Chapter 6
Regions, Innovations, and the North–South Divide in Italy

Using firm-level data collected by Statistics Italy for 2008, 2011, and 2015, the Triple-Helix synergy among geographical and size distributions of firms and technology classes is analyzed both regionally and nationally. The Italian system is both knowledge-based and knowledge-intensive, and therefore an interesting case. The contributions to national synergy of the twenty regions in Italy have increased between 2008 and 2015, but synergy generation at levels above the regions has remained relatively stable at approximately 45%. As against the statistical classification into twenty regions, or into Northern, Central, and Southern Italy, the greatest synergy is retrieved by defining the country in terms of Northern and Southern Italy as two sub-systems, with Tuscany included as part of Northern Italy. Different innovation strategies could be developed for these two parts of the country. However, the current focus on twenty regions for innovation policies may to some extent be an artefact of the statistics and EU policies. In terms of sectors, both medium- and high-tech manufacturing (MHTM) and knowledge-intensive services (KIS) are integrated proportionally in the various regions.

Italy was shaped as a nation state in the period 1848–1870. During the Second War of Independence (1859–1861), the northern part of Italy was unified under the leadership of the Kingdom of Piemonte (Turin), and the southern part—the Kingdom of the Two Sicilies (with Naples as capital)—was conquered by Garibaldi in 1860. Central Italy, which until then had been the Papal State, was invaded by Italy in 1870 and thereafter Rome became the capital of the nation. The division into three parts—Northern, Central, and Southern Italy—has remained important; it is commonly used for policy purposes. However, the North/South divide is also a common terminology in political discourse. In short, the North and the South have different cultural traditions and marked differences in GDP per capita, the composition of economic activities, and employment indicators.

At a lower level of aggregation, the country is administrated in terms of twenty regions, of which five have a special status. Among these, Valle d'Aosta is an

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autonomous region in which French functions as a second language. Alto Adige (also known as Süd-Tirol) is an autonomous province of Trentino-Alto Adige, bordering on Austria, with German as a second language. Below the level of regions, 107 provinces are defined in the statistics.[1] Furthermore, Italy is known for its "industrial districts" which often cover a small territory within one or more provinces, with specialized manufacturing or services (Becattini et al., 2003; Bertamino et al., 2017). These districts are highly innovative and mainly located in the northern part of the country (Biggiero, 1998). Using 2011 census data, Statistics Italy (IStat) distinguished 141 industrial districts and furthermore 611 so-called local labour systems based on commuting patterns ("sistemi locali del lavoro," SLL). Insofar as SLLs overlap with industrial districts, the data allows for economic analyses at the district level(e.g., Paci & Usai, 2000; Mameli, Faggian, & McCann, 2008). Industrial districts, however, are not a separate level of administration and hence not included in the national statistics.

National statistics for Italy are aligned with the hierarchical classification of the European Union in the "Nomenclature des Unités Territoriales Statistiques" (Nomenclature of Territorial Units for Statistics, or NUTS). In this classification, NUTS1 is defined as lands (e.g., the German *Länder*), NUTS2 as regions (e.g., Lombardia), and NUTS3 as provinces or metropolitan areas (e.g., the metropolitan region of Milano or the province of Lecce).

Grilliches (1994) noted that the use of administrative units in statistics can be a data constraint for innovation studies and also for innovation policies. For example, innovation is not constrained geographically (Carlsson & Stankiewicz, 1991). Innovation systems may depend on interactions and infrastructures that do not match regional and national boundaries. Sectorial innovation systems (e.g., oil refinement, biotechnology) are in important respects organized internationally (Carlsson, 2006 and 2013). Furthermore, firms can interact with non-regional universities if the knowledge and skills required are not available within the region (Asheim & Coenen, 2006; Fritsch & Schwirten, 1999), or when they are seeking higher-quality collaboration partners at the international level (d'Este & Iammarino, 2010; Laursen, Reichstein, & Salter, 2011). For the purpose of implementing innovation policies at the appropriate level, however, it is important to understand the boundaries of innovation systems. This is a complex undertaking which could be addressed at different levels (e.g., municipal, provincial, regional, national, supra-national; by sector or comprehensively) and using different instruments, such as various combinations of qualitative analyses and quantitative indicators.

Italy is a challenging and exemplary case: to what extent and at which levels is innovation-systemness indicated? Can the regions carry the function of regional innovation organizers (Etzkowitz & Klofsten, 2005)? If we test regional innovation systems using the generation of redundancy as an indicator of synergy, the results show that the understanding of Italy in terms of regional innovation systems is not optimal when synergy is measured in terms of the interactions among (i) the geographical distributions of firms, (ii) the economic structure in terms of firm sizes, and (iii) the technological knowledge bases of these firms as indicated by the

[1] These numbers change over time. The current count of provinces is 110.

NACE-codes. (NACE is the acronym for the "Nomenclature générale des Activités économiques dans les Communautés Européennes" used by the OECD and Eurostat.) Most synergy is found by considering Italy in terms of a northern and southern part, with Tuscany as part of Northern Italy.

6.1 Innovation Policies and Innovation Systems in Italy

Both the OECD and the EU provide incentives for organizing regional innovation policies. Among other things, the OECD reviews regional innovation policies with the objective of providing policy recommendations (e.g., OECD, 2009). In innovation studies (economic geography and evolutionary economics), it is increasingly assumed that regions (including metropolitan regions) are the appropriate units of analysis for studying the transition to a knowledge-based economy (e.g., Braczyk, Cooke, & Heidenreich, 1998; Cooke, 2002; Feldman & Storper, 2016; Florida, 2002; Storper, Kemeny, Makarem, Makarem, & Osman, 2015).

In Italy, regions have gained importance as innovation-policy units since 2001, when the Italian constitution was changed (*Riforma del Titolo Quinto*). A range of devolution measures gave regional governments greater control over policy areas such as health, education, and economic and industrial development, including innovation policy (Rolfo & Calabrese, 2006). This devolution led to a sharp reduction of the national budget for the support of industrial and R&D activities, particularly in the South. Brancati (2015) estimates that between 2002 and 2013, state aid decreased by 72%; the remaining state interventions privileged Central and Northern Italy, while industrial policies in favor of the Southern regions were virtually abandoned after 2000 (Prota & Viesti, 2013).

Furthermore, the 2007–2009 economic and financial crisis has severely impacted the Italian industrial system. Compared with the trends calculated for the 1992–2008 period, about 300 bn Euro of gross investment were lost in Italy between 2008 and 2013 (Cappellin et al., 2014). Southern regions were disproportionally affected: between 2007 and 2012, industrial investment in the South decreased by 47% (Prota & Viesti, 2013). This retreat of national policy has only partly been compensated by regional policies, supported to varying degrees by EU Cohesion and Structural funds. In the EU programs during the period 2007–2013, about 21.6 bn Euro of EU funds (FESR/ERDF and FSE/EFS) were allocated to regions in Southern Italy for Convergence objectives (Calabria, Campania, Puglia, and Sicilia) and 6.3 bn to regions in Central and Northern Italy for so-called Competitiveness objectives.

Despite the increasing role played by regional governments in innovation policy, it has remained a subject of debate whether the regional level is most appropriate for the design and implementation of such policies. On the basis of an analysis of the performance of the Italian national innovation system during the 1980s and 1990s, Malerba (1993, at p. 230), for example, argued that "not one, but two innovation systems are present in Italy." The first is a "core R&D system" that operates at

the national level through systematic cooperation between large firms with industrial laboratories, small high-tech firms, universities, public research institutes, and the national government. The second innovation system would be a "small-firms network" composed of a plurality of small- and medium-sized firms that cooperate intensively at the local level, often within industrial districts, and generate incremental innovation through learning-by-doing.

Malerba mentions the lack of overall coordination in public policy and R&D support services and a weak tradition of successful university-industry cooperation in research as major problems in the Italian innovation system. Nuvolari & Vasta (2015) added that Italy can be characterized as a structurally weak national innovation system in comparison to its main competitors. The diverging performance between scientific and technological activities can lead to major difficulties in the technology transfer of scientific results from universities to firms due to a lack of bridging institutions (e.g., Balconi et al., 2004).

A number of studies in various sectors of the economy (e.g., Antonioli et al., 2014; Belusssi et al., 2010; De Marchi & Grandinetti, 2017; Lew et al., 2018) have argued that the international orientation of research collaborations means that Italian regions cannot be considered as innovation systems. These innovative regions are better characterized as "glocal" systems. They pair a relatively low connectedness at the local level with strong knowledge-intensive relationships at the international level. On the industrial side, this international orientation carries a threat of de-industrialization of innovative districts and regions because new options can easily be bought by multinational corporations and relocated elsewhere (Cooke & Leydesdorff, 2006; Dei Ottati, 2003).

In sum, the gradual emergence of knowledge production as an additional coordination mechanism in an industrial system that is otherwise coordinated in terms of institutions and markets introduces the risk of "footloose-ness" (Vernon, 1979). Knowledge-intensive services and high-tech manufacturing tend to uncouple an innovation system from a specific geographical address and can thus be counterproductive from the perspective of regional innovation policies (Leydesdorff & Fritsch, 2006).

6.2 Methods

Elaborating on the reasoning in Chaps. 4 and 5, I note that mutual information among three (or more) dimensions does not measure action (e.g., academic entrepreneurship) as *relations* between input and output, but the investment climate as a structural consequence of *correlations* among distributions of relations. However, the distinction between these structural dynamics in terms of changing selection environments and the historical dynamics of relations is analytical; the historical and the evolutionary dynamics are coupled in the events. Mutual information indicates a trade-off between variation and selection as positive and negative contributions to the prevailing uncertainty. The question of systemness can thus be made empirical

and amenable to measurement: when the generation of redundancy prevails over the generation of uncertainty, "innovation systemness" is indicated.

Furthermore, in the case of groups (e.g., subsamples at a lower geographical scale), one can decompose the information as follows: $H = H_0 + \sum_G \frac{n_G}{N} H_G$ (Theil, 1972, pp. 20f.). Since T values are decomposable in terms of H values, one can analogously derive (see Chap. 5; Leydesdorff & Strand, 2013, at p. 1895):

$$T = T_0 + \sum_G \frac{n_G}{N} T_G \tag{1}$$

In this formula, T_G provides a measure of synergy at the geographical scale G; n_G is the number of firms at this scale, and N is the total number of firms under study. One can also decompose across regions, in terms of firm sizes, or in terms of combinations of these dimensions.

The three relevant dimensions are the (g)eographical, (t)echnological, and (o)rganizational; synergy will be denoted as T_{GTO} and measured in millibits with a minus sign. Because the scales are sample-dependent, values are normalized for comparisons across samples as percentages. After normalization, the contributions of regions or groups of regions can be compared. The between-group term T_0 (Eq. 6.1) provides us with a measure of what the next-order system (e.g., the nation) adds in terms of synergy to the sum of the regional systems.[2]

6.3 Data and Descriptive Statistics

Statistics Italy (IStat) collects firm census data every ten years. Complete data sets for the years 2008, 2011, and 2015 were harvested from the so-called ASIA ("Archivo Statistico delle Imprese Attive") database of Statistics Italy. This database includes all enterprises that performed productive activities for at least six months during the reference year. However, this data does not cover the sectors agriculture, fisheries, and forestry. Public administration and non-profit private organizations are also excluded. The data contain 4,514,022 firms in 2008, 4,450,937 firms in 2011, and 4,338,085 in 2015.

For a Triple-Helix analysis of synergy, we need three key variables: (1) the administrative location of the firm in the form of its postal address indicating the geographical dimension (government); (2) the NACE code indicating the main technology in the knowledge base of the firm; and (3) the character of the firm in terms of its size indicated as the numbers of employees. These three dimensions have been used in a number of previous studies about the TH in various nations (see Chap. 5).

[2] A routine with further instructions is available at https://www.leydesdorff.net/software/th4 which generates the synergy values from data which for this purpose have to be organized as comma-separated variables with for each case (that is, firm) a unique identifier, a postal code, a size class, and a NACE code. The results are organized into a file which can be read into programs like SPSS or Excel for further processing.

6.3.1 The Geographical Distribution of Firms in Italy

The administrative division of Italy into Northern, Central, and Southern Italy and, alternatively, into twenty regions is visualized in Fig. 6.1 and further specified in

Fig. 6.1 Organization of Italy into Northern, Southern, and Central Italy, and regions; Northern Italy is indicated in dark green, Central Italy is in very light green, and Southern Italy is in light green. *Source* Figure produced by the authors using SPSS v.22

Table 6.1 Regional Division of Italy at the NUTS 1 and NUTS 2 levels

Codes of *ISTAT*	NUTS1	NUTS2	Name of the region	Macro-regions	North–South
	(a)	(b)	(c)	(d)	(e)
1	North-west Italy (ITC)	ITC1	Piemonte	*Northern Italy*	*Northern Italy*
2		ITC2	Valle d'Aosta		
7		ITC3	Liguria		
3		ITC4	Lombardia		
4	North-east Italy (ITH)	ITH1/TH2	Trentino-Alto Adige		
5		ITH3	Veneto		
6		ITH4	Friuli Venezia Giulia		
8		ITH5	Emilia Romagna		
9	Central Italy (ITI)	ITI1	Toscana	*Central Italy*	
10		ITI2	Umbria		*Southern Italy*
11		ITI3	Marche		
12		ITI4	Lazio		
13	Southern Italy (ITF)	ITF1	Abruzzo	*Southern Italy (Mezzogiorno)*	
14		ITF2	Molise		
15		ITF3	Campania		
16		ITF4	Puglia		
17		ITF5	Basilicata		
18		ITF6	Calabria		
19	Insular Italy (ITG)	ITG1	Sicilia		
20		ITG2	Sardegna		

Table 6.1. Among other things, I shall test the three conventional partitions of Italy provided in columns *c*, *d*, and *e* of Table 6.1.

Table 6.2 provides the numbers of firms in the years under study. With the exceptions of Trentino-Alto Adige and Lazio, the numbers of firms have been declining during this past decade. This confirms the impression of stagnation since the crisis of 2007–2009. Italy has only partly recovered from this crisis.

6.3.2 Small, Medium-Sized, and Large Enterprises

In addition to the assignment of geographical addresses and NACE codes, firms can be scaled in terms of the number of their employees. SMEs, for example, are commonly defined in terms of this proxy. Financial turn-over is also available in the

Table 6.2 *N* of firms in 20 Italian regions

Region	2008	2011	2015	% change 2008–2015
Piemonte	344,334	339,261	323,184	−6.1
Valle d'Aosta	11,959	11,933	11,257	−5.9
Lombardia	822,579	818,998	805,755	−2.0
Trentino-Alto Adige	83,121	83,656	84,398	1.5
Veneto	406,800	402,976	391,474	−3.8
Friuli-Venezia Giulia	88,683	86,797	82,720	−6.7
Liguria	132,288	129,708	122,874	−7.1
Emilia-Romagna	389,123	370,778	366,475	−5.8
Toscana	338,943	332,563	320,167	−5.5
Umbria	70,892	69,411	66,455	−6.3
Marche	133,261	131,567	126,213	−5.3
Lazio	423,059	428,715	426,322	0.8
Abruzzo	100,120	101,115	97,184	−2.9
Molise	21,705	21,445	20,631	−4.9
Campania	351,688	340,601	336,819	−4.2
Apulia	254,431	254,277	249,196	−2.1
Basilicata	36,169	35,234	34,586	−4.4
Calabria	114,858	110,391	105,878	−7.8
Sicily	278,451	273,155	264,480	−5.0
Sardegna	111,558	108,356	102,017	−8.6
Sum	4,514,022	4,450,937	4,338,085	−3.9

data as an alternative indicator of economic structure. However, we chose to use the number of employees since one can expect this number to exhibit less volatility than turn-over, which may vary with stock value and economic conjecture more readily than numbers of employees. However, the numbers of employees are sensitive to other activities, such as outsourcing.

The definitions of small and medium-sized businesses, large enterprises, etc., vary among world regions. Most classifications use six or so categories for summary statistics. I use the nine classes provided in Table 6.3 because this finer-grained scheme produces richer results (Blau & Schoenherr, 1971; Pugh, Hickson, & Hinings, 1969a, b; Rocha, 1999).

6.3.3 The Technological Dimension (NACE Codes)

The third dimension of the data to be used is the attribution of NACE codes. The classification of firms in terms of the *Nomenclature générale des Activités*

Table 6.3 Classification of firms (2015) in terms of the number of employees. *Source* Statistics Italy

CLASS	Number of employees	Frequency	Percent	Valid percent	Cumulative percent
1	0–1	3,473,928	80.1	80.1	80.1
2	2–4	493,365	11.4	11.4	91.5
3	5–9	201,497	4.6	4.6	96.1
4	10–19	99,554	2.3	2.3	98.4
5	20–49	45,476	1.0	1.0	99.4
6	50–99	13,275	0.3	0.3	99.7
7	100–199	6223	0.1	0.1	99.9
8	200–499	3225	0.1	0.1	100.0
9	500 or more	1542	0.0	0.0	100.0
		4,338,085	100.0	100.0	

Note that micro-enterprises (with fewer than five employees) constitute 91.5% of the firms under study

économiques dans les Communautés Européennes (NACE, Rev. 2) is used for indicating the technological dimension.[3] The NACE code can be translated into the International Standard Industrial Classification (ISIC) that is used in the USA (e.g., Leydesdorff, Wagner, Porto-Gomez, Comins, & Phillips, 2019). The disaggregation in terms of medium- and high-tech manufacturing, and knowledge-intensive services, is provided in Table 6.4.[4]

We will additionally analyze the subsets of high- and medium-tech companies, and (high-tech) knowledge-intensive services, because one can expect very different dynamics for these sectors in contributing to synergy in the knowledge base of regions.

6.4 Results

6.4.1 Regions

Figure 6.2 provides a visualization of the percentage contribution of the twenty regions to the national synergy of Italy in 2015. The visualizations for 2008 and 2011 are not essentially different.[5]

[3] Firms are classified in the ASIA database using ATECO 2007 codes, the Italian version of NACE Rev. 2.

[4] A complete index of NACE codes can be found, for example, at https://www.cso.ie/px/u/NACECoder/Index.asp.

[5] The rank-order correlations among the regions in these three years are significantly the same (Spearman's $\rho > .99$; $p < 0.001$).

Table 6.4 NACE classifications (Rev. 2) of high- and medium-tech manufacturing, and knowledge-intensive services. Sources: Eurostat/OECD (2011); cf. Laafia (2002, p. 7) and Leydesdorff et al. (2006, p. 186)

High-tech Manufacturing	***Medium–high-tech Manufacturing***
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	50 Water transport
26 Manufacture of computer, electronic and optical products	51 Air transport
30.3 Manufacture of air and spacecraft and related machinery	58 Publishing activities
Medium–high-tech Manufacturing	59 Motion picture, video and television programme production, sound recording and music publishing activities
20 Manufacture of chemicals and chemical products	60 Programming and broadcasting activities
25.4 Manufacture of weapons and ammunition	61 Telecommunications
27 Manufacture of electrical equipment	62 Computer programming, consultancy and related activities
28 Manufacture of machinery and equipment n.e.c	63 Information service activities
29 Manufacture of motor vehicles, trailers and semi-trailers,	64–66 Financial and insurance activities
30 Manufacture of other transport equipment • Excluding 30.1 Building of ships and boats, and • Excluding 30.3 Manufacture of air and spacecraft and related machinery	69 Legal and accounting activities
32.5 Manufacture of medical and dental instruments and supplies	70 Activities of head offices; management consultancy activities
	71 Architectural and engineering activities; technical testing and analysis
	72 Scientific research and development
	73 Advertising and market research
	74 Other professional, scientific and technical activities
	75 Veterinary activities
	78 Employment activities
	80 Security and investigation activities
	84 Public administration and defence, compulsory social security
	85 Education
	86 to 88 Human health and social work activities
	90 to 93 Arts, entertainment and recreation
	Of these sectors, 59 to 63, and 72 are considered ***high-tech services***

Figure 6.2 shows that Tuscany belongs to the northern part of Italy as a knowledge-based economy; the distinction of Central Italy including Tuscany is not supported by this data.

Mountainous regions both along the Alps and in the Apennines are weakest in generating synergy. However, one should keep in mind that Italy has a system of excellent highways and trains that cross these regions. Their relative marginality is thus not likely to be due to the mountainous character of these regions, but perhaps more a consequence of their structural positions such as their distance from metropolitan centers, harbors, and airports.

Figure 6.3 shows that triple-helix synergy has increased over time in virtually all regions (but not in Sardegna). The strongest regions became even stronger in terms of their contributions to the national synergy. For example, Lombardia increased its

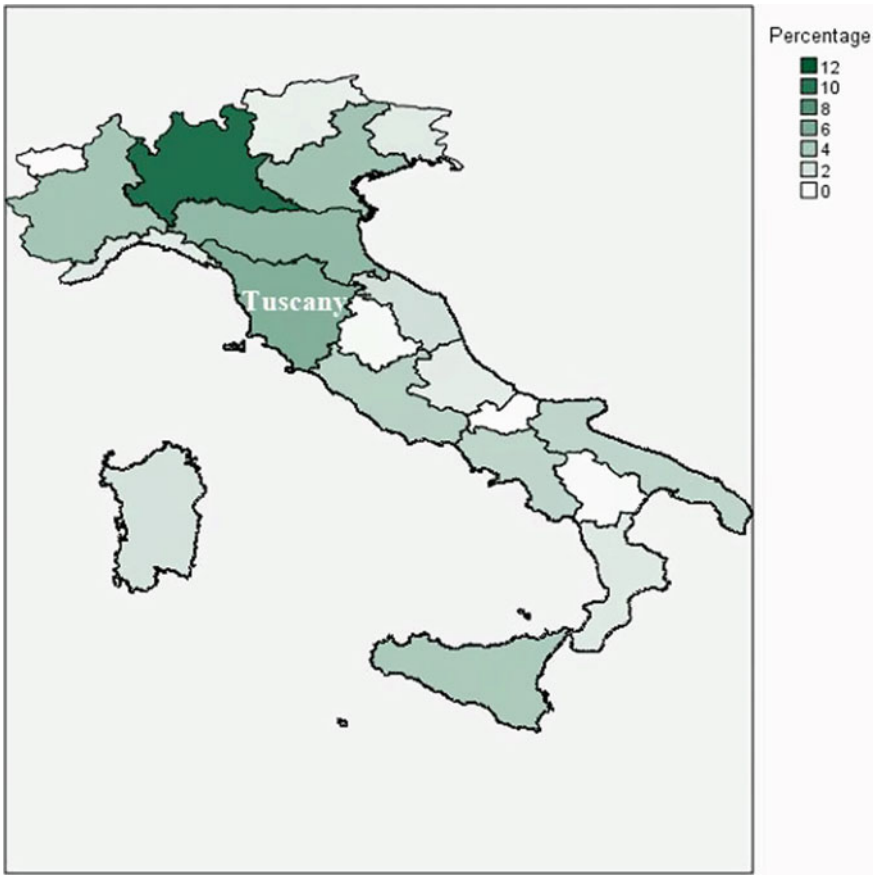

Fig. 6.2 Percentages of contributions of the regions to the national synergy of Italy in 2015

leading contribution to the national synergy by a further 1.8%. The percentage of synergy generated above the regional level—that is, the complement to 100% of the sum of the regional contributions—declined from 48.9% in 2008 to 44.4% in 2015 (–4.5%). This reduction of above-regional synergy contribution over time as a percentage is consistent with the progressive withdrawal of innovation policy-making at the national level, and the growing importance of the regions (Table 6.5).

In summary: regions have become more important, but only 55% of the synergy is realized at the regional level. The other 45% is realized at the above-regional level (such as across the North/South divide or in Italy as a national system).

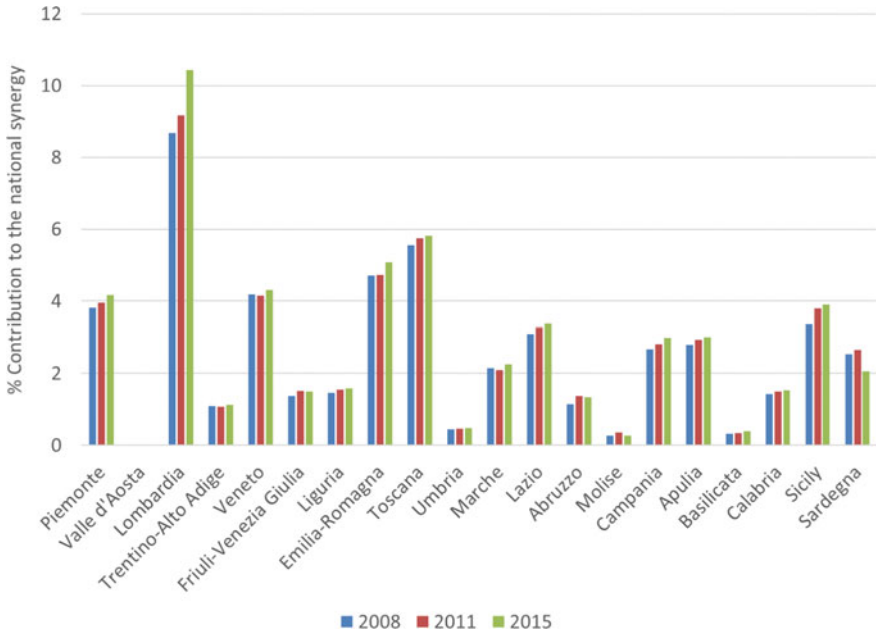

Fig. 6.3 Percentages of contributions of the regions to the national synergy of Italy in 2008, 2011, and 2015

6.4.2 Northern, Central, and Southern Italy

Using the classification of regions into Northern, Southern, and Central Italy as provided in Table 6.1 , Fig. 6.4 shows the above-regional synergy development using three (northern, southern, central) or two (northern and southern) groups of regions, respectively, on the right side, and the values of T_0 on the basis of twenty regions on the left side. As noted, the latter declined from 48.9 in 2008 to 44.4% in 2015.

The above-regional synergy development among the *three* groups of regions (north–south-center) is of the order of 22.5%, but is not increasing consistently as the supplement of the synergy among the twenty regions. Among *two* groups of regions (north–south), however, T_0 was further reduced to 18.2% in 2015.

Both the northern and southern parts are more synergetic when compared with the division into three parts. If Tuscany is analyzed as part of northern Italy, however, the northern part of Italy accounts for 47.0% of the synergy and the southern part for 34.9%; with an additional 18.2% synergy at the national level. Values around 20% for the national surplus synergy were also found for other countries in previous studies. Adding Tuscany, which itself contributes only 5.8% to the synergy at the national level, to the northern part (instead of the central one) increases the contribution of the north by more than 9% (=46.95 − 37.90; in Table 6.6). Thus, an additional synergy is indicated by using this model of Italy.

Table 6.5 Percentages of contributions of the regions to the national synergy of Italy in 2015

Region	2008	2011	2015	% change 2008–2015
Piemonte	3.82	3.95	4.17	9.2
Valle d'Aosta	0.00	0.00	0.00	0.0
Lombardia	8.67	9.18	10.43	20.3
Trentino-Alto Adige	1.09	1.08	1.13	3.6
Veneto	4.19	4.15	4.31	3.0
Friuli-Venezia Giulia	1.37	1.51	1.49	8.4
Liguria	1.47	1.56	1.58	7.5
Emilia-Romagna	4.71	4.73	5.08	7.7
Toscana	5.55	5.75	5.81	4.7
Umbria	0.45	0.46	0.48	6.0
Marche	2.14	2.10	2.26	5.6
Lazio	3.09	3.27	3.38	9.5
Abruzzo	1.15	1.37	1.33	15.5
Molise	0.27	0.35	0.26	−4.6
Campania	2.67	2.82	2.99	12.2
Apulia	2.79	2.94	3.01	8.1
Basilicata	0.32	0.33	0.38	21.4
Calabria	1.43	1.50	1.54	7.5
Sicily	3.36	3.79	3.89	16.0
Sardegna	2.54	2.66	2.07	−18.7
T_0	48.91	46.48 lePara>	44.40	−9.2

Sources Eurostat/OECD (2011); cf. Laafia (2002, p. 7) and Leydesdorff et al. (2006, p. 186)

The conclusion is that considering Italy as twenty regions leaves 45% of the synergy in the Italian innovation system unexplained. This is extremely high when compared with other nations. In the USA, we found that the additional synergy at the national (above-state) level is only 2.8%. This is much less than we found in previous studies of national innovation systems: Norway (11.7%), China (18.0%), the Netherlands (27.1%), Sweden (20.4%), and Russia (37.9%). Italy would score above the Russian Federation when considered in these terms, but for very different reasons (Leydesdorff, Perevodchikov, & Uvarov, 2015). The high surplus in Russia is caused by the centralized nature of this system, while in Italy, the high surplus is unexplained when the wrong data model is used. When Italy is conceptualized as a country with two or three innovation systems, the results accord with those for other EU nations.

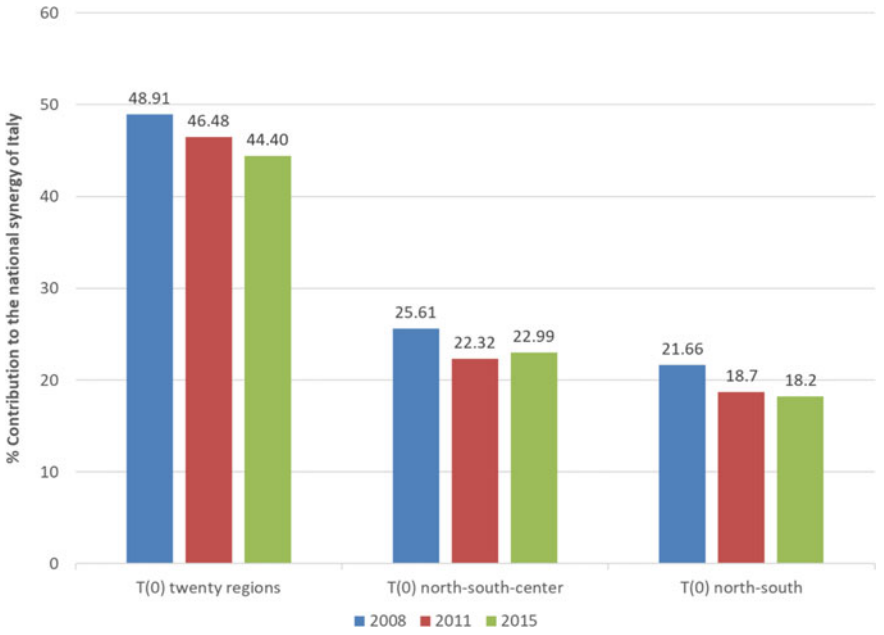

Fig. 6.4 Above-regional synergy for Italy on the basis of 20 NUTS2-regions (left) and three macro-regions (north—south—center)

Table 6.6 Percentage contributions of Northern, Southern, and Central Italy to the national synergy in 2015

	North-central-south	North–south
North	37.90	46.95
Center	17.50	
South	21.62	34.85
Sum	77.02	81.80
T_0	22.98	18.20
	100	100

6.4.3 Sectorial Decomposition

Using the NACE codes (provided in Table 6.4), we can repeat the analysis for subsets of firms which are classified as high- or medium–high-tech, and for knowledge-intensive services. Of the approximately 4.3 million firms, 1,294,874 (29.8%) provide knowledge-intensive services, while only 40,083 (0.9%) are classified as MHTM in 2015. However, the differences between the distribution of the set and the subsets are marginal. Table 6.7 shows the rank-order correlations which are all above 0.95 ($p < 0.001$). In other words: both medium-high-tech and knowledge-intensive services are distributed proportionally over the country in terms of numbers of firms. Table 6.8 provides a summary of the results, including the values for these subsets as

Table 6.7 Rank-order correlations between the samples of firms classified as high- and medium–high-tech manufacturing (MHTM) and knowledge-intensive services (KIS) over the twenty regions of Italy

		Full set	MHTM
MHTM	Correlation Coefficient	0.955**	
	Sig. (2-tailed)	0.000	
	N	20	
KIS	Correlation Coefficient	0.982**	0.950**
	Sig. (2-tailed)	0.000	0.000
	N	20	20

** Spearman's rho; correlation is significant at the 0.01 level (2-tailed)

Table 6.8 Summary table of percentages of contributions to the synergy in the Italian innovation system (2015)

Region	2015	north_south_center	north_south	MHTM	KIS
Piemonte	4.17	37.90	46.95	**7.14**	3.58
Valle d'Aosta	0.00			0.00	0.00
Lombardia	10.43			11.68	**9.19**
Trentino-Alto Adige	1.13			0.94	0.80
Veneto	4.31			**7.66**	3.54
Friuli-Venezia Giulia	1.49			2.72	1.38
Liguria	1.58			1.93	1.59
Emilia-Romagna	5.08			**7.40**	5.20
Toscana	5.81	17.50		**8.15**	4.81
Umbria	0.48		34.85	0.67	0.50
Marche	2.26			4.06	2.12
Lazio	3.38			3.07	**2.07**
Abruzzo	1.33	21.62		2.32	1.30
Molise	0.26			0.30	0.21
Campania	2.99			3.70	2.45
Apulia	3.01			3.76	2.36
Basilicata	0.38			0.70	0.42
Calabria	1.54			1.96	1.47
Sicily	3.89			4.44	4.09
Sardegna	2.07			1.34	1.85
Sum	55.60	77.01	81.80	73.94	48.93
T_0	44.40	22.99	18.20	26.06	51.07

percentages of synergy in the two right-most columns.

In Table 6.8, values with outliers for MHTM and/or KIS are boldfaced in the right-most columns: when we focus on MHTM, Piemonte, Veneto, Emilia-Romagna, and Toscana provide contributions to the synergy more than two percent higher than without this focus. Lombardia, Marche, and Friuli-Venezia Giulia follow with more than one percent higher values.

Unlike manufacturing, services can be offered nation-wide or even beyond the nation, and thus tend to uncouple from a specific location, leading to a negative effect on the local synergy. In Italy, this is the case mainly for services in Lombardia and Lazio, since these two regions contain the two metropoles of Milano and Rome with airports, etc. Toscana (Florence) and Veneto (Venice) follow with smaller effects.

In Southern Italy, there are no effects from either MHTM or KIS. A negative effect of MHTM is indicated for Lazio, probably meaning that some manufacturing may have administrative offices located in Rome without contributing to the knowledge-based synergy in this region (Lazio). Sardegna also has a negative effect when focusing on MHTM because the medium- and high-tech sectors are marginal in this local economy.

6.5 Conclusions and Discussion

In analogy to "national innovation systems" (Freeman, 1987; Lundvall, 1988, 1992; Nelson, 1993), many studies have argued for studying "regional innovation systems" such as Wales or Catalonia (Braczyk, Cooke, & Heidenreich, 1998; Cooke, 1998, 2002). However, innovation systems are not bound by administrative and political borders. In my opinion, one should not make the choice between studying regions or nations on a priori grounds and across the board. The function of regions in an otherwise relatively homogeneous country (e.g., Denmark) is different from that in a country with a federal structure, such as Belgium.

From this perspective, Italy is an interesting case because there is a traditional divide between the North and the South, but there are also common denominators such as a single language (with small exceptions), and national institutions such as a network of state universities, a national research council (CNR) with a similar structure in all regions, and a national government without a federal structure. During the last two decades, the regions have become more important because of the devolution policies of the central government and the emphasis on regions in EU policies.

One would expect the coherence of an innovation system to be a mixture of both national and regional aspects. The research question then becomes: how much innovation-systemness is generated at the various levels? Is this innovation-systemness distributed across regions or specialized in specific regions? The synergy measure enables us to address these questions empirically and in considerable detail.

In summary, Italy as a nation is integrated, albeit not at the level of the twenty regions. Eight regions in Northern Italy (including Tuscany) are well developed as innovation systems. These eight regions contribute 34.0% to the national synergy.

However, as a separate subsystem Northern Italy contributes 47.0% of the synergy (Table 6.6). This is 13% more than the sum of the individual regions. The regions on the Northern borders with different cultural orientations (Alto Adige and Valle d'Aosta) contribute marginally to the synergy in the Northern-Italian system.

If we apply the same reasoning to Southern Italy (the Italian *Mezzogiorno*), twelve regions contribute 21.6% to the national synergy. Considered as a subsystem (Table 6), the South contributes 34.9%; that is, another 13.3% more synergy. On top of these two sub-systems, Italy as a nation contributes 18.2% to the national synergy. This can be interpreted as a synergy generated as a result of interactions among sub-systems. Most synergy is found by considering Italy in terms of a northern and southern part, with Tuscany as part of Northern Italy.

As one would expect, synergy is enhanced by focusing on high- and medium-tech manufacturing. Rome and Milano function as metropolitan centers of innovation systems, followed by Florence and the region of Venice (including the harbour). Unlike Spain, where Barcelona and Madrid function as metropolitan innovation systems without much further integration into the remainder of the country (Leydesdorff & Porto-Gómez, 2018), the Italian system is nationally integrated in terms of MHTM and KIS.

6.6 Policy Implications

Innovation policies focusing on the regional level in Italy may miss important opportunities in inter-regional interactions. In other words, the coordination of innovation policies among regions, particularly within each of the two major innovation (sub)systems of Northern and Southern Italy, could be considered as potentially more effective. More generally, our results provide support for the argument that administrative borders which originated for historical and administrative reasons should be examined critically in terms of their functionality for innovation, particularly in a knowledge-based economy that is far more networked than a political economy.

The knowledge dynamics added to the economic and political dynamics generates a complex system with a volatile dynamics that *tends to self-organize its boundaries* (Bathelt, 2003). A complex system is resilient and thus adapts to signals that do not accord with its internal dynamics. A political administration that is not reflexively aware of and informed about how the relevant innovation systems are shaped may lack the flexibility required to steer these systems and feel in the longer term constrained by the unintended consequences of its own actions (Ashby, 1958; Luhmann, 1997).

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