; k = 1, \dots, k(i), \dots, N; k' = \{k | k \neq k(i)\}; k'' = \{k | k \neq k(i), k(j)\}$ and both ρ and μ are both assumed to be larger than 0.5.

The endogenous determination of size and number of cities requires the simultaneous solution of problem (12) by all potential LPs. The solution can be found through the following steps:

1. Impose zero profit in all cities: $\left|V^{LP_{k(i)}}(\cdot)\right| = 0 \qquad \forall k = 1, \dots, N$ (13)

2. Derive the first order condition for LP k: $\left|\frac{dV^{LP_{k(i)}}}{dS_{k(i)}}\right|_{\bar{S}_{k'}} = 0 \qquad with \quad k' = \{k | k \neq k(i)\}$ (14)

3. Impose symmetry at level of cities in (17) and (18): $S_{k(i)} = S \qquad \forall k = 1, \dots, N$ (15)

4. Solve the system (13) - (15) under symmetry.

The zero profit condition in (13) states free-entry at city level (this is the condition for sub-game perfection): when N is given, since it is not profitable to create new cities, and each planner is already maximizing his own welfare, there are no cities interested in changing size. Since SOCs are satisfied by the concavity in S of (12), condition (14) guarantees maximization and represents the reaction function of $LP_{k(i)}$ to each $S_{k'}$, once N has been determined. Condition (15) directly follows from the symmetry in the reaction functions due to (5).

The system, as it appears after calibration, is reported in Figure 2. The solution can be read in part (b) of the figure.[5]

[5] The equilibrium is the solution of the game $\Gamma = [N, \{S_k\}, \{V_k(\cdot)\}]$ with N players (the LPs), in which $k = 1, \dots, k(i), \dots, N$ and $S_k \in (1, W]$. Pure strategies consist in choosing S_k, and the equilibrium in pure strategies is the set $\{S_k^*\}$ of the N values of S_k satisfying $V_{k(i)}(S_{k(i)}^*, S_{k'}) \geq V_{k(i)}(S_{k(i)}', S_{k'}) \quad \forall k = 1, \dots, k(i), \dots, N$ and $\forall S_{k(i)}' \neq S_{k(i)}^*$, with $k' = \{k | k \neq k(i)\}$. Under perfect information, the LP_k has perfect knowledge of its payoff for each combination $(S_k, S_{k'})$; in this case, the game can be thought of as a two-stage process in which: in the first stage, all potential LPs decide whether or not to form a city; in the second stage, the LPs that actually formed cities simultaneously decide the size of their own city, given number and size of all

<< FIGURE 2 ABOUT HERE >>

2.3 Agglomeration and decentralization

We compare the concentration level resulting from the CP solution (Equation 10), with the equilibrium concentration level resulting from system (13) - (15) in order to predict a relationship between decentralization and agglomeration. As highlighted, the spatial structure of the model is such that agglomeration can be consistently expressed in terms of the concentration index $CI = S/N$.

Table 1 reports the ratio of the decentralized to the centralized solution, showing that the economic system is much more concentrated in the first case: CI under decentralization is more than thirteen times the centralized CI outcome.

<< TABLE 1 ABOUT HERE >>

This result is associated with the presence of a higher number of cities, which are bigger in size (i.e., higher within-city variety). Moreover, Table 1 shows that W falls with decentralization (i.e., lower overall variety). Since the centralized solution represents the welfare-maximizing ourcome, these results point to "over-agglomeration" and inefficiently low overall variety: local TAs tend to inefficiently increase the size of cities, which becomes excessive, and to engage in a sort of competition leading to a decrease in number of cities and total number of sites.

It is noteworthy that a typical finding in the literature on city formation and optimal city size is that, when

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the other cities. The solution has the characteristics of a SPNE (i.e., Symmetric Perfect Nash Equilibrium) and is trembling hand perfect, since the calibrated objective function is strictly concave. The sequence in (13)-(15) corresponds to the determination of the equilibrium by backward induction. Calibration is meant to satisfy the existence of a subset $\{\overline{S}_k\} \in \{S_k\}$, nonempty, convex and compact, such that: i) $V_k(\overline{S}_k)$ is continuous and quasiconcave; ii) $V_k = 0 \ \forall k$ (free-entry condition).

cities form through the action of local developers, as in our decentalized case, city size can still be optimal if the developers act in a perfectly competitive ’market of cities’. This is not the case in our model. In fact, while assuming perfect competition might seem realistic at a national scale (provided that the number of cities is large enough), when one moves to a regional level, it seems more realistic to think of the market of cities as non competitive (the way in which our results fit into extant literature on city formation and optimal city size is discussed in Appendix C).

All in all, these results suggests the following:

Testing hypothesis: *Compared to the centralized solution, decentralization results in a more concentrated outcome in terms of both economic activities and population.*

To accommodate the idea of over-agglomeration, consider a system of cities in which $LP_{k(i)}$ (i.e., the local TA) has to decide whether to increase $S_{k(i)}$ or not. Initially, examine the effects on domestic sites – i.e., the sites located in $k(i)$. On the one hand, a larger number of inputs is now available at a lower price (internal trade costs are lower than external trade costs); this effect is amplified by the presence of technological externalities (λ). On the other hand, however, the increase in size generates higher heterogeneity costs. If the positive effect more than compensate for the negative one, $LP_{k(i)}$ proceeds with increasing the number of sites. Let us go to the effects of this choice on the other cities. On the one hand, a larger number of inputs is now available (although external trade is more costly than internal trade, so that the returns in the other cities are relatively lower) and, as before, technological externalities intervene in amplifying this positive effect. On the other hand, through increasing heterogeneity costs, this induces a generalized pressure towards city size reduction. This is a positive externality that is not taken into account by $LP_{k(i)}$ at the time $S_{k(i)}$ was set and that should induce a system of under-sized cities. The

intuition for over-agglomeration is that the generalized reduction in city size makes less inputs available in (not only in $k(i)$) up to the point in which the size of the cities is so small that each LP is faced with two choices: to leave the system or to increase its size unilaterally. These possibilities both lead to an increase in the agglomeration level around the system.

Table 2 reports the results of the sensitivity analysis on the model parameters. Notably, the negative relation between concentration and transport costs, which is usual in ecoomic geography, applies here only to within-city transport costs: a fall in τ is associated with more agglomeration (resulting from higher S and W, and a smaller N). Conversely, a fall in external transport costs β leads to lower concentration (increase in both number of cities and total number of sites in the system, with city size following opposite paths[6]).

3 Empirical analysis

In this section, we bring our testing hypothesis to the data using Italy as a case study. Italy is an interesting case because several institutional reforms took place, during the 1990s and 2000s, aimed at fostering decentralization. In fact, as pointed out by relevant literature, these years represent "a period of radical change in the financial relationships between levels of government" (Ambrosiano et al., 2010: 77).

3.1 Fiscal devolution in Italy in a nutshell

Two relevant reforms were introduced in 1993 for municipalities: the direct election of mayors for cities with more than 15,000 inhabitants, and the municipal property tax (Bordignon et al., 2012).

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[6] This is explained by the different way in which the two types of planners regard trade costs. The CP perceives trade costs as a weight for the economy as a whole and reacts to a decrease in inter-city transport costs by minimizing the impact on each site; the best way to do this is to favor external trade by reducing city size and increasing the number of cities, so lowering the agglomeration level. On the other hand, LPs perceive only their own part of trade costs and react to a fall in inter-city transport costs seeking to maximize the level of welfare in their own city. Hence, owing to the fact that a reduction in transport costs increases profits in each city, both the number of sites in each city and the number of cities grow and, since the latter grows more than city size, concentration shrinks.

Furthermore, a constitutional reform was approved in 2001 in order to expand the responsibilities of regions (Art. 117), fostering the subsidiarity principle (Art. 118), and consolidating new financial and political relationships between governments (Art. 119) (Ambrosiano et al., 2010).

From a fiscal perspective, in 2009, Law No. 42 introduced general principles aimed at preparing the overall layout of fiscal federalism. The intention was to: i) limit local expenditures by introducing the standard costs criterion; ii) introduce the principle of territory, based upon the territorial nature of regional and local taxes; iii) establish the principle of relationship between tax levies and benefits connected to the functions exercised on the administrated territory by encouraging the correspondence between financial and administrative responsibility (Scuto, 2010).

A large body of empirical work has assessed the impact of the fiscal decentralization process on a number of socio-economic issues (see Martinez-Vazquez et al. (2017) for a comprehensive review).

As for the Italian case, existing (mixed) findings are linked to the effects of fiscal decentralization reforms on: i) health expenditures (Porcelli, 2014); ii) regional disparities in health services (Ferrario and Zanardi 2011), education system (Ferrari and Zanardi 2014), the size of interregional redistribution and risk-sharing; (Arachi et al. 2010); iii) inter-governmental transfer (Padovano 2012); iv) political cycle (Bordignon et al. 2003).

Nevertheless, to the best of our knowledge, there are not contributions regarding the effects of fiscal decentralization on some demographics dynamics and more specifically on the concentration of population in few major cities. The following section aims to partially fill this gap by means of a first empirical contribution.

3.2 Data and methodology

Although the Italian decentralization process dates back early in the 1990s, our empirical analysis will

focus on the 2000-2012 period due to lack of reliable data for the computation of our fiscal decentralization indicator in the 1990s.

Table 3 reports relevant information on definitions and data sources, while Table 4 provides main descriptive statistics of all variables included in estimated models.

<< TABLES 3 AND 4 ABOUT HERE >>

To measure population concentration, we compute the Gini concentration index (*Gini*) for each Italian region, using information on population at the municipality level provided by the Italian National Bureau of Statistics (ISTAT). The index is plotted in Figure 3[7]. We note the highest values of concentration in a Central region (Lazio), followed by two Northern regions (Liguria and Piemonte). Lombardia – the richest Italian region – experiences a decreasing trend. The opposite occurs in most Southern regions (Abruzzo, Basilicata, Calabria, Molise and Sardinia). The remaining regions show a constant trend. However, it is worth noting that time variability is significant, even for those regions showing a constant trend in Figure 3.

<< FIGURE 3 ABOUT HERE >>

The measurement of fiscal decentralization is not an easy task. As the relevant literature has highlighted, fiscal decentralization is a very complex phenomenon, which lacks a univocal definition and is very difficult to measure (Rodden, 2004, Pedone, 2008, Torrisi et al., 2011). On the one hand, while several

[7] We refer to the typical geographical aggregation of Italian regions in the four macro-regions named North-West (Piedmont, Aosta Valley, Lombardy, Liguria), North-East (Veneto, Trentino Alto Adige, Friuli Venezia Giulia, Emilia Romagna), Centre (Tuscany, Umbria, Marche, Lazio) and Mezzogiorno. The Italian Mezzogiorno includes the Southern peninsular regions of Abruzzo, Molise, Campania, Apulia, Basilicata and Calabria and the islands Sicily and Sardinia. We will use the words Mezzogiorno and South as synonyms.

public expenditures have been decentralized in Italy over recent years, it is worth noting that these expenditures can be also be financed by central grants. On the other hand, local revenues could measure the space of fiscal autonomy that sub-national governments have. For this reason, we rely on a key aspect of the fiscal decentralization process: the devolution of tax responsibilities from central/regional to sub-regional tiers of government (i.e., provinces and municipalities). Our index of fiscal decentralization measured at the regional level (*Fiscdec*) is computed as the ratio of local revenues collected by provinces (NUTS 3) and municipalities over total revenues collected in the region. Information is provided by the Italian governmental agency "Agenzia per la Coesione Territoriale" through the database *Conti Pubblici Territoriali* (CPT).

<< FIGURE 4 ABOUT HERE >>

Figure 4 shows the evolution of *Fiscdec* by region. Reported patterns indicate that several regions experienced a large increase in the share of local taxes after 2009. As said, 2009 was an important year due to institutional reform carried out by Law 42, which aimed at introducing important principles in fiscal disciplines inspired by fiscal federalist theory. Looking at the relative level of the variable, the graph shows that Trentino Alto Adige and Aosta Valley report the lowest share of local taxes over the total revenue of the region, whereas the highest values after the shift registered in 2009 are reported by Apulia and Campania. Friuli Venezia Giulia is the only region which reports a slight reduction over the last years. The majority of the regions report important growth in the share of local taxes, while Lombardy increases its value by considerably less. Trentino Alto Adige is the only region with a substantially constant trend.

It is hard to sustain that concentration is only influenced by the degree of (fiscal) decentralization. Thus, we include a number of control variables. Two of them are suggested by the model, namely, internal and

external transport costs. According to the model predictions, internal and external transport costs have a negative and positive relationship with agglomeration, respectively. To operationalize these two dimensions, we rely on (time invariant) measures of accessibility computed at the municipality level. The former (i.e., *IntAcc*), meant to capture the action of internal transport costs, is provided by Del Gatto and Mastinu (2018) and computed following the potential accessibility formulation proposed by Wegener et al. (2002):

$$\Psi_f = \sum_j^{F(A)} B_j \; exp(-\rho \tau_{jf}) \tag{16}$$

where index f refers to the given municipality, index j refers to the generic municipality located within the driving distance[8] of fifteen minutes from f – with F(A) denoting the number of municipalities therein) –, τ_{jf} is the vector of journey time between municipality f and municipality j; B_j is the total available income in municipality j, drawn from ISTAT (the Italian National Institute of Statistics); ρ is a decay parameter set at 0.05. A more in-depth description is provided in Del Gatto and Mastinu (2018).

To capture the effect of external transport costs, we use the measure of multi-modal accessibility across Italian provinces provided by ESPON (*ExtAcc*). This is a province-level accessibility measure computed on 2006 data following the same formulation that we use for *IntAcc*, with the difference that τ_{jf} is replaced by an aggregation, over transport modes (i.e., air, rail, road), of the cost of reaching the other provinces using a given transportation mode.

As well as controlling for accessibility, we include regional gross domestic product per capita (*Gdppc*), regional unemployment rate (*Unempl*), share of value added in the services sector over total value added in all economic sectors (*Servsh*).

[8] The driving times are estimated through a GIS program taking into account four key variables: length, direction of travel, hierarchy of the functional road classes, and journey speed.

We estimate the following model:

$$Gini_{it} = f(Fiscdec_{i\,t-1}; IntAcc_{i\,t}; ExtAcc_{i\,t}; Gdppc_{i\,t-1};\ Unempl_{i\,t-1};\ Servsh_{i\,t-1}) \qquad (17)$$

where the cross-municipalities concentration of population in region *i* at time *t* depends on its (lagged) degree of decentralization, internal and external accessibility and the other control variables.

3.3 Results

We estimate different specifications of equation (17). To reduce possible endogeneity issues, we use lagged values at time t-1 of the time varying covariates.

Our baseline specification is a fixed effects panel estimator, which allows us to take into account the institutional time invariant features of large statistical units such as provinces or regions (Ercolano et al., 2018)[9].

Table 5 presents the results of the regression analysis. We estimate three different fixed effects models (M1, M2 and M3), adding covariates step-by-step. In the first model (M1) we only include the fiscal decentralization measure as our main variable of interest. In the second model (M2) we add the vector of economic covariates to control for structural differences across regions. In the third model (M3) we add year dummies. This is a very common strategy when dealing with panel data, in order to additionally check possible heterogeneity among years (Greene 2003). In fact, time dummies allow to control for the exogenous increase in the dependent variable not explained by other variables.

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[9] Correlation between individual (regional) level effects and the covariates included in the specification leads us to the fixed effects estimation strategy (FE), which treats the individual level as additional parameters to be estimated assuming independence between the regressors and the error term. As usual, common econometrical tests have been carried out to select the most appropriate estimator. Nevertheless, as pointed out by the literature, even if correlation between random effects and regressors is a very important element when choosing between fixed and random effects, it is worth noting that when the unit of observation is a large geographical unit, it seems reasonable to prefer fixed effects (Wooldridge , 2006; Gujarati, 2007).

The coefficients of fiscal decentralization variables in the first three models are all significant and have a positive sign: higher degree of fiscal decentralization is positively correlated, *ceteris paribus*, to a higher concentration of population within regions. The estimates are very stable for all the other covariates as well. The only exception is per capita gross domestic product, which loses its statistical significance in the third model when dummy years are included in the specification.

In specifications M4 and M5 we add the complete set of control variables and use random effects and the pooled estimator to circumvent multicollinearity between fixed effects and time invariant covariates.

Also the results reported in the last two columns of Table 1 support the Proposition 2. Moreover, *ExtAcc* is in a positive and significant relationship with concentration in both models, as expected, whereas IntAcc exhibits the expected negative sign, although the coefficient is only significant in the pooled model. The magnitude of the fiscal decentralization estimated coefficient in the pooled model is higher compared to fixed- and random-effects models. The explanation of this result is grounded in the main characteristics of the pooled model: unlike fixed- and random-effects models, which are meant to capture within-region effects, the pooled estimator captures interregional differences, thereby resulting in higher values.

To summarize, our findings provide evidence supporting the idea of a positive relationship between decentralization and agglomeration, with population more uniformly distributed across municipalities in the Italian regions that carried out lower fiscal decentralization over the period 2000-2012. This result is robust to using different estimators and different specifications. In line with the theoretical prediction, we also find satisfactory evidence that the concentration of population is positively correlated to the degree of accessibility within the municipality and negatively correlated with the accessibility between municipalities.

4 Concluding remarks

While suggested by different veins of literature, whether and how agglomeration can be affected by the political-institutional sphere seem to arouse only little interest in economics.

We tackle this issue in a system of cities in which agglomeration and dispersion forces are both affected by the degree of decentralization (towards lower tiers of government) of the authority to set the spatial distribution of population and economic activities (through deciding on the bulk of policy measures affecting, either directly or indirectly, the spatial distribution of economic activities and population - i.e., “spatial policy”).

We claim that agglomeration can be higher when spatial policy is set out locally. This theoretical prediction is then tested in correspondence of the process of fiscal devolution that took place in Italy in the 2000s. The econometric analysis suggests that, when the degree of fiscal decentralization (from regions to cities) is higher, population tends to agglomerate in a smaller number of cities, rather than uniformly spread out across the cities.

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A Appendix: Derivation of Equation (5)

To derive equation (6), use equation (2) and the input demand functions Z_{ii} and Z_{ij} discussed in Section 2, to write Equation (1) as

$$Y_i = A_{k(i)} L_i^{(1-\alpha)} \{\sum_i [(1-\tau)Z_{ii}]^{\alpha} + \sum_{k'} \sum_j [(1-\beta)Z_{ji}]^{\alpha}\} \tag{A.0}$$

with $i \in S_{k(i)}$; $j \in S_{k'}$; $k = 1, \dots, k(i), \dots, N$; $k' = \{k | k \neq k(i)\}$

Marginal cost pricing implies that

$$A_{k(i)} L_i^{(1-\alpha)} \alpha (1-\tau)^{\alpha} Z_{ii}^{\alpha-1} = P_{ii} \tag{A.1}$$

$$A_{k(j)} L_j^{(1-\alpha)} \alpha (1-\beta)^{\alpha} Z_{ij}^{\alpha-1} = P_{ij} \tag{A.2}$$

with $i \in S_{k(i)}$; $j \in S_{k'}$; $k = 1, \dots, k(i), \dots, N$; $k' = \{k | k \neq k(i)\}$.

In the above equations, P_{ii} and P_{ij} are the prices per unit of input i traded, respectively, within the city and between different cities. All sites belonging to city $k(i)$ demand the same amount Z_{ii} of intermediate good i, while sites located in a different city demand an amount equal to Z_{ij}.

With no price discrimination, the price of input i has to be the same wherever it is sold (i.e., $P_{ii} = P_{ij}$ $\forall j$. This entails that (A.1) and (A.2) are in the following relationship:

$$\frac{Z_{ij}}{Z_{ii}} = \left(\frac{A_{k(j)}}{A_{k(i)}}\right)^{\frac{1}{1-\alpha}} \left(\frac{1-\beta}{1-\tau}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{L_j}{L_i}\right) \tag{A.3}$$

From (A.3) it is possible to derive the domestic and imported input demand functions exploiting the resource constraint in Equation (4). Setting the price of Y as numeraire, we can write the amount of each domestic input demanded by site i as

$$Z_{ii} = \frac{A_{k(i)}^{\frac{1}{1-\alpha}}(1-\tau)^{\frac{\alpha}{1-\alpha}}L_i R_i}{S_{k(i)}A_{k(i)}^{\frac{1}{1-\alpha}}L_i(1-\tau)^{\frac{\alpha}{1-\alpha}}+\sum_{k\prime} S_{k\prime}A_{k\prime}^{\frac{1}{1-\alpha}}L_j(1-\beta)^{\frac{\alpha}{1-\alpha}}} \tag{A.4}$$

with $\quad i \in S_{k(i)}; \quad j \in S_{k\prime}; \quad k = 1, \dots, k(i), \dots, N; \quad k' = \{k|k \neq k(i)\}$

Similarly, the amount of each input demanded by site i, but produced in other cities than city $k(i)$, amounts to

$$Z_{ji} = \frac{A_{k\prime}^{\frac{1}{1-\alpha}}(1-\beta)^{\frac{\alpha}{1-\alpha}}L_j R_j}{S_{k\prime}A_{k\prime}^{\frac{1}{1-\alpha}}L_j(1-\tau)^{\frac{\alpha}{1-\alpha}}+\sum_{k\prime\prime} S_{k\prime\prime}A_{k\prime\prime}^{\frac{1}{1-\alpha}}L_q(1-\beta)^{\frac{\alpha}{1-\alpha}}+S_{k(i)}A_{k(i)}^{\frac{1}{1-\alpha}}L_i(1-\beta)^{\frac{\alpha}{1-\alpha}}} \tag{A.5}$$

with $\quad i \in S_{k(i)}; \quad j \in S_{k\prime}; \quad q \in S_{k\prime\prime}; \quad k = 1, \dots, k(i), \dots, N; \quad k' = \{k|k \neq k(i)\}; \quad k'' = \{k|k \neq k(i), k(j)\}$

Equations (A.4) and (A.5) provide the demand function for each input by the generic site i. Using theese in (A.0), together with (3), yields Equation (6).

B Appendix. Derivation of Proposition 1

Let v_s^{CP} and v_{ns}^{CP} be the CP value function in the two cases of symmetric and non-symmetric city size, with S^* and S_k^* referring to the relevant optimal city size ($k = 1, \dots, N$). Indicating by V_k^{CP} the CP value function concerning city k, we have:

$$v_s^{CP} = NV^{CP}(S^*) \qquad v_{ns}^{CP} = \sum_{k=1}^{N} V_k^{CP}(S_k^*) \tag{B.1}$$

The condition under which the former solution always dominates the latter is $v_s^{CP} > v_{ns}^{CP}$ $\forall k = 1, \dots, N$. Dividing both sides by N, this condition can be written as:

$$\frac{v_s^{CP}}{N} > \frac{\sum_{k=1}^{N} V_k^{CP}(S_k^*)}{N} \tag{B.2}$$

Thanks to concavity of $V^{CP}(\cdot)$, equation (B.2) is always true within the interval $S^* \in (1, W]$, while it is not satisfied when $S_k = W$, i.e. complete agglomeration, and $S_k = 0$ $(N = W)$, i.e. complete dispersion. Thence proposition 1 and the assumption that $S^* \in (1, W]$, which we assume to keep throughout the analysis.

C Appendix. Comparison with the literature on city formation and (optimal) size.

In the literature, cities are assumed to form either by *self-organization* or through the action of large scale agents (i.e., *city developers*), driving the formation of cities and/or managing them once they have been set up.[10] However, whether the final outcome in terms of 'size and number of cities' is optimal or not strictly depends on the assumptions about the origin of the scale economies driving the agglomeration process. Since technological externalities admit perfect competition, while pecuniary externalities require the assumption of imperfect competition, and since welfare analysis is straightforward under perfect competition, the practical consequence of using one or other approach is that information on the relationship between optimality in city size and the mechanism of city formation (i.e. self-organization versus action of city developers) is far richer in the case of technological externalities. Let us synthesize these results. First, since Henderson (1974), we know that cities are always oversized when they form through self-organization. Second, remaining with Henderson (1974), the presence of city developers can correct this form of market failure. Moreover, Vickrey (1977) shows that, also in the absence of city developers, a socially optimal equilibrium is always possible if a perfectly competitive land market is included in the analysis. From this point of view, literature on city size intersects that in which cities are regarded as providers of local public goods. The Henry George Theorem is a point of reference in this field: given the level of expenditure on a pure public good (in a certain city), city size is optimal when it maximizes the utility level of all residents. The condition of efficiency is that the aggregate differential land rent (i.e. the sum of the land rent in each location across the city, less the opportunity cost of land)

[10] Henderson (1974) adopted the notion of 'city corporations' but, since Stiglitz (1983a,1983b), the literature has used slightly different terminology: 'city developers' or 'land developers' (Henderson and Becker, 2000b; Helsley and Strange, 1997), 'large agents' (Henderson and Becker, 2000a). We use these definitions interchangeably, since they all refer to perfectly informed organisms, operating under perfect competition, and able to control the movement of people at local level. For further considerations see Wildasin (1987), as well as Fujita and Thisse (2002).

equals the public expenditure for the provision of the public good[11]: this is the size that would be chosen by a central planner. With local governments, as highlighted by Fujita and Thisse (2002) (cfr. Proposition 5.2.), an urban system is efficient if, and only if, it constitutes a free-entry equilibrium at city level, since the local government can be thought of to capitalize the losses stemming from the provision of public goods. Accordingly, the presence of city developers operating in a perfectly competitive ’market of cities’ assures optimal size (Henderson and Becker, 2000a,2000b). The vast majority of models with agglomeration driven by pecuniary externalities, though achieving a better explanation of city formation in presence of trade, move in the self-organization framework, usually neglecting the presence of a regulatory authority and the problem of optimality in spatial concentration. An exception is Ottaviano et al. (2002), who show that, in correspondence of intermediate transport costs, pro-dispersion policies can be desirable.

Collating these points, what we do know at the state of the art is that, without trade, or when trade is costless, city size is surely optimum in presence of a perfectly competitive land market. In the absence of such a market, and still without trade, a sufficient condition for optimality is that cities are formed by city developers acting in a perfectly competitive ’market of cities’.

However, by requiring each city to be irrelevant, in terms of size, with respect to the market, the hypothesis of perfect competition implicitly restricts the scale of the analysis to the national level, provided that the number of cities is sufficiently high.[12] If one moves to a regional level, it seems more realistic to think of the market of cities as an oligopolistic market. In our ’decentralized case’, this assumption drives a fundamental departure from the findings typical of the perfect competition approach:

[11] For this definition of the Henry George Theorem see Fujita and Thisse (2002), Ch. 5. For further details: Flatters et al. (1974), Arnott and Stiglitz (1979).

[12] Following Herrschel and Newman (2002), systems of cities can be thought of to assume two alternative configurations at a regional scale of analysis: ’monocentric city regions’ and ’policentric city regions’. The former indicating a geography characterized by the presence of a dominant metropolitan core, that reduces the role of the region to little more than its own hinterland. The latter referring to the presence of more than one urban center, that assures a certain degree of competition among cities themselves. In this terms, a model of perfect competition in the market of cities would apply neither to the former nor to the latter.

city size is not optimal (mainly due to the action of pecuniary externalities). In our opinion, this shows that the concern about the realism of the idea that cities could form through the action of city developers (Henderson and Mitra, 1996) would be better understood as a problem of scale.

Tables and figures

Table 1: Centralisation versus TA devolution

S	***W***	***N***	***CI***
2.5	0.47	0.19	13.16

Ratio of the decentralised to the centralised solution

Table 2: Comparative statics

	Centralized solution				***Decentralized solution***			
	S	***W***	***N***	***CI***	***S***	***W***	***N***	***CI***
τ	-	-	+	-	-	-	+	-
β	**+**	-	-	+	**-**	-	-	+
α	-	-	-	**+**	-	-	-	**-**
λ	+	+	+	+	+	+	+	+
ψ	**+**	-	-	**+**	**-**	-	-	**-**
μ	-	-	+	-	-	-	+	-
ρ	**+**	-	-	**+**	**-**	-	-	**-**

Starting values (centralised equilibrium): W=83; S=4; N=16; Y= 927.491.

Table 3: Description of the variables used in the estimations

Label	Description	Source
Gini	Gini concentration index at regional level of municipal population data (2000-2012)	Own elaboration on ISTAT data
Fisc_dec	Regional index of fiscal decentralization as the ratio of the local revenues collected by the local bodies over the total revenues collected in the regions (2000-2012)	Own elaboration on CPT data
IntAcc	Internal transport costs	Del Gatto and Mastinu 2018
ExtAcc	External transport costs	ESPON
Gdp pc	Regional gross domestic product per capita at costant price (2000-2012)	ISTAT
Unempl	Regional unemployment rate (2000-2012)	ISTAT
Servsh	Share of value added in the services sector over the total value added in the whole economic sectors (2000-2012)	Own elaboration on ISTAT data

Table 4: summary descriptive statistics

Variable	N.	T.	Mean	Std. Dev.	Min	Max
Gini	20	13	0.664	0.067	0.553	0.829
Fisc_dec	20	13	0.042	0.010	0.017	0.080
IntAcc	20	1	539.606	493.900	76.838	2262.514
ExtAcc	20	1	88.820	20.971	58.350	127.573
Gdp pc	20	13	26727.940	6611.605	15998.390	37437.920
Unempl	20	13	8.390	4.659	2.543	24.117
Servsh	20	13	0.723	0.056	0.591	0.849

Table 5: Panel regression results.

Model	M1	M2	M3	M4	M5
Estimator	FE	FE	FE	RE	Pooled
Dependent variable	*Gini*	*Gini*	*Gini*	*Gini*	*Gini*
	b/se	b/se	b/se	b/se	b/se
Fiscdec	0.228***	0.160***	0.219***	0.222***	2.356***
	(0.039)	(0.037)	(0.051)	(0.052)	(0.428)
IntAcc				0.000	0.000***
				(0.000)	(0.000)
ExtAcc				-0.002**	-0.002***
				(0.001)	(0.000)
Gdp pc		-0.000**	-0.000	-0.000	0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
Servsh		0.055***	0.043**	0.050**	0.561***
		(0.018)	(0.021)	(0.022)	(0.061)
Unempl		-0.000***	-0.000**	-0.000**	0.005***
		(0.000)	(0.000)	(0.000)	(0.001)
Year dummies	no	no	yes	yes	yes
Constant	0.655***	0.643***	0.638***	0.497***	-0.127***
	(0.002)	(0.021)	(0.021)	(0.064)	(0.046)
N	240,000	240,000	240,000	240,000	240,000
r2_a	0.055	0.228	0.234		0.532

Figure 1: Central Planner's problem: (*equation 21*).

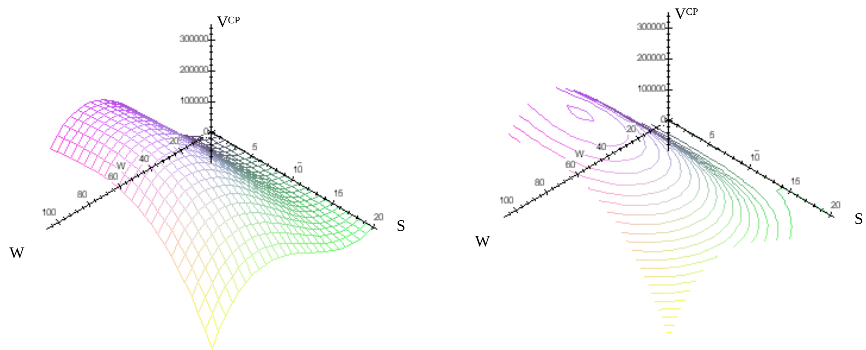


Figure 2: Local Planners' problem.

Fig. 2.a. System (30-32): free-entry condition (close-mesh) and First
Order Condition (wide-mesh).
Fig. 2.b. Solution: free-entry condition (thin line) and First Order Condition (thick line).

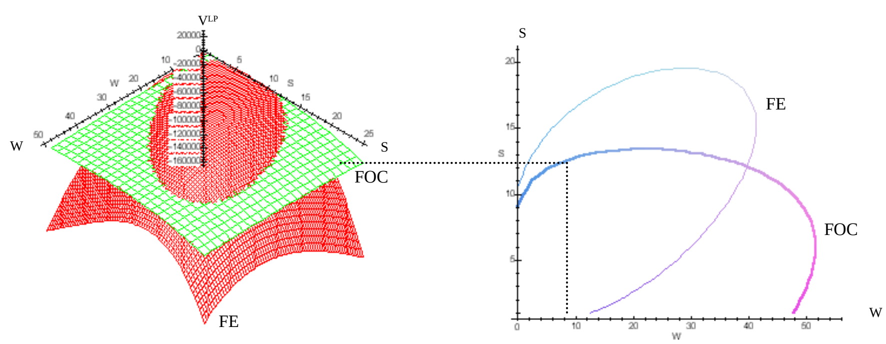
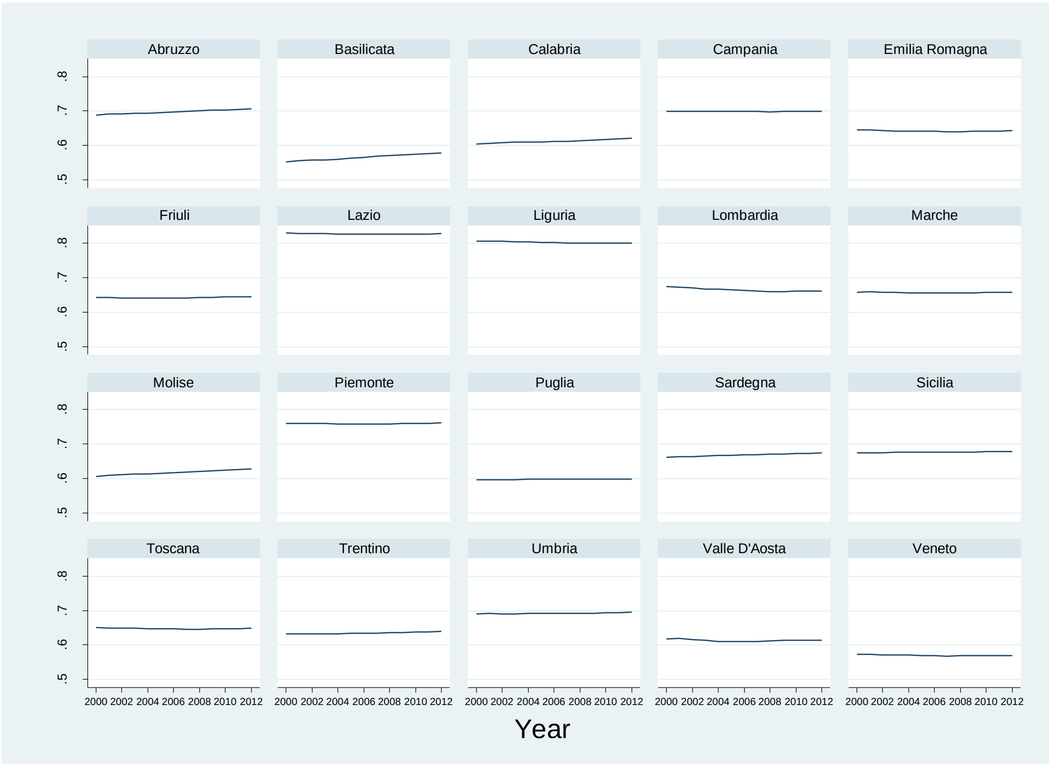


FIG. 2.A

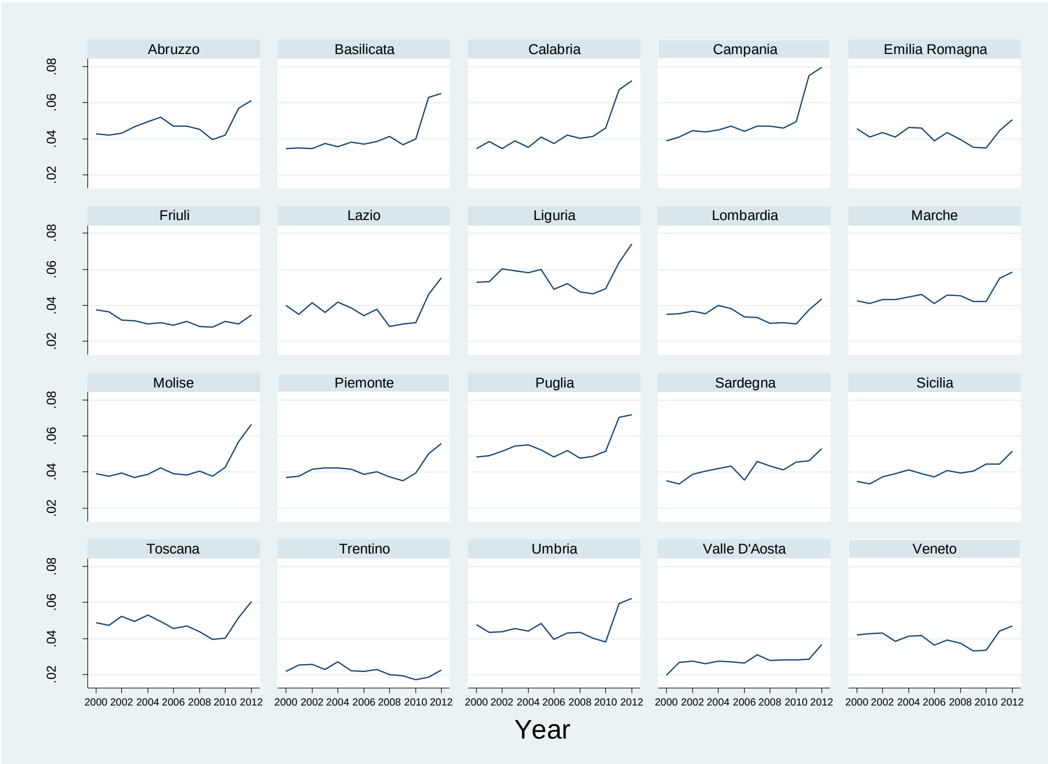
FIG. 2.B

Figure 3: Gini index by regions



Source: Own calculation on ISTAT data

Figure 4: Fiscal decentralization index by region



Source: Own calculation on CPT data