PRELIMINARY DRAFT

Uneven Development as the Outcome of Economic Integration: Analysis of the Statistical Structure of Italian Economic Geography

Oriol Vallès Codina

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Abstract

This paper empirically addresses the economic geography of uneven development in the context of the Italian regions during the European Monetary Union. It applies a machine-learning method, Gaussian mixture modeling, to identify clusters on a wide variety of socio-economic indicators of Eurostat data and classify Italian regions accordingly in a simple and parsimonious way. The analysis of the complex statistical structure of Italian regional inequality confirms that it is most importantly characterized by its marked dual polarization into North and South as core and periphery, but still shows the empirical relevance of Arnaldo Bagnasco's "Third Italy" hypothesis. Further analysis of sectoral wage shares of income corroborates the more complex bi-modal/tri-modal structure in the economy. Regional rates of gross value added follow a Laplace distribution, while the distributions of sectoral compensation and gross value added follow a power law. After 160 years of political and monetary unification, there is no evidence for any convergence of Italian regions in most of the data. In the broader context of European economic integration, the Italian economic geography is characterized by protracted peripheralization. The paper concludes with a political-economic argument on how the interplay of trade and capital-account imbalances leading to such peripheralization fuel the Euroskeptic populist backlash against EU-led globalization.

JEL Codes

1 Introduction

Whether economic integration between countries or regions within the same country leads to income convergence or divergence (in the form of core-periphery dynamics of uneven development) is an important subject of debate among the

different economic theories of free trade, especially within the current wave of globalization and European monetary unification. When the Maastricht Treaty that founded the European Union was signed in 1992, the conventional expectation among economists was that poor countries would grow faster than rich countries so that they would eventually catch up [Solow, 1956; Barro and Sala-i Martin, 1995]. However, the rise in within-country income inequality, the robust persistence of bi-modal distributions of country incomes [Quah, 1996b], the existence of a middle-income trap [Felipe et al., 2012], and the most recent political backlashes against economic integration around the world have led many to review the supposed benefits of free trade [Stiglitz, 2002; Rodrik, 2011, 2020].

In fact, all economic theories (neoclassical, neo-Keynesian, structuralist, post-Keynesian, evolutionary, and classical) address the possibility of core-periphery dynamics and uneven development between countries and regions within the same country. Except the structuralist model that relies on the Prebisch-Singer hypothesis, all other theories agree in the fundamental role of increasing returns to scale and cumulative causation underlying the agglomeration of economies in the form of clusters of economic activity, which results in a geographical concentration and centralization of capital. However, since they disagree in the actual causal mechanisms at play, this makes difficult to empirically identify which particular countries and regions actually belong to the core-periphery dichotomy that most theoretical models presume. In other words, the fundamental and complex question of how 'regional' and 'local' economies can be meaningfully conceptualised, and how such conceptions can be translated into empirical terms, is not considered at all [Martin, 1999].

This paper empirically addresses the question of the proper characterization of clusters of economic activity by employing an atheoretical, 'distribution' approach, in line with Quah's "twin-peaks" work [1996b] as well as the econophysics literature [Drăgulescu and Yakovenko, 2001; Scharfenaker and Foley, 2017; Shaikh, 2020], in the context of Italy, which is seen as a case study or 'natural experiment' of 160 years of political and economic integration. The 'Southern Question' on the origins and causes of the divergence between Northern Italy and the Mezzogiorno has been intensely debated in political and academic circles since Unification in 1871 [Graziani, 1978; DiGiorgi et al., 1980; Fenoaltea, 2003; Felice, 2012; Felice and Vecchi, 2015; de Oliveira and Guerriero, 2018; Federico et al., 2019]. At the current moment, there is disagreement whether the divergence started with unification or instead predated it [Missiaia, 2016; Ciccarelli and Fenoaltea, 2013]. The analysis of the statistical structure of a variety of Italian regional and socio-economic Eurostat indicators for the 2008-2017 period reveals a complex economic geography that confirms it to be, as expected, fundamentally characterized by the dual polarization between North and South, akin to the bi-modality found for the global distribution of country incomes. The clustering method allows to further evaluate empirical hypotheses for higher number of clusters, and the analysis shows qualified support for Arnaldo Bagnasco's hypothesis of tri-modality for Italy.

In this direction, most of the empirical growth literature in neoclassical analysis emphasizes the role of group heterogeneity, differential club convergence,

and regional variation in shaping economic growth [Quah, 1996a; López-Bazo et al., 1999; Boldrin and Canova, 2001; Magrini, 2004; Fischer and Stirböck, 2006; Geppert and Stephan, 2008; Franks et al., 2018; Haupt et al., 2018]. However, many of these studies employ the conventional cross-sectional regression analyses of growth with respect to initial income and a variety of determinants as regressors and use the problematic Cobb-Douglas production function [Felipe and McCombie, 2014]. Such methods may suffer from the underspecification of regressors, as well as nonlinearities in the growth equation, which may obfuscate the actual statistical structure of the socio-economic variables and their interactions. This has led many to develop nonparametric models that can be time-varying [Phillips and Sul, 2007, 2009; Haupt and Petring, 2011; Haupt et al., 2018]. In a similar spirit, an unsupervised machine-learning method is employed for cluster identification, Gaussian mixture modeling, that pressuposes the data as a superposition of Gaussian distributions and quantifies the probability of a particular region of belonging to a particular cluster. Rather than imposing a particular number of clusters on the data, the algorithm chooses the optimal number of components or clusters through the Bayesian information criterion (BIC).

I first examine the distribution of regional income per capita as a simple uni-variate case, which reveals, as expected, the markedly bi-modal polarization between North and South, although the potential existence of subclusters paints a much richer picture on its regional structure in conversation with the debates on the 'Third Italy' hypothesis [Bagnasco]. Clustering analysis is further applied on 260 socio-economic regional indicators in demographics, health, poverty, education, tourism, and transportation, which reveals a robust pattern of uneven development in most of them. Further, uni-variate and multi-variate cluster analysis is performed on more specific economic variables: gross fixed capital formation as % of GDP, the wage share of income (employee compensation as % of GDP), the unemployment rate, the rate of gross value added (GVA), household disposable income, and labor productivity (GDP over labor-hours). Income shows a very strong anti-correlation with unemployment and a weaker correlation with labor productivity. Considering that sectoral disaggregation is also available in Eurostat, I evaluate the complex geographical and sectoral structure of the wage share of income (as % of GVA) and labor productivity (as GVA over labor-hours). While the aggregate wage share of income (a proxy of unit labor costs) is one of the few dimensions for which the data is regionally homogeneous, the sectoral decomposition reveals a pattern of geographical differentiation in cost competitiveness between North and South. Further, maximum-likelihood estimation returns with high significance a characteristic tent-shaped Laplace distribution for the regional rates of gross value added, as well as power-law distributions for sectoral wage bill and gross value added.

2 Uneven development and theories of trade

In this section, I briefly review what the different economic theories of trade and growth can say with respect to Italy's Southern Question.

In general, neoclassical theory expects income convergence between trading countries and regions. However, the neoclassical approach is widely based on the problematic Cobb-Douglas production function, which is just a mathematical approximation to the accounting rule that net output is divided into profits and wages [**?**]. The conventional Heckscher-Ohlin model of free trade [1991], which builds on the comparative-advantage theory of Ricardo [1891], precisely assumes away what characterizes trade between core and a periphery: in the model, there are no differences in technology, no mobility of capital and labor, and no unemployment. On the basis of diminishing returns to capital, the Solow growth model predicts all closed economies to eventually reach a balanced-growth steady state that is determined as the ratio of the savings rate to the growth of the labor force, technological progress, and the depreciation rate. Poorer countries should catch up with richer ones in the case all these parameters are constant and homogeneous across countries; in fact, these parameters not only change over time [Barro and Sala-i Martin, 1995] but they are interrelated between countries [Quah, 1993; Pesaran and Smith, 1995]. Following the development of endogenous growth theory, which simply consisted in adding further determinants of income times an elasticity into a logarithmic specification of the Cobb-Douglas function, Barro and Sala-i-Martin also predicted unconditional convergence under constant returns to scale for both countries and regions [Barro and Sala-i Martin, 1995]. Such a linear functional specification became extremely convenient to perform cross-sectional regression panels and estimate the elasticities (that the model itself tautologically imposes on the data), triggering a wealth of literature in empirical growth. However, most of these studies found very low convergence rates [Martin, 1999] and instead emphasized the role of group heterogeneity, differential club convergence, and regional variation in shaping economic growth and found evidence for persistent bi-modal distributions of country income [Quah, 1996a; López-Bazo et al., 1999; Boldrin and Canova, 2001; Magrini, 2004; Fischer and Stirböck, 2006; Geppert and Stephan, 2008; Franks et al., 2018; Haupt et al., 2018]. Variations in regional convergence are thus significant and reflect complex, geographically-differentiated processes [Dunford, 1993; Vickerman and Armstrong, 1995].

In contrast, the New Economic Geography is premised on the argument that the observed patterns of trade and specialization are driven by increasing returns, economies of scale, cumulative causation, and imperfect competition; and that the market, technological and other externalities underpinnning increasing returns arise through a process of regional or local economic agglomeration [Krugman, 1991, 1998; Arthur et al., 1994; Venables, 1996a,b; Ottaviano and Puga, 1998]. Local clustering in economic activity is driven by Marshallian externalities such as technological spillovers and supply-and-demand linkages in intermediates goods [Marshall, 1890; Mongiovi, 1996]. On a broader regional level, pecuniary externalities in the form of market-size effects are also impor-

tant, leading to a large-scale core-periphery pattern of economic development within nations [Krugman, 1991]. Unfortunately, unemployment is once again assumed away. Transport costs and labor mobility are the key determinants to account for spatial agglomeration or dispersion: the more mobile labor is, the more agglomeration will prevail over dispersion. Bertola develops an endogenous growth model to show how capital and labor mobility lead, via localized increasing returns, to the increasing concentration of economic activity and growth in some locations at the expense from others; Bertola thus expects European economic integration to likely lead to greater regional concentration of production [Bertola, 1993]. In a critical review, Martin argues that the New Economic Geography is a mere re-invention, by applying highly abstract mathematical models that fail to encapsulate the empirical realities of economic geography, of the long-standing German tradition of equilibrium location theory, as well as regional science [Martin, 1999].

Krugman's argument shares its emphasis on cumulative causation and path dependency with Kaldor's export-led growth model in the demand-led post-Keynesian tradition, which also features core-periphery divergence on the basis of increasing returns to scale [Kaldor, 1970; Setterfield, 1997]. In Dixon and Thirlwall's formalization of Kaldor's model (as well as Setterfield's), technical progress occurs endogenously through Verdoorn's law, which expresses productivity growth as an increasing function of output growth, e.g. "learning by doing" [Dixon and Thirlwall, 1975, 1978; Setterfield, 1997, 2013]. It can thus can be interpreted as representing increasing returns akin to Adam Smith's notion of the extent of the market and thus constitutes the mechanism at the heart of cumulative causation . As well, exports are considered the key source of autonomous demand. Kaldor already presented a verbal model specifically to address interregional differences in growth, where core-periphery divergence then becomes locked in due to initial differences in regional income. Due to the conceptual similarities to New Economic Geography, Kaldor's model as formalized by Thirlwall has been argued to have anticipated it by twenty years [McGregor and Swales, 1986; Bhattacharjea, 2010].

In a similar direction, evolutionary economic geography extends the work on increasing returns to scale by the new economic geography and post-Keynesian theory to focus on the study of agglomeration economies by formalizing the existence of spillovers in technological innovation on the stock of knowledge [Silverberg and Verspagen, 1995; Maurseth and Verspagen, 2009; Boschma and Martin, 2010; Harris, 2011]. Caniels and Verspagen [2001] model core-periphery dynamics considering that the intensity of spillovers depends on geographical distance between regions. The removal of country borders, thought as barriers to technological diffusion, may exacerbate centrifugal polarization, which leads Caniels and Verspagen to caution against European economic integration.

Thirlwall further extended Kaldor's theory into the balance-of-payments constrained growth model [Thirlwall, 1979; McCombie and Thirlwall, 2016], which espouses the view that international trade can drive long run growth without creating external imbalances [Setterfield, 1997, 2011]. It thus assumes away the chronic trade deficits that peripheries characteristically suffer amidst global

and regional competition, as well as changes in the terms of trade (which are assumed constant), and international financial flows can only influence short-run growth [Setterfield, 1997, 2011, 2013]. By relaxing these assumptions, Thirlwall and Hussain find significant and persistent fluctuations in terms of trade changes and capital inflows, which provides a better picture of the conditions of the periphery [Thirlwall and Hussain, 1982]. While the structuralist literature also emphasizes the role of cumulative causation in interregional divergence [Hirschman, 1958], the Prebisch-Singer hypothesis precisely argues contra the assumption of constant terms of trade, which implies non-price competition prevails in international trade, that the price of primary commodities –produced by the periphery– declines relative to the price of manufactured goods –produced by the core– over the long term, which causes the terms of trade of primary-product-based economies to deteriorate. Empirical evidence gives qualified support to the Prebisch-Singer hypothesis [Harvey et al., 2010]. Dutt [2002] interestingly builds on Thirlwall's law to provide a core-periphery model that addresses explicitly changing terms of trade and the distinction between short-run and long-run dynamics, where a core with excess capacity follows demand-led Kaleckian growth while the periphery is based on a Marx-Lewis model with fixed real wage and unemployed labor. Dávila-Fernández and Sordi incorporate Goodwin's distributive cycle model to a balance-of-payments-constrained open economy in the direction of Pugno [1996; 1998] by allowing technical change to be endogenous to the cyclical dynamics of the system, which generates a Hopf bifurcation [Dávila-Fernández and Sordi, 2019]. Spinola [2020] addresses the transition dynamics incompatibility between the balance-of-payments constrained model and the Prebisch-Singer hypothesis. Spinola finds damped cycles towards convergence by extending Dutt's model by adding endogenous productivity gap dynamics, including a Phillips wage curve, and modelling Goodwin labor supply dynamics that considers the labor transfer issue between traditional and modern sectors.

In the context of Thirlwall's law, Setterfield argues that permanent net inflows of capital (in domestic currency) that cover persistent imbalances have actually no effect in the long run [Setterfield, 1997]. Moreno-Brid reaches the same result by assuming the growth of financial inflows is equal to the growth in output [Moreno-Brid, 1998]. The classical theory of trade [Shaikh, 1980, 2016] critically disputes this argument. In the classical theory of trade, trade imbalances follow absolute, not comparative, cost differentials due to differences in increasing-to-returns technology between countries. Economies of scale also play a fundamental role in classical competition, since they are major means of lowering costs and hence gaining competitive advantage – in addition to wage repression. The feedback effect from prices to costs as identified by Sraffa implies that comparative costs many not change at all in response to changes in the exchange rates and hence do not follow Ricardo's comparative-cost story of self-stabilizing trade imbalances [Shaikh, 2016].

As observed in reality, trade imbalances are not self-stabilizing by automatic real exchange rate adjustments on the basis of the quantity theory of money; instead, they are remarkably chronic and persistent. Persistent trade imbal-

ances will create imbalances of payments in the capital account that will affect interest rates and induce short-term international capital flows from the core to the periphery until the interest-rate differentials are balanced. Economic integration will consolidate: countries with absolute cost advantage will recycle their trade surpluses by lending to the periphery, which will use foreign borrowing to cover their trade deficits and thus chronically burying it in debt due to interest payments. Between regions within the same country, the state will have to cover the trade imbalance via fiscal transfers – which is what happened in Italy with the advent of Fascism in the 1920s and in the postwar period of 1951-71 [Graziani, 1978; DiGiorgi et al., 1980]. A core-periphery pattern in interregional and international development will thus inevitably emerge under classical competition.

Under a regime of fixed exchange rates and in the absence of stabilizing automatic fiscal transfers, fiscal consolidation in the advent of the sovereign debt crisis will repress real wages and thus transfers income from low-saving workers to high-saving rent-seeking landowners, who had already been benefiting from the inflows of capital from core to periphery. In fact, political and economic integration of the core and the periphery under the state always follows a social pact between the capitalists in the core and the landlords in the periphery, where the former sells their excess produce to the latter – one can think of the Italy, Spain, US, or the European Union as a whole. Landlords as owners of nontradable goods constitute an essential actor to understand core-periphery dynamics of political and economic integration that models of trade tend to omit [Shaikh, 2016].

The effects of competitive wage deflation –wage-seeking labor flows from core to periphery, heightened social tensions, and polarizing income inequality– are thus confronted by pro-austerity policy-making elites with increased domestic and border policing and militarization [Jayadev and Bowles, 2006]. This induces a protracted decline in the liberal-democratic features of the capitalist system [Lührmann et al., 2018] and destabilizing societal responses in the form of anti-establishment populisms vying for inflationary fiscal spending once again, focused on either revolution (socialism) or reaction (fascism) – a political business cycle of the kind described by Polanyi and Kalecki in their seminal works [Kalecki, 1943; Polanyi, 1944]. For Polanyi, it was the systematic devaluation of the wage, which resulted from the workings of the Gold Standard and laissez-faire trade, that regularly imposed a level of social dislocation that eventually led to the rise of political extremes on both sides of the political spectrum (e.g. fascism and communism). Hence, the core-periphery dynamic in its classical form eventually results in the interplay of growing authoritarianism and destabilizing political polarization, that is, "populist backlash" against economic integration – a "integration-breeds-disintegration" hypothesis in line with Rodrik [2020]. In particular, Arrighi arguably considered the peripheral status of Italy to be the main reason why it developed Fascism in the 1920s [Arrighi, 1985].

3 Italy's Southern Question

The origins and the historical evolution of the gap in economic performance and living standards between Italy's North and South remains an unsettled and controversial issue in Italian economics and politics since political unification in 1871 [Graziani, 1978; DiGiorgi et al., 1980; Fenoaltea, 2003; Felice, 2012; Felice and Vecchi, 2015; de Oliveira and Guerriero, 2018; Federico et al., 2019] Since the early 2000s, economic historians have started to rely on data, but this 'quantitative turn' has not yet settled the issue. Trends in regional GDP per capita are fairly well established for the 20th century: in 160 of years of internal political and monetary union under free trade, regional incomes of North and South have constantly *diverged* starting from similar levels, except for the period of the *miracolo economico* between 1951 and 1971, during which much state investment was spent in the South [Felice, 2012; Federico et al., 2019]. In particular, the gap widened with the industrialization of the North in the three decades before World War 1 and peaked just after World War 2, reduced during the 1951-1971 period of the *miracolo economico*, and widened again after 1971 [Felice, 2012; Federico et al., 2019]. Hence, it appears that it was during the forty years after unification (1871-1911) that the South effectively de-industrialized while the North developed its manufacturing power [Ciccarelli and Fenoaltea, 2013]. Missiaia suggests home market access as the prime driver of the North-South divergence in Italy, while Ciccarelli mentions initial productivity differentials – which would lend credence to an explanation based on increasing returns to scale and cumulative causation. However, Federico et al. [2019] contend that real wages already diverged before unification, so the gap must be located in the marked difference in literacy rates between North and South in shaping long-run economic growth.

For DiGiorgi [1980], the continuing underdevelopment of Southern Italy is the a result of deliberate state policy, rather than as a failed attempt at development. Before 1945, the State supported the Southern landowning oligarchies. Since then, it has supplanted their power with that of a new state bourgeoisie – privileged revenue recipients supported by public expenditure. This was done to respond to social tensions and to strengthen the Christian Democratic regime, as well as to create markets for Northern industry's durable goods. In this direction, Graziani [1978] argues that economic developments in the Mezzogiorno can only be properly understood if they are considered in relation to the structural transformation of Italy as a whole. Graziani counters a common view that stresses that the implementation of development policy is distorted by 'vested interests' that prevent such measures from being successfully applied. Such 'vested interests' are treated somehow as exogenous to the political economy of core-periphery relations, but they are no-one else than the Southern landlord oligarchies that benefited the most from political and economic integration with the North and hence should be treated as endogenous. In this direction, Graziani [1978] finds a high correlation between Southern net imports and current transfers of external aid to the Mezzogiorno (including government contributions, subsidies, pensions and the remittances of emigrant workers), as

well as a moderately good correlation for north-west Italy which, being the main source of finance for the Mezzogiorno.

In the literature on world systems, Immanuel Wallerstein [1974] identified "the southern tiers of Italy" as semi-peripheral economy, locked in between the core of advanced capitalist nations and the periphery in structural dependency, or Global South in more modern terms. For Giovanni Arrighi, Wallerstein's definition of the semi-periphery was ambiguous, suggesting to consider it in terms of the international division of labor, following Prebisch's core-periphery analysis for Argentina [Arrighi and Drangel, 1986]. Like Prebisch, Arrighi considered the semi-periphery to have a geographical character, to be a place, and identified it with southern Europe, with Calabria as a case study [Arrighi, 1985]. Following Arrighi, Massimo Paci denounced the particularly pronounced dualism afflicting the Italian economy in his compelling unified theory of Italian capitalism as an *economia periferica* in which Italy's petty capitalist small firm economy not only served for Italian monopoly capitalist out-sourcing, but also undermined worker unrest by dividing the working class and its unions between core and periphery workers, and absorbed cheaply surplus laboring populations such as women, former rural migrants to the big cities, as well as young and old people expelled from mature industrial sector in times of economic crisis [Paci, 1973]. Based on the strength and the geographical distribution of small-firm economies, Arnaldo Bagnasco countered with the hypothesis that central and northeastern Italy constituted a social formation just as specific as that of the north and south: there were indeed not two but three clusters of related regions, each cluster with an empirically discernible way of life and standard of living distinct from the other two. This "Third Italy" consisted of the regions of Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia Romagna, Toscana, Umbria, and Marche [Bagnasco, 1977]. In his formulation of the "Third Italy" hypothesis, Bagnasco searched for geographical clusters while analyzing a variety of empirical measures, such as criminality, divorce rates, homeownership, ratio of home space to persons, days lost due to labor-management conflicts, election results, non-food consumption, hospital beds per population, and family size.

4 A Gaussian Mixing Model of the Social Division of Labor

This paper aims for a methodological contribution in the form of an econometric application of machine-learning methods of cluster analysis in order to properly characterize the agglomerative nature of economic activity in the form of a geographical division of labor. Datasets are viewed as statistically interdependent distributions aggregated over time, instead of time series that require a convenient Cobb-Douglas functional specification that may suffer from underspecification and nonlinearity [Phillips and Sul, Haupt and Semmler]. Most economic indicators used for policy are generally provided in terms of statistical averages for whole countries in spite of potential regional dispersion, e.g. "the

Table 1: **List of Indicators**

id	description
Demographics (10)	
population	Population
pop.change	Population change
births	Live births
deaths	Deaths
fertility	Total fertility rate
expectancy	Life expectancy at birth
Economic (18)	
gdp	Regional gross domestic product (million EUR)
gdp.pps	Regional gross domestic product (million PPS)
gdp.pps.hab	Regional gross domestic product (PPS per inhabitant)
gva	Real growth rate of regional gross value added (GVA)
income	Disposable income of private households
primary.income	Primary income of private households
EU.income	Regional gross domestic product relative to EU average
employment.1564	Employment rate of the age group 15-64
employment.5564	Employment rate of the age group 55-64
employment.2064	Employment rate of the age group 20-64
Industry (By Sector, 196)	
unemployment	Unemployment rate
gva.nama	Gross value added at basic prices
gfcf	Gross fixed capital formation
comp	Compensation of employees
emp.pop	Employment (thousand persons)
emp.h	Employment (thousand hours worked)
household.income	Income of households
profit.share	Profit Share
labor.share	Labor Share
productivity.pop	Productivity (GVA per worker)
productivity.h	Productivity (GVA per hour)
KL	Capital-to-Labor Ratio (gfcf to comp)
Health (8)	
ulc	Unit labor cost
death.causes	All causes of death
cancer	Death due to cancer
ischaemic	Death due to ischaemic heart diseases
accidents	Death due to accidents
transport.accidents	Death due to transport accidents
doctors	Physicians or doctors
dentists	Dentists
hospital.beds	Available beds in hospitals

Table 2: **List of Indicators (Continued)**

id	description
Education (9)	
tertiary	Tertiary educational attainment
HR	Human resources in science and technology (HRST)
hightech	Employment in high-tech sectors
patent	Patent applications to the European patent office (EPO)
hightech.patent	High-tech patent applications to the European patent office (EPO)
RD	Intramural R&D expenditure (GERD)
researchers	Researchers, all sectors
Poverty (5)	
longterm	Long-term unemployment rate (12 months and more)
atriskofpoverty.rate	At-risk-of-poverty rate
severedeprivation	Severe material deprivation rate
atriskofpoverty.pop	People at risk of poverty or social exclusion
lowworkintensity	People living in households with very low work intensity
Tourism (5)	
tourist.nights	Nights spent at tourist accommodation establishments
tourist.establishments	Number of establishments and bed-places
Transport (6)	
mar.passenger	Maritime transport of passengers
mar.freight	Maritime transport of freight
air.passenger	Air transport of passengers
air.freight	Air transport of freight
rail	Rail network
motorway	Motorways network

Table 3: **Table of Indicators with 1 as Optimal Cluster Number**

id	theme	description
accidents	health	Death due to accidents
fertility	demographics	Total fertility rate
hospital.beds	health	Available beds in hospitals
ischaemic	health	Death due to ischaemic heart diseases
transport.accidents	health	Death due to transport accidents
pop.change.natgrowrt	demographics	Population change, Natural
expectancy.M	demographics	Life expectancy at birth, Male
expectancy.T	demographics	Life expectancy at birth, Total
tertiary.F	education	Tertiary educational attainment, Female
tertiary.T	education	Tertiary educational attainment, Total

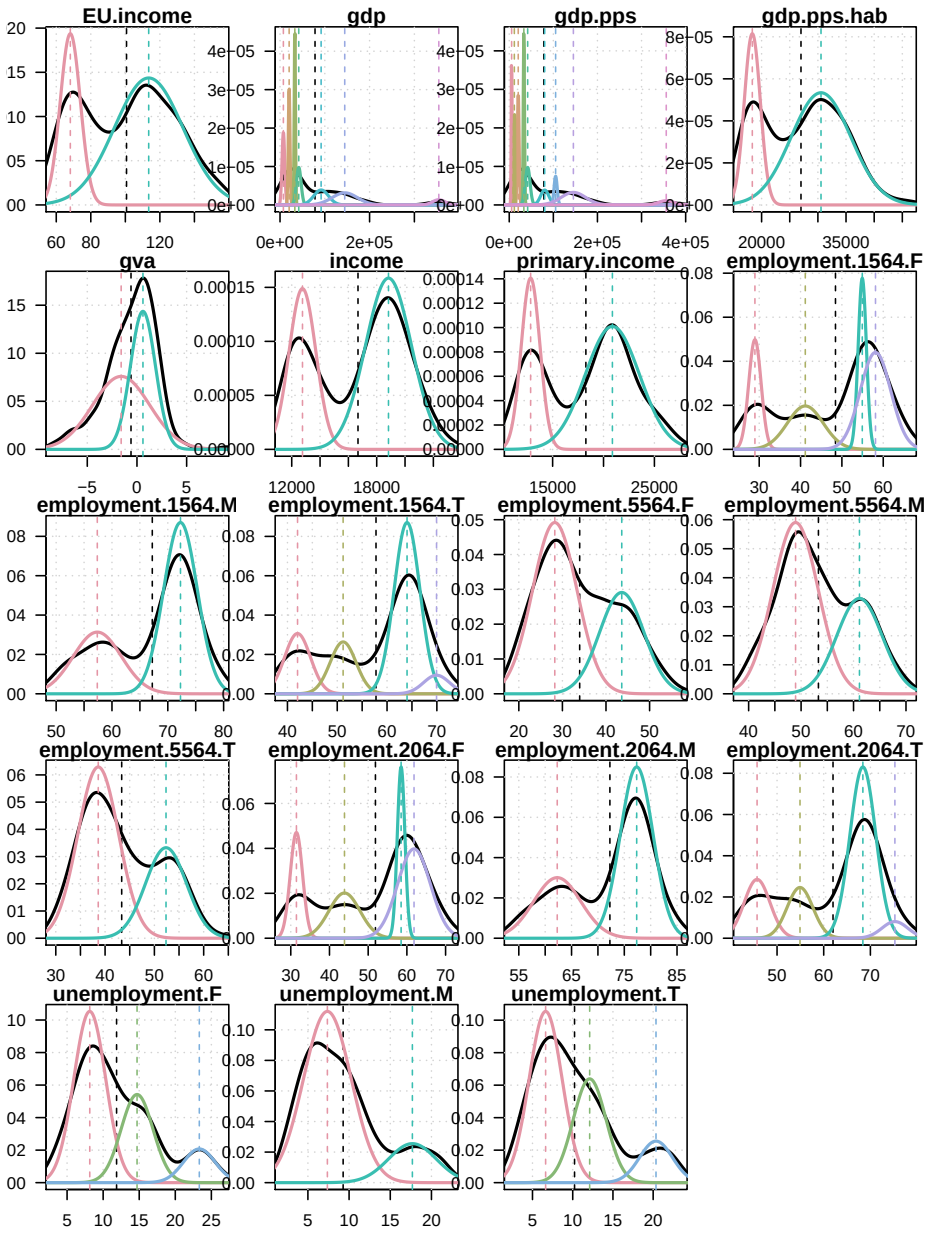

Figure 1: **Model-Based Clustering for Economic Indicators** Line in black depicts the distribution of regional values, colored lines depict the distributions of the distinct cluster components as found by the algorithm. Vertical lines indicate their corresponding averages.

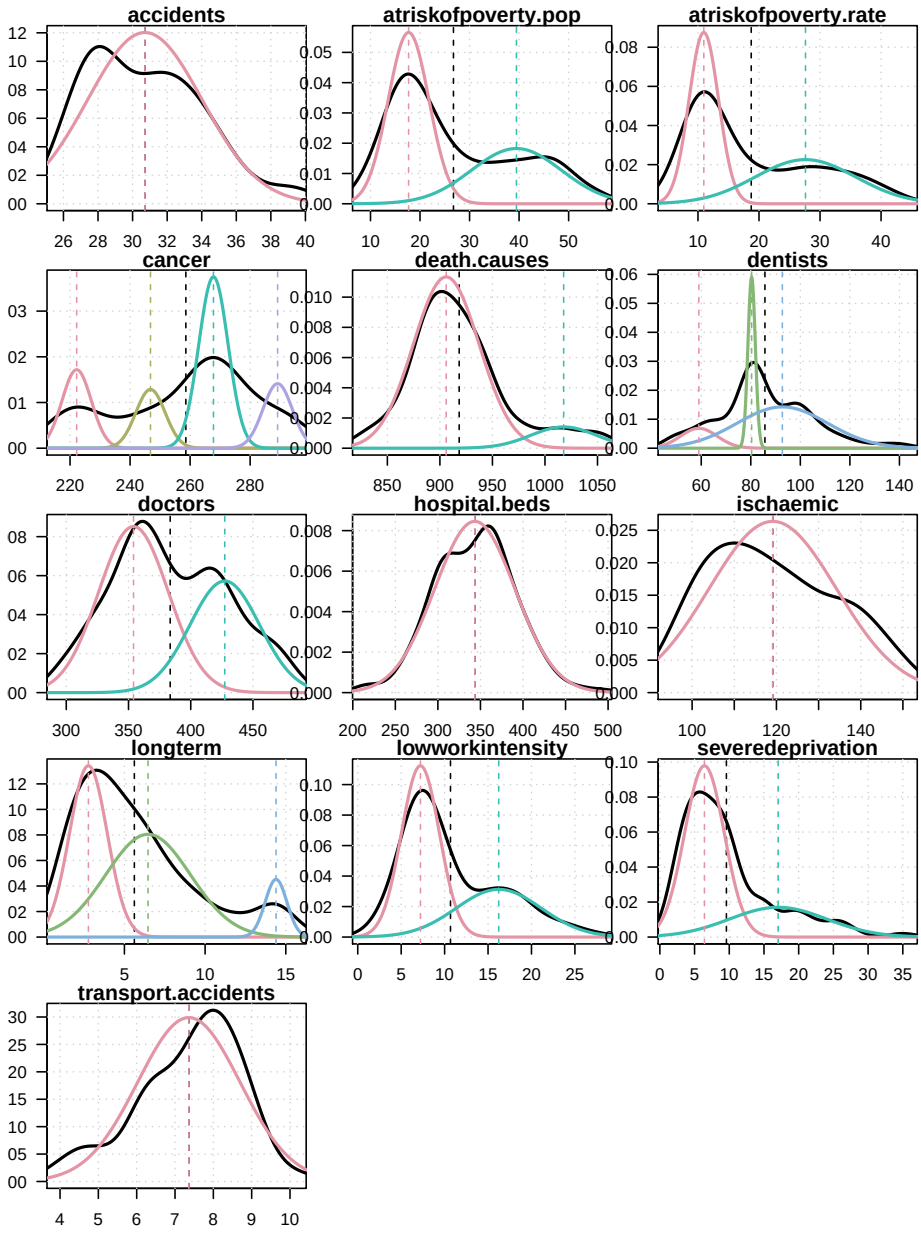

Figure 2: **Model-Based Clustering for Health and Indicators**

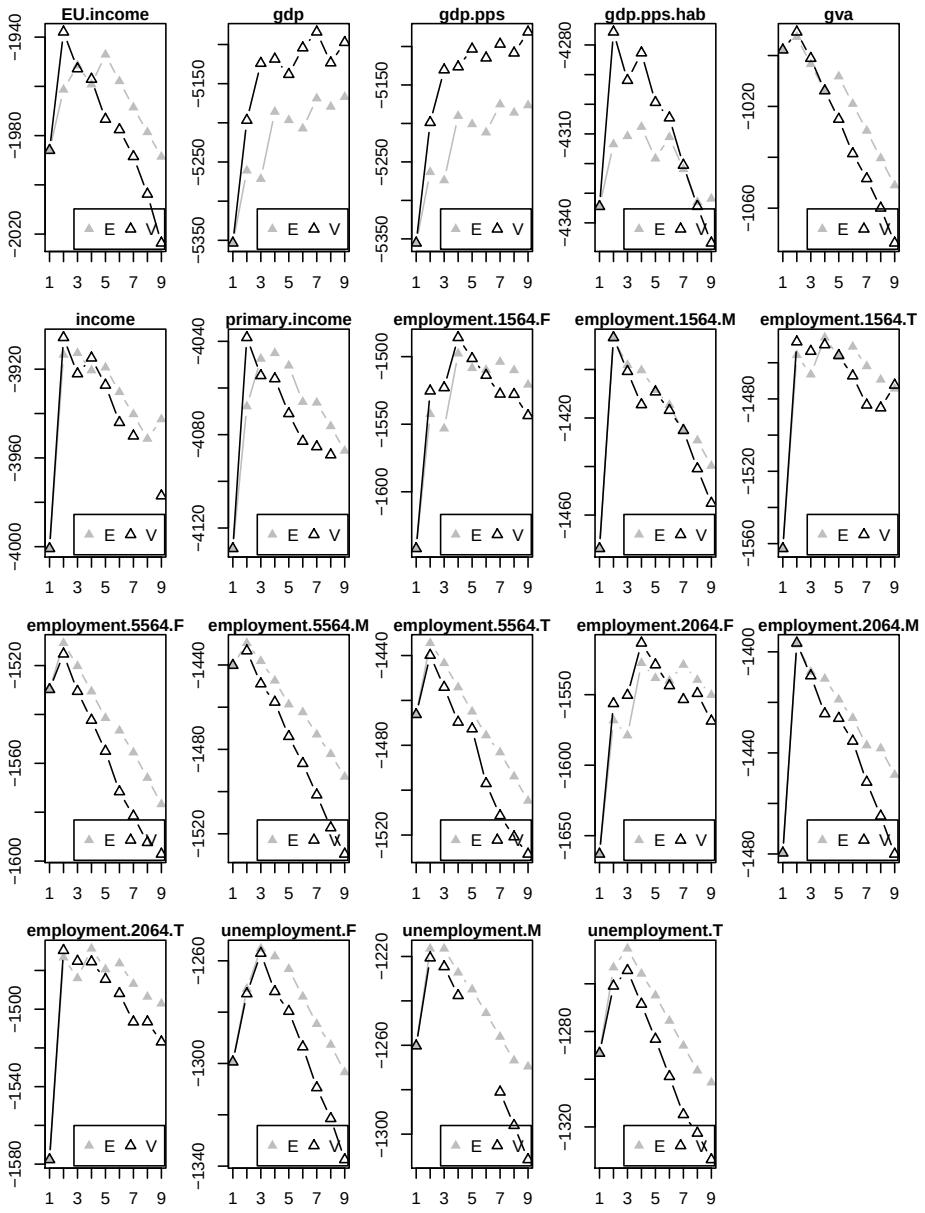

Figure 3: **BIC Score For Different Cluster Numbers, Economic Indicators** For most indicators, there is a stable peak between 2-4 components, which suggests a more complex distribution than strictly bi-modal.

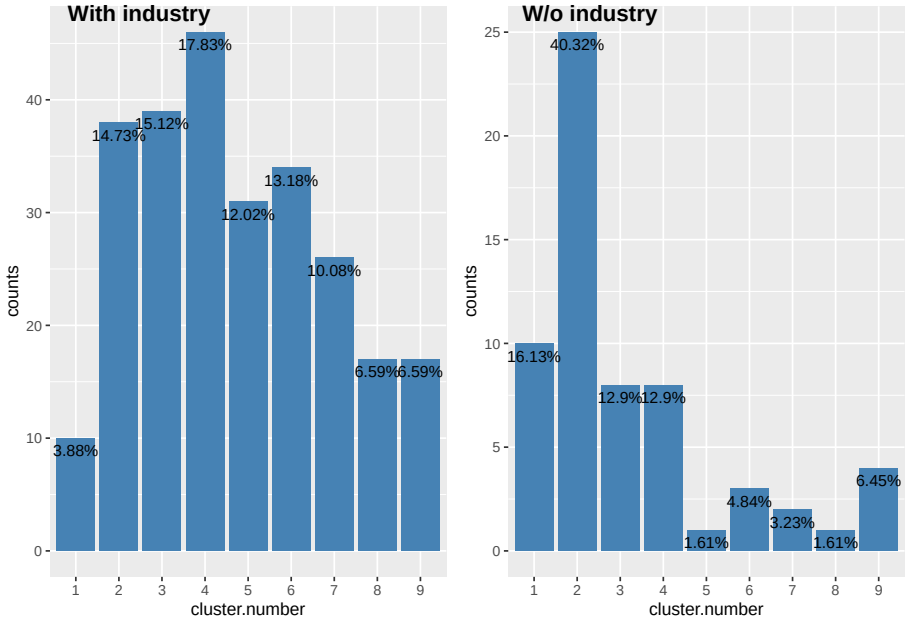

Figure 4: **Geographical Variation: Optimal Number of Clusters**

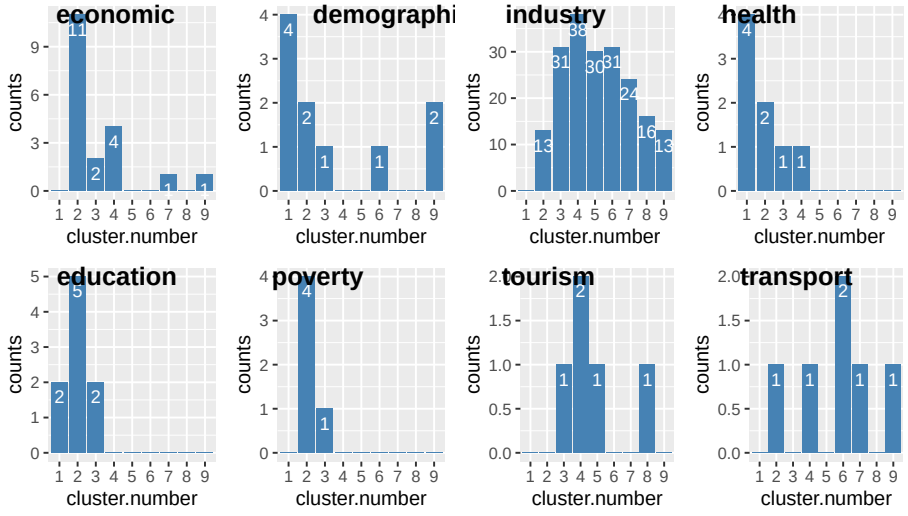

Figure 5: **Optimal Number of Clusters**

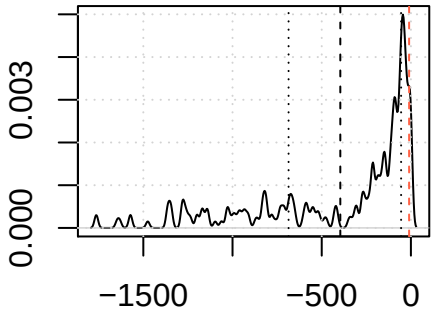

Figure 6: **Distribution of BIC Score Differences between Optimal and 1 Number of Clusters**

Table 4: **BIC Score Differences between Optimal and 1 Number of Clusters** The strength of the evidence against the model with the higher BIC value can be summarized as follows: 0-2, not significant; 2-6, positive; 6-10, strong; >10, very strong. [Schwarz, 1978]

	FALSE	**TRUE**
> -2	248	10
> -6	245	13
> -10	242	16

US unemployment rate is at 5%" or "Italian inflation is below 2%", aggregate measures that may gloss over important social and geographical variation. If geographical variation was not relevant, the statistical average of any indicator would be sufficiently informative to characterize the whole of the regional distribution. In this situation, the statistical distribution $p(x)$ over geographical space and time of the values of any indicator, namely x, could be roughly approximated to a single Gaussian distribution of mean μ and variance σ^2:

$$p(x|\mu,\sigma) = \frac{1}{\sqrt{4\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{4\sigma^2}} \tag{1}$$

where the variance is related to how the indicator varies over time, that is, it will be sharply peaked if the indicator is stable or flat and smooth when it evolves greatly over time. However, for many indicators a single Gaussian distribution with a corresponding single average for a whole country may give an imprecise description of its actual regional dispersion. In this situation, the regional values of a national distribution may be clustered, or agglomerated, or concentrated, around K particular groups, subsets, or clusters, with corresponding averages μ_k and σ_k that may be very different from the μ and σ from equation (1):

$$p(x|\mu_1,...\mu_K;\sigma_1,...,\sigma_K) = \sum_{k=1}^{K} \frac{\theta_k}{\sqrt{4\pi\sigma_k^2}} e^{-\frac{(x-\mu_k)^2}{4\sigma_k^2}} \tag{2}$$

where θ_1,...,θ_K are the weights of each kth Gaussian component, for which $\sum_k \theta_k = 1$ holds (normalization). The algorithm considers both the possibility of equal (E) and unequal variances (V) for each component.

Finding the optimal number of clusters K in a systematic and quantifiable way, following the Bayesian Information Criterion (BIC, or Schwarz Information Criterion) is the purpose of Gaussian mixture modeling (GMM). The Bayesian Information Criterion is a criterion for model selection among a finite set of models that introduces a penalty term for the number of parameters in the model in order to avoid overfitting:

$$\mathrm{BIC} = k \ln n - 2 \ln L \tag{3}$$

where L is the likelihood of the model, n is the number of observations, and k is the number of parameters [Schwarz, 1978]. Hence, equal-variance models enjoy of an advantage in the BIC score over unequal-variance models, since they use considerably less parameters, although they sacrifice explanatory power in the process.

This econometric technique is a model-based approach to clustering identification in the domain of unsupervised machine learning, whereby each observation is assumed to have arisen from an underlying mixture of a finite number of Gaussian distributions. The number of components in the mixture model (2) corresponds to the number of clusters to be imposed on the data [McLachlan and Peel, 2004]. Hence, this econometric technique may be very useful to identify existing geographical dispersion of indicators and properly inform policy

to correct existing geographical imbalances within the social division of labor. Further, Gaussian mixture modeling helps characterize systematically the geographical core-periphery divisions within a national or international division of labor in the context of the literature on uneven development and world-systems theory [Wallerstein, 1974; Arrighi and Drangel, 1986]. GMM also provides an alternative method to identify the existing convergence clubs found by the literature in economic convergence in a way that is fundamentally multi-dimensional. Finally, it also provides a systematic method of evaluation of Arnaldo Bagnasco's hypothesis of a 'Third Italy' in the Italian context.

McLachlan and Basford [1988] highlighted the usefulness of mixture models as a way of providing an effective clustering of various data sets under a variety of experimental designs, which explains its wide applicability across the scientific disciplines[1] [McLachlan and Basford, 1988; McLachlan and Peel, 2004]. It was in the 1990s that the extent and the potential of the application of finite mixture models widened considerably — fields in which mixture models have been successfully applied include astronomy, biology, genetics, medicine, psychiatry, economics, engineering, finance, and marketing, among many other fields in the biological, physical, and social sciences [McLachlan and Peel, 2004]. More recently, mixtures of normal distributions have been increasingly applied in macro- and micro-economics (i.e. regime-switching models of economic time series, or analysis of dynamics of educational attainment), marketing science (structured representation of market information and forecasting of new product sales), and empirical finance (modeling stock returns, stochastic volatility models) [Khorunzhina and Richard, 2016]. Just before the advent of the euro, cluster analysis was applied to the European Monetary Union in the domain of optimum currency area theory to find a robust core-periphery structure in business cycle synchronization and real interest rate volatility [Artis and Zhang, 1997, 2002]. Hierarchical clustering has also been applied on the European Union to analyze industry structures, although only from a uni-dimensional, state-level perspective [Gräbner et al., 2020].

5 Statistical Analysis of the Italian Economic Geography

In particular, Gaussian mixture modeling allows to evaluate quantitatively Bagnasco's hypothesis on the existence of a Third Italy beyond the stark dual polarization between an Italian North and South that is conventionally assumed. GMM is applied on a dataset of 257 Italian indicators extracted from the Eurostat database that are disaggregated regionally by NUTS2 regions within the time window of 10 years between 2008 and 2017, which amounts to 51,670 observations [tables 1 and 2]. Some of these indicators are also disaggregated by

[1] In labor economics, mixtures have been used to control for person-specific differences in models of dynamic discrete choice. Nonparametric maximum likelihood estimation has been used to study the effect of family background on educational achievement.

gender, while the indicators that belong to the theme 'industry' are disaggregated by industrial sectors following the standard ISIC classification.

When Gaussian mixture modeling is applied to each indicator separately, the BIC score reports 1 as optimal number of clusters for only 3.89% of them [table 3]. Excluding the 196 industry indicators, only 16.39% of the remaining 61 are best described by a single Gaussian distribution [figures 4 and 5]. This result implies that presenting statistics in the form of national averages, at least in the case of Italy, fails to properly represent the whole regional distribution due to geographical dispersion. Figure 1 shows the different real distributions of the indicators belonging to the 'economic' theme and the estimated optimal superposition of Gaussian distributions, including their corresponding averages: national averages, depicted with horizontal black lines, systematically diverge from the cluster averages, depicted with colored lines. Excluding industry, the majority (39.34%) of the indicators are best described by a two-component Gaussian model, which supports the conventional classification of Italian regions between North and South. Since Italian unification dates from 1871, one would have expected to find convergence on the basis of conventional economic theory. Instead, these results show that economic divergence, not convergence, systematically characterizes the Italian division of labor, more in agreement with economic theories that emphasize growth clustering and uneven development. However, the three-cluster hypothesis often scores the second highest for most indicators in terms of the BIC score, much higher than the one-cluster hypothesis – hence suggesting that there is still empirical evidence for the existence of a "Third Italy". For most indicators, there is a peak in BIC scores between 2 and 4 number of components, suggesting a more complex geographical structure than strictly bi-modal [figure 6]. The bi-modal/tri-modal dichotomy is evaluated for a particular indicator, GDP per capita relative to EU average (i.e. "EU.income"), in the next section.

5.1 GDP per capita relative to the EU average

Let's examine one single indicator, GDP per capita relative to the EU average, in order to clarify what the econometric method of Gaussian mixture modeling does and what economic significance can be extracted from its results – especially by assessing whether its distribution is better approximated as bi-modal or tri-modal. Figure 7 shows both the indicator as a time series (left) and as a distribution (right). As a time series, it is not that clear that the different regional distributions are in fact clustered in two groups, which correspond to the classic dual polarization of Italy between North and South. When visualized as a distribution, its double-peaked character clearly stands out. Gaussian mixture modeling sheds further light on the rich underlying geographic structure of Italian income [figure 9]. Figure **??** shows the BIC scores for models of different number of components (from 1 to 9) with equal (E) and unequal (V) variance.

Using the Eurostat data from 2004 to 2015, when sorting the GDP per capita data for the regions into two clusters, the Third Italy is robustly identified as North. When dividing Italy into three economic clusters on the basis of

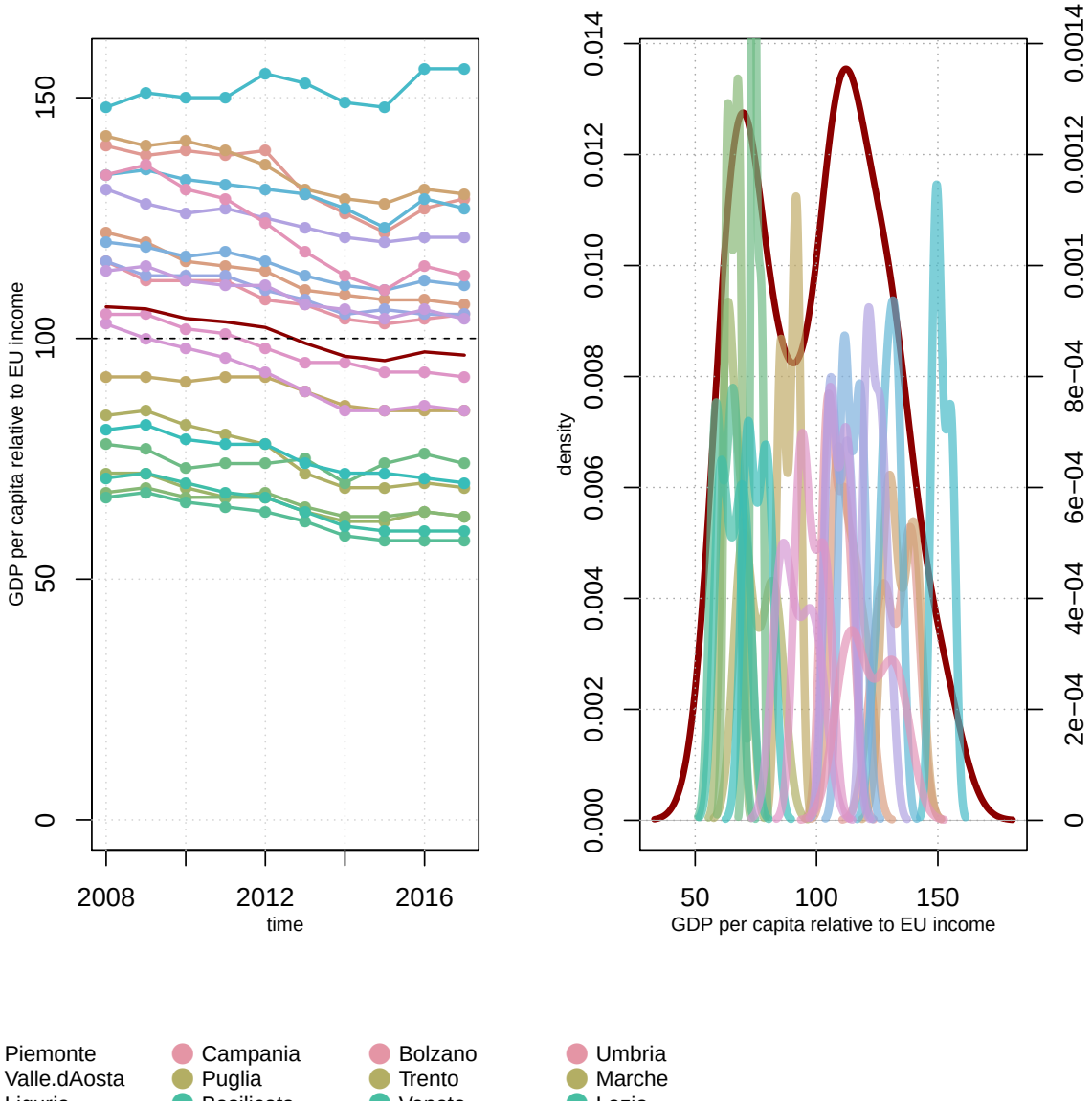

Figure 7: **Time Series of Italian Regional Data (EU Average = 100; left) and its corresponding frequency distributions (right)** For the right panel, the left axis indicates the density of the aggregate distribution, while the right axis shows the density of the different regional distributions.

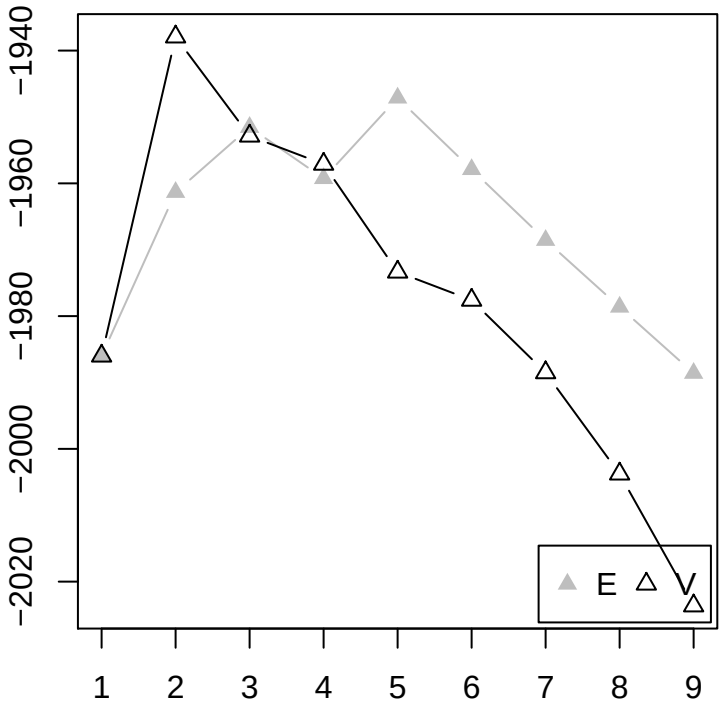

Figure 8: **BIC Scores for Gaussian Models of Different Number of Components with Equal (E) and Unequal (V) variance** The optimal number of clusters is 2, with unequal variance.

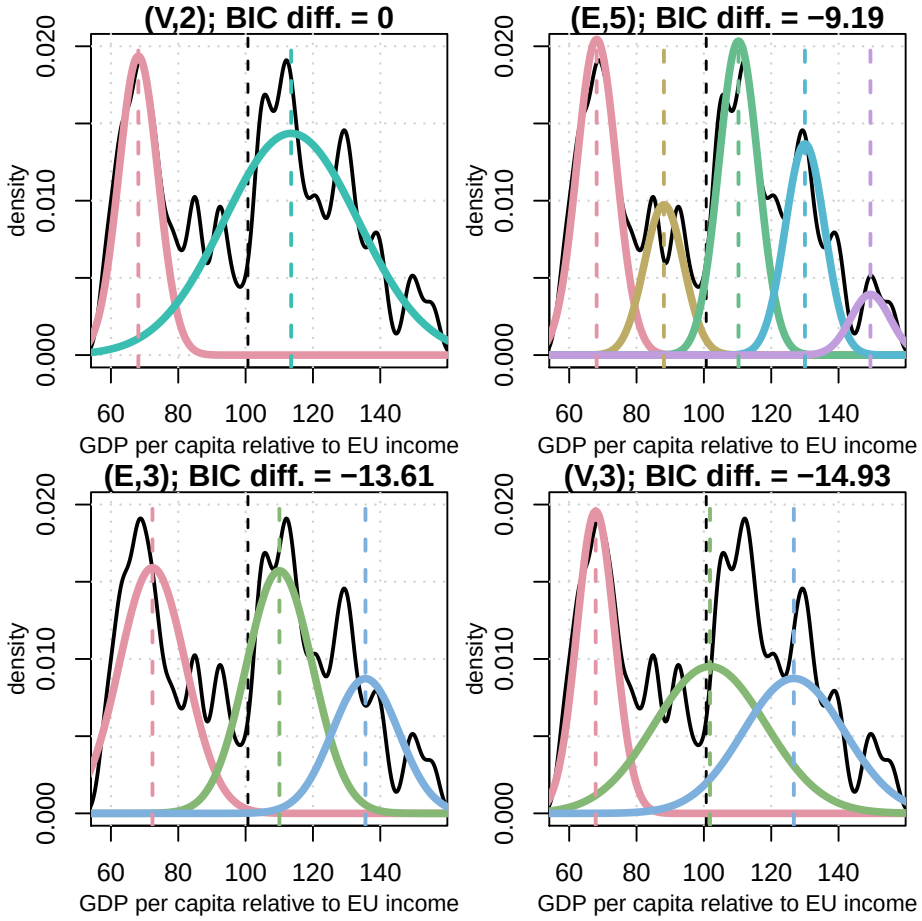

Figure 9: **Different Gaussian mixture models for GDP per capita relative to the EU average, with their corresponding BIC scores** The optimal number of clusters is 2, with unequal variance. The vertical dashed lines indicate the corresponding component averages, which systematically diverge from the total average.

GDP per capita for the period ending 2015, one gets a very different picture from that proposed by Bagnasco forty years ago, underlying its political and economic evolution in relation to the European division of labor: Piemonte and Liguria fall out of the northern cluster and into the Third Italy, while Lazio, Trentino-Alto Adige, and Emilia-Romagna (to a lesser degree) take up residence in the northern cluster. The three-cluster classification allows a more nuanced understanding of the peripheralization of Italy, bearing in mind it is a complex process operating on many multiple dimensions affecting each region differently, yet following identifiable structural patterns. The Abruzzo, beginning in 2010, joins the Third Italy, less for its great strides than for its relatively stable GDP per capita during the general decline.

Piemonte, home of Fiat Automobiles, and Liguria, once part of the historical industrial triangle, now find themselves clustered with the "Third Italy," while Trentino-Alto Adige and Emilia-Romagna, once the crown jewel of the Third Italy, now find themselves in good company with the wealthier northern cluster. This suggests the robustness of the economic fabric of Emilia-Romagna vis-a-vis other regions over a general dynamic of peripheralization. In agreement with Arrighi and Piselli, no specific economic organization has a privileged claim to economic success, but some economies are better at resisting secular demotion in the current macroeconomic environment. The key, as they stress, is the articulation of local economies with the demands and devices of a capitalist world-economy by definition more powerful than any particular local economy. Like Bagnasco, I find that Lazio is an anomaly for clustering purposes: though its GDP per capita would put it in the wealthier northern cluster, it might be revealing to examine internal differences in the capital regions economy. Finally, the Mezzogiorno remains a solid and the poorest bloc, suffering neither regional desertions nor additions, save the borderline status of the Abruzzo.

The instability in both the northern and Third-Italy regional clusters may indicate that the three Italies schema upon which center-left economic development programs, have dined on for over 35 years may no longer obtain. Such programs, which went against the political constituency of a center-left in decline, had to be curbed under the Maastricht discipline of primary budget surpluses and inflation targeting that has drained the Italian economy of much-needed investment while contracting its consumption, a primary driver of Italian growth, typical of the European economies of the southern periphery. Instead, it seems the Italian core and periphery are being reshaped by a secular national economic decline within an evolving, interconnected European division of labor that is moving to the East through integrating its low-wage inputs into German industry. The former center-northeastern cluster, once an industrial competitor to Germany, is being pulled apart and pieces re-attached to either the classic Italian core or its own semi-periphery, while leaving its regional imbalances intact. Such economic dynamic happens to underlie the very political constituency of the former Italian government, a regional alliance between a North in demotion (the Lega Nord) and a South in stagnation (the 5-Star Movement), which is opposed to the contractionary economic plans of the European Commission.

Following the typical Polanyian double movement also under way in so many

nations around the world, a far-right, populist government constitutes the political reaction of society to the social erosion mandated by the free-market forces of a neoliberal order in collapse. Even more than a Le Pen presidency in France, a Eurosceptic Lega Nord-Cinque Stelle majority in the Italian Parliament is one of the most probable pathways to the breakup of the euro in its current form, which may precipitate the greatest default in history. Maastricht discipline has imposed undue pain on Italy, which at moment and like many other European nations, requires better institutions at channeling and expanding investment to promote growth and employment appropriately over its regions.

5.2 Cluster Analysis of Key Indicators on the Italian Economic Geography

In this section, I explore the geographical and sectoral structure of the Italian economy by deploying the Gaussian mixture modeling approach. In particular, I study the regional structure of gross fixed capital formation as % of GDP, the wage share of income (employee compensation as % of GDP), the unemployment rate, the rate of gross value added (GVA), household disposable income, and labor productivity (GDP over labor-hours). Since employee compensation, gross value added, and employee hours are variables for which sectoral disaggregation is available in Eurostat, I evaluate the geographical and sectoral structure of the wage share of income (as % of GVA) and labor productivity (as GVA over labor-hours). In order to complete the picture of the Italian economic geography, capital intensity and the capital-to-labor ratio could be computed if regional estimates of capital stocks were available in the Eurostat database. Derbyshire, Gardiner, and Waights propose a simple procedure to compute such estimates using the perpetual-inventory method, which is improved by the corrections of Anwar Shaikh.

The results are very interesting to the extent that they give robust, rigorous evidence of the already-known stark regional polarization of the Italian economy. At a geographical level, only the wage share of income can be approximated to a single Gaussian distribution (e.g. there is a single cluster of data), while unemployment, the rate of GVA, labor productivity, and household income can be approximated by two well-defined clusters in the form of Gaussian distributions. Further, gross fixed capital formation as % of GDP and the unemployment rate feature three clusters, which suggest that the hypothesis of a Third Italy may still be relevant after all.

The rate of gross value added follows a Laplace or double-exponential distribution,

$$p(x|\mu, b) = \frac{1}{2b} \exp - \frac{|x - \mu|}{b} \tag{4}$$

where μ is the location parameter and b is the scale parameter. The maximum likelihood estimator of location is the median (which is also the mean), while the maximum likelihood estimator of the scale is the mean absolute deviation

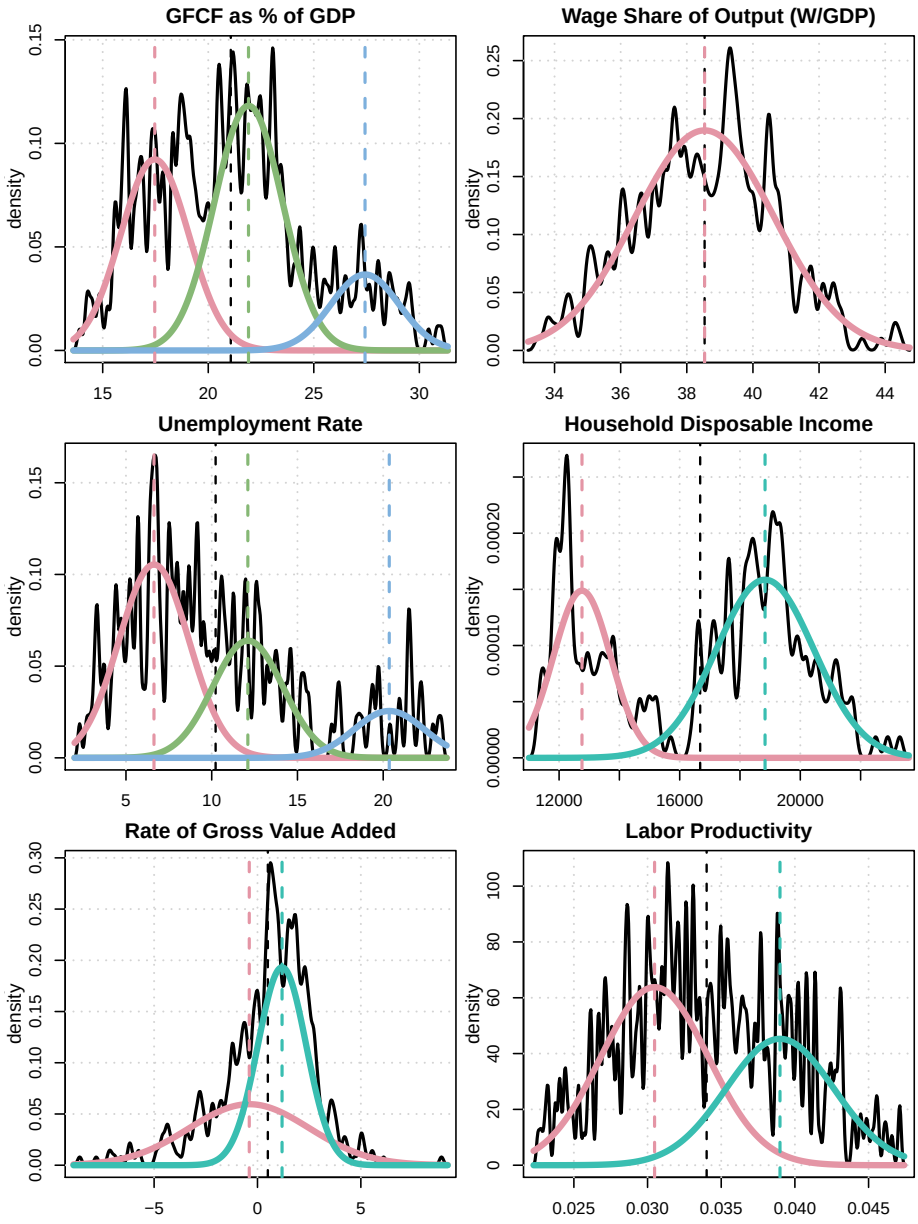

Figure 10: **Model-Based Clustering for Economic Indicators**

Table 5: **Key Indicators on the Italian Economic Geography**

id	**description**
gva	Rate of Gross Value Added
gfcf	Gross fixed capital formation
labor	Labor Share (Compensation / GVA)
unemp	Unemployment Rate
income	Disposable Household Income
pr	Productivity (GVA / Employment Hours)

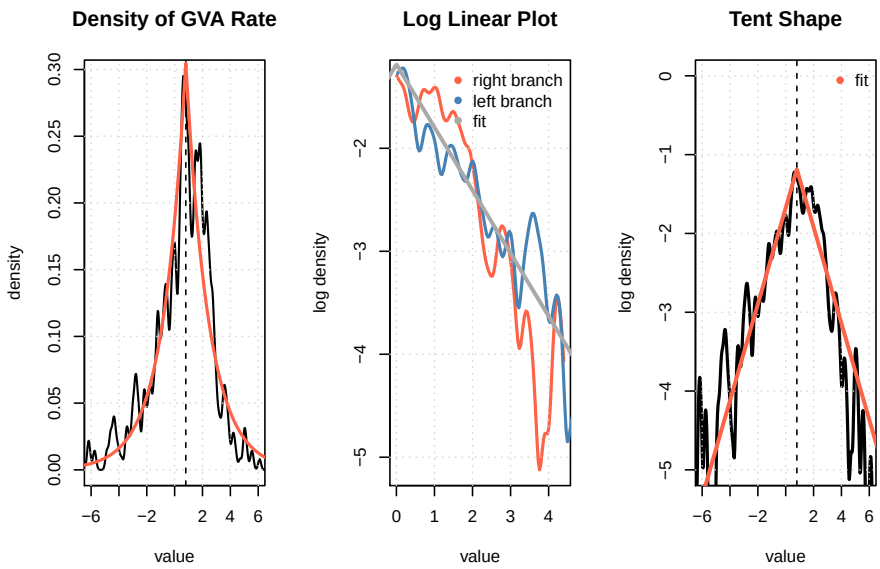

Figure 11: **Laplace Distribution for the Rate of Gross Value Added**

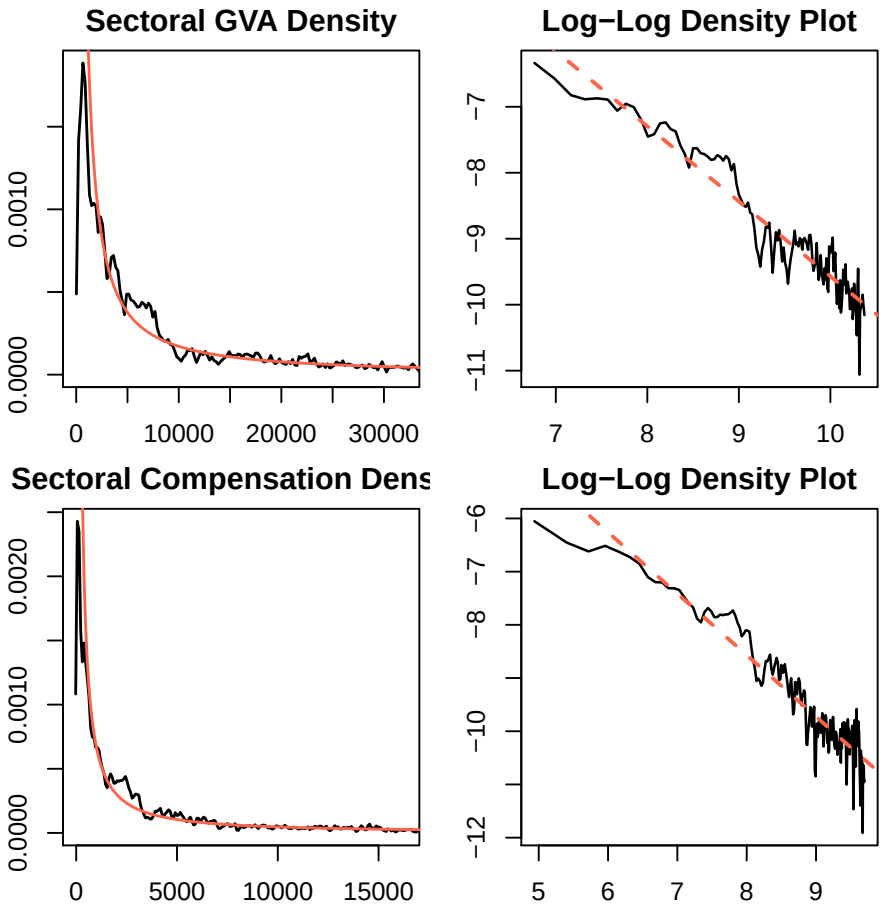

Figure 12: **Power Law Distribution for Gross Value Added and Compensation**

from the location,

$$b_{MLE} = \frac{1}{N} \sum_i |x_i - \mu| \tag{5}$$

The maximum likelihood estimation gives a very good fit of the distribution of the rate of gross value added.

The sectoral disaggregation of key economic indicators shows a more revealing picture of the statistical structure of the recent Italian economic geography. Both distributions of gross value added and compensation can be characterized by a power law, for which the BIC scores of different number of clusters seem to show a definite pattern,

$$p(x|k, A) = Ax^{-k} \tag{6}$$

Power-law distributions are ubiquituous around nature, in the form of occurrence of earthquakes, wars, city ranks, and word frequency (ie Zipf's Law); in economics, the observed Pareto distribution of income is a power law [Gabaix, 2009]. Power laws have the scale-free property in the sense that they are scale invariant and thus possess no meaningful scale [Barabási, 2009]. Given that both of the power exponents k of compensation and gross value added are less than 2, neither of these economic variables have a well-defined average and variance and thus show black-swan behavior. Like the top 1% of income in the Pareto power law, extreme events such as high and low GVA regional sectors are overrepresented in the power law in relation to Gaussian or even exponential distributions, further indicating the highly polarized character of the Italian division of labor, e.g. the existence of agglomeration economies.

Since compensation is a share of gross value added, it may be expected that both feature the same distributional functionals – gross profits, defined as gross value added minus compensation, also show a power law. However, the fact that sectoral gross value added follows a power law while its rate follows a double-exponential is quite striking. In the context of maximum entropy, power laws are associated with data-generating mechanisms that operate under the constraint on the average of the logarithm of the quantity in question – which in economics is related to a growth rate, ie the rate of gross value added. Laplace distributions are associated with the constraint on the average absolute deviation from the median, which is its maximum likelihood estimator for the scale of the distribution.

5.3 Regional Classification

In this section, I show the classification results from the application of the univariate GMM algorithm on the preceding economic indicators of the different regions of Italy, which yields a complex picture beyond the conventional dual classification between North and South. The GMM algorithm classifies each data-point of the time series for each regional value as belonging to a particular cluster. In order to classify a particular region, I average the classification results of its whole time series and thus the time dimension vanishes. While this often

returns unambiguous results especially for the rate of gross value added, some regions can be classified in two different clusters, which adds complexity to the cluster analysis. For the variables that exhibit 3 clusters (gross fixed capital formation as % of GDP and the unemployment rate), the corresponding map shows the cluster that encompasses the maximum data points of each time series and thus is painted in a discrete scale. For the remaining indicators, the GMM algorithm yields a 2-cluster classification that can be depicted using a continuous scale, showing the percentage of data points of a particular regional time series that are classified as belonging to one of the clusters. For the sake of comparison, average values are also plotted in the adjacent map. Since the labor share of income is well represented by a single cluster, no classification analysis is required.

Out of all the economic variables, only the regional classification for disposable household income follows the conventional North-South division. Labor productivity follows a very similar classification to household income, but diverges for Toscana, Umbria, and Marche, which are classified along with the South. For the unemployment rate, the North cluster remains, while the South is divided into two regions. For the rate of gross value added, the time dimension becomes much more relevant: each year most regions belong to the cluster with a positive mean, except for 2000, 2008-2009, and 2012-14, years that were associated with recessions. However, its classification value from 0 to 1 still bears similarity to the classifications of income and labor productivity, which is expected.

5.4 Multi-Variate Cluster Analysis

Multi-variate cluster analysis can be performed in order to further understand the interrelation of the economic indicators of the Italian geography. According to the Integrated Complete-data Likelihood (ICL) criterion, the EVE model (with ellipsoidal, equal volume and orientation) with 4 clusters is the second best performing after 9 clusters with ellipsoidal, equal volume, shape, and orientation (EEE). The information criteria tend to score better likelihoods for EEE models with a high number of clusters due to its low number of parameters, but they give very complex classification results to interpret.

For the 6 economic dimensions, we scale them for the sake of comparison and apply the multi-variate cluster analysis of an EVE model with 4 clusters. The results are plotted for the correlation of the economic indicators, the density of the clustering results, its classification, and a bar plot that assigns a maximum of 9 counts for each cluster (1 for each data point in the time series for which all indicators are available). Many of the correlation values are expected: labor productivity and disposable household income show the highest positive correlation, while income and the unemployment rate show the highest negative correlation. While there is no correlation between income and investment, there is a negative correlation between unemployment rate and investment.

5.5 Sectoral Cluster Analysis

In order to shed further light on the geographical and sectoral structure of the Italian division of labor, cluster analysis is performed on sectoral wage shares of income (here defined as compensation over gross value added) and labor productivity (gross value added over labour hours).

The BIC scores for the sectoral labor share reveal a pointed two-layered structure that can be explained using 3 and 6 clusters grouped around varying averages. The 3-cluster classification clearly divides the Italian economy into 3 groups, irrespective of geographical location: cluster 1 only encompasses real estate (L), cluster 3 covers public administration (including education, health, and social work), and cluster 2 encompasses the rest of the economy. This can be explained due to the over- and undervaluation of real estate (a sector characterized by speculation) and public administration activities (a sector whose value added is difficult to estimate [Mazzucato]) in national economic accounts, respectively.

When disaggregating by 6 clusters, a more complex picture of the Italian economy arises, where cluster 2 is divided into 3 sectors: agriculture (A) and (partially) professional, scientific and technical activities (M-N) are grouped into cluster B; construction (F), wholesale and retail trade (G-J) and information and communication (J) belong to cluster C; and mining and quarrying (B), manufacturing (C), Electricity and Water and Gas Supply (E), and Financial and Insurance Activities (K) are grouped into cluster D. While real estate and public administration exhibit no regional variation, geographical structure is more clearly observed in the remaining clusters. For instance, the sectors of construction or manufacturing can be actually divided between clusters C and D; construction in the Italian South belongs to cluster C, while in the Italian North belongs to cluster D (with a higher labor share of income).

In terms of labor productivity (gross value added over labor hours), the best classification yields 4 clusters. Agriculture (A) and arts and entertainment (R-U) belong to the least productive cluster; information and communication (J) and financial and insurance activities (K) belong to the most productive cluster, while the remaining economic activities belong to the rest and show some geographical structure. For instance, manufacturing (C) or professional and scientific activities (M-N) are divided between North in the less productive cluster C while manufacturing in the South belongs to the more productive cluster D.

6 European Economic Integration

Italian economic decline since the introduction of the Euro in 2002 is by now proverbial, as highlighted by Stiglitz in his latest book on the common currency [Stiglitz, 2016]. Its economy has shrunk since the onset of the economic crisis by 12%, many of its national corporate champions have been sold off to larger, more successful foreign firms, and even Fiat, the Italian marquee brand, has

decamped to run its world operations among the Dutch. Its banks groan under the greatest percentage of bad loans, those gently referred to as *in sofferenza*, of any major northern country, the historic Monte Paschi di Siena teeters on insolvency, and the others are finding it very difficult to raise capital to surmount their sorry states [Blim and Vallès Codina, 2017]. Foreign investment has been all but non-existent for decades, though this trend has been interrupted to some extent by significant Chinese moves into ownership or participation in firms in Italian power, food, and machinery.

From a standard neoclassical exogenous growth framework, several studies have addressed Italy's decline [Parisi et al., 2006; Rabellotti et al., 2009; Ramazzotti, 2010; Bagnai, 2016], reaching a consensus on the fact that Italy's decline depends on a fall in labour productivity growth. Bagnai [2016] argues that these studies fail to provide a convincing explanation of the sudden stop of labour productivity growth experienced in Italy around 1996, after three decades of relatively good performance, and examines whether this fact can be explained by adopting the cumulative growth model of Kaldor, Dixon and Thirlwall. Such a stagnant economic scenario is the blueprint of a growing peripheralization of the Italian economy within the Eurozone [Cesaroni and De Santis, 2015; Gambarotto and Solari, 2015], which has triggered a strong populist backlash against EU economic integration and the common currency, led specially by the far-right *Lega*. According to my own calculations, a comparison of regional Lega results in the last two elections shows no correlation with regional income, but the highest correlation with *decreases* in income per capita. Further, decreases in conme per capita are also very highly correlated with deaths by cancer (in an extreme way), deaths by ischaemic heart disease, and deaths in general, as well as tourist establishments.

What follows is a cursory exploration of regional inequality at a European level based on our analysis of the Italian economic geography of uneven development with the goal of applying Gaussian mixture modeling to detect its clusters in future research. The data shows that income divergence is a fundamentally regional phenomenon, not only at the state level of analysis, which is the exclusive focus of most studies on European uneven development [Storm and Naastepad, 2015; Regan, 2017; Gräbner et al., 2020]. In figure 22, the distributions of NUTS2 regional values are plotted based on a conventional classification of three major clusters of EU countries into core/North and its two distinct peripheries within the EU, South and the post-socialist East. At a first glance, there is no evidence of income convergence after three decades of the Maastricht Treaty, given how distinct the EU countries' regional distributions remain grouped by the three major divisions of North/Core, South and East; and how spread the EU aggregate distribution is. Within the European Monetary Union (i.e. excluding the East), there is no sign of convergence either. Instead, the statistical analysis at the regional level shows a marked economic geography of uneven development.

The dominant view on the crisis of the Eurozone is that current uneven development is driven by differentials in labor-cost competitiveness, which underlie the existing trade imbalances especially between Germany and the South

and hence foreign indebtedness between surplus and deficit countries [Lapavitsas, 2012; Sinn, 2014]. Thus, the mainstream solution is a deflationary policy of 'internal devaluation' (i.e. cutting the wage share of income as much as 30%) in the deficit countries in order to restore labor-cost competitiveness [Sinn, 2014]. While in agreement with the fact that Southern competitiveness deteriorated, other authors dispute the mainstream view by suggesting that causality is in fact reversed, highlighting that it was the inflow of capital to Southern countries precipitated by the monetary union that relaxed their borrowing constraints and thus deteriorated their competitiveness. At the same time, they contend that German export-led prowess is not due to its lower labor costs, but rising foreign demand by fast-growing countries outside of the EU (especially China) [Gabrisch and Staehr, 2013; Storm and Naastepad, 2015]. However, it is important to note that the increase in German cost competitiveness does not necessarily need to be explained by the 2004 Hartz IV austerity reforms, but by the Eastern expansion of the European Union, which allowed it to repress its labor costs by outsourcing the manufacturing of its industry inputs to the low-wage post-socialist East, weaving global value chains in intermediate goods within the EU: an average of 25 percent of the total exports of the Czech Republic, Austria, Poland, Hungary, Slovenia, Slovakia, and Romania, with a high of 32 percent for the Czechs and a low of 19 percent for the Romanians, go straight to Germany. Of those totals, an average of 10 percent of these countries' exports are in one category: parts and accessories of motor vehicles [Blyth, 2016].

This paper argues that both views are not necessarily incompatible but instead that they emphasize two aspects of the same phenomenon that are self-reinforcing: considering the role of trade in intermediate goods, the observed pattern of uneven development between European North and South can still be driven by absolute-cost advantage, in line with the classical theory of free trade [Shaikh, 1980, 2016]. Free trade will lead to persistent trade imbalances if there are structural differences in international competitiveness, while linkages between trade imbalances and international finance liquidity implies that persistent trade balances are compatible with balance of payments through countervailing short-term capital flows. In the context of the classical theory of free trade, the massive flow of capital from North to South in the first decade of the monetary union can still be explained as responding to the existing labor-cost differentials underlying the imbalances in trade and further deterioriating them in self-reinforcing, unsustainable fashion until an inexorable sovereign debt crisis comes up. Such debt crisis came in 2010-12, forcing Southern indebted countries into fiscal consolidation (i.e. austerity) and wage repression. This was already the intended outcome of the architecture of European monetary unification all along: by not building a supra-national fiscal authority to regulate fiscal transfers from surplus to deficit regions, the burden of the adjustment was to fall on wage repression in line with the interests of European capitalists [Rathgeb and Tassinari, 2020]. In this sense, one can consider the Maastricht Treaty as the European version of the neoliberal Washington Consensus.

Remarkably, the two-pronged Italian distribution of household income reveals that the Italian North is at income levels akin to the Core, while the

Italian South is at the level of the South, which gives the South distribution of income the same two-pronged shape of Italy [figure 22]. Italy's unification dates from the 1870s; no income convergence has been attained since under its own monetary union and no income convergence seems to be expected within the European monetary union. In addition, in the last two decades the Italian North has been experiencing a protracted peripheralization, when before it was well integrated into the high-income "European banana" that ranges from Milan to London going through Austria, Germany, and the BENELUX. Such protracted peripheralization, explained by decades of fiscal consolidation, stagnant GDP and starved investment, underlies the current Euroskeptic political insurgency in Italy, where the wage share is already very low with respect to other Eurozone members. In this context, Italy is another loser in the process of [EU-led] globalization [Villaverde and Maza, 2011; Stiglitz, 2002; Williamson, 2005; Milanovic, 2012; Case and Deaton, 2020].

In figure 23, three maps are plotted based on a simple k-means classification of household income, the unemployment rate, and investment, which clearly shows the so-called "European banana" in terms of household income and the unemployment rate. In contrast, investment (in the European context of free mobility of capital) flooded Spain and Ireland in search of higher interest rates, fueling real estate booms at an unprecedented scale. One can note the high investment levels (in tandem with low unemployment) in Eastern Europe, product of German outsourcing of its manufacturing inputs, as well as very low levels of investment for the UK, which may help explain its recent support for Brexit. In absence of massive investment to correct its regional imbalances, the economic geography of the European Union will still be marred by protracted uneven development and will move towards disintegration, not integration [Gräbner et al., 2020]. Yet how such disintegration may occur?

Debates by European policy-makers on crisis management mimic the conundrum, on a regional dimension, detailed by Kalecki in 'Political Aspects of Full Employment' [Kalecki, 1943]. Often these debates are coached in terms of Northern versus Southern countries, but such framing serves to obfuscate the actual class war waged by European elites on its workers. In other words, trade wars –as they are occurring between North and South– are in fact class wars [Pettis]. At the European level, surplus Northern regions (where most European capitalists live, after all) play the role of capitalists in advocating for fiscal austerity, while deficit Southern regions play the role of the working class in their advocacy of fiscal expansion. As Kalecki pointed out, if working-class demands for fiscal expansion are not met by capitalists, those demands will be met by authoritarian Fascist leaders by providing employment through an expansion of the military-industrial complex, policing, and border security. As an advisor to Roosevelt noted while discussing 1930s deflationary European politics, "one either observes a surge in prices, or a surge in dictators". By simple arithmetic, the Northern emphasis on a trade surplus strategy exports deflationary pressures and imposes systematic economic contraction not only on the European South, but also, on the rest of the world, especially the Global South. Following the Polanyian double movement, Neo-Fascist authoritarism emerges as an

alternative to elites to quell any political opposition to the subsequent wage repression that follows the economic contractionimposed by European capitalists. For instance, the 2011 Arab Spring, the 2016 coup in Turkey, or the 2016 coup in Brazil against Dilma Rousseff can be thought of as political responses to the trade war the European North has been waging against the rest of the world through the operation of the Single Market.

7 Conclusions

This paper presents a multi-dimensional, statistical characterization of Italian regional inequality and argues that the observed "twin-peaks" polarization into North and South should be treated as the natural outcome of political and economic integration rather than an exceptional result. The machine-learning method of Gaussian mixture modeling for cluster identification can be very useful in order to characterize the economic geography of the European division of labor by distinguishing the regional elements that compose core and periphery, as well as to inform policy aimed at correcting its imbalances. Most studies on European uneven development focus on the convergence of state and regional time series in income per capita, which grossly underestimates the level of geographical unevenness in the economic development of Europe. I find evidence of a tent-shaped distribution for regional rates of gross value added, as well as evidence of power-law distributions in the distribution of sectoral compensation and gross value added. In line with the econophysics literature, the existence of such well-defined stable distributions indicates that robust economic processes are at play, rather than being exceptional outcomes of imperfect competition [Shaikh, 2020]. Instead, the statistical analysis gives evidence of economic competition on classical lines rather than neoclassical, driven by increasing returns to scale and in the process yielding the agglomeration economies that lie at the basis of uneven development.

The next step in this research is to implement the algorithm in a more systematic way for the whole of the Europe in order to provide further light on the statistical structure of its economic geography, and estimate regional capital stocks in order to add regional capital intensity and capital-to-labor ratio as relevant variables.

Finally, a more rigorous analysis could be complemented by PCA analysis of the indicators in order to clarify the interaction between the bi-modal and tri-modal hypothesis.

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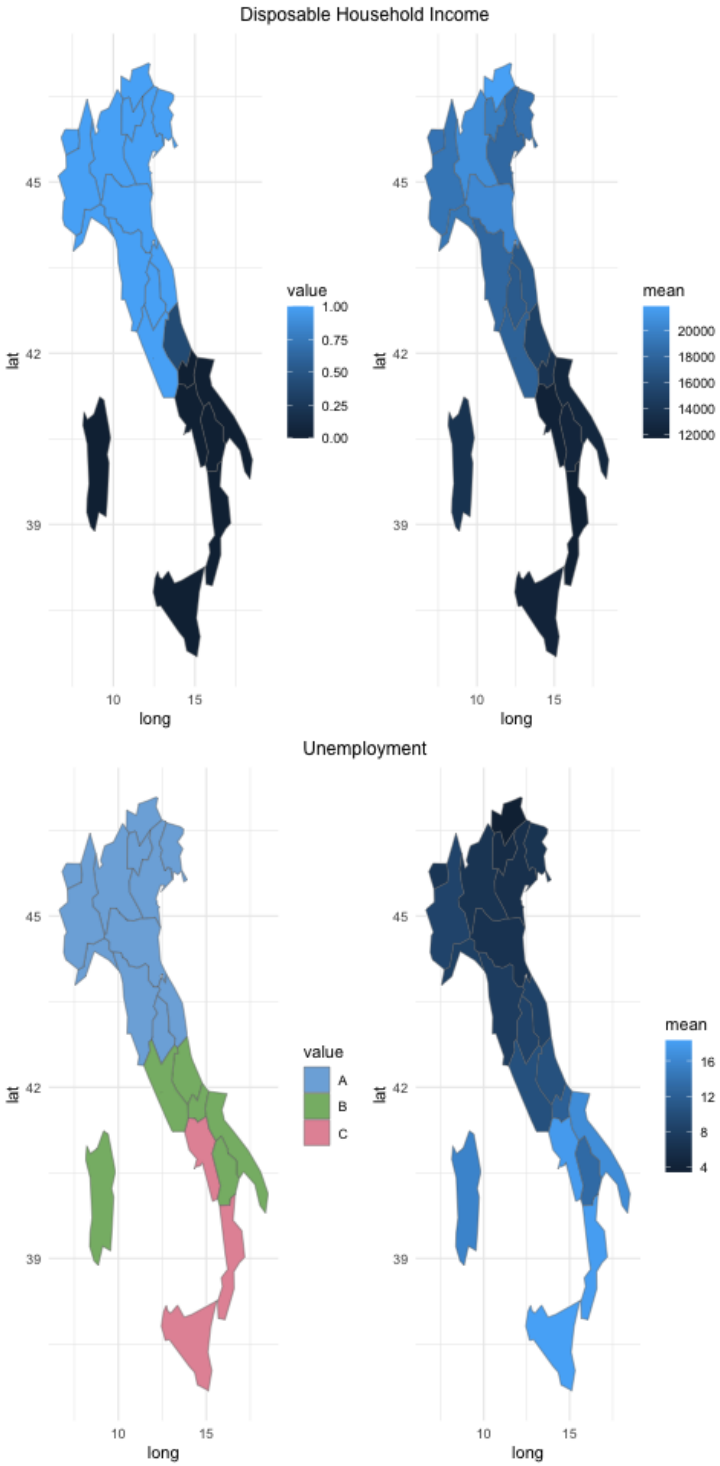

Figure 13: **Household disposable income and unemployment rate, maps including cluster identification of each Italian region and their corresponding time average**

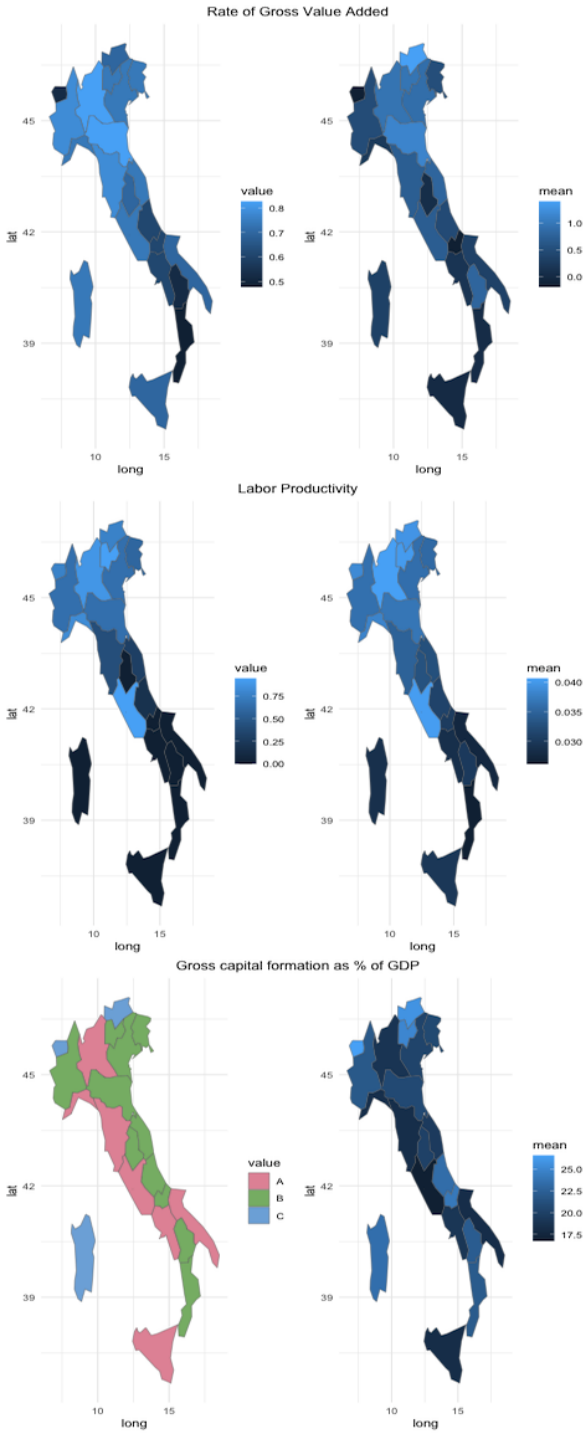

Figure 14: **Rate of gross value added, labor productivity, and gross fixed capital formation as % of GDP, maps including cluster identification of each Italian region and their corresponding time average**

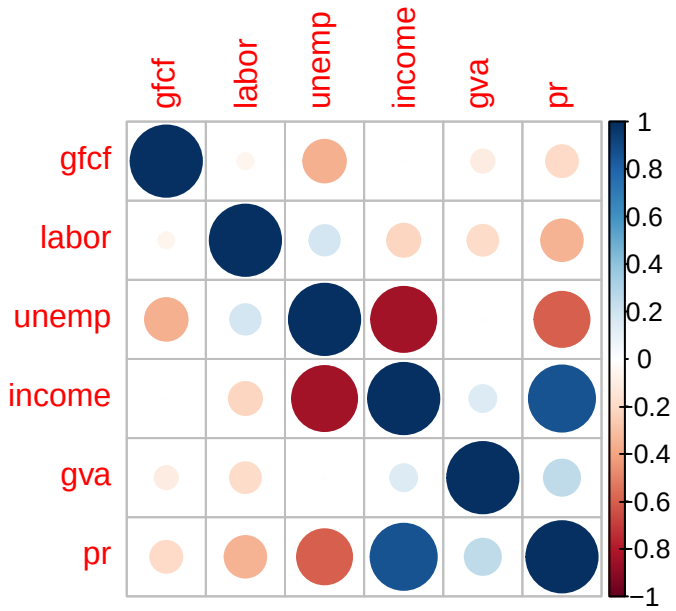

Figure 15: **Correlation between Economic Indicators:** investment (gross fixed capital formation as percentage of GDP), labor share of income, unemployment rate, household disposable income, rate of gross value added, and labor productivity.

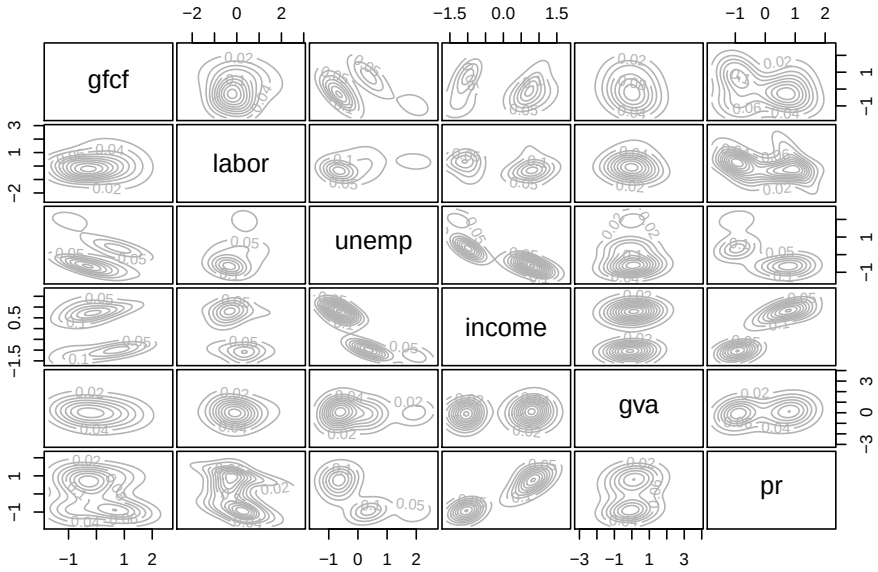

Figure 16: **Density of Gaussian Components and Classification**

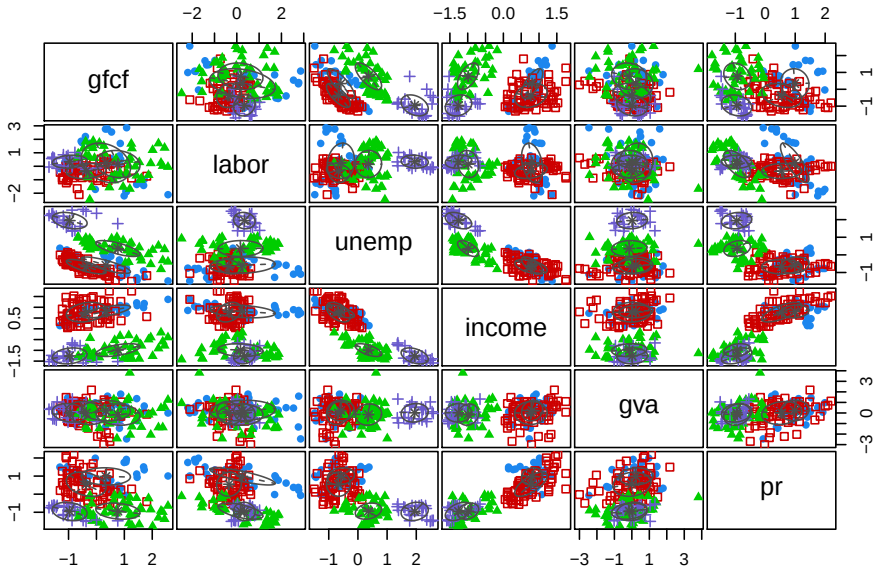

Figure 17: **Density of Gaussian Components and Classification**

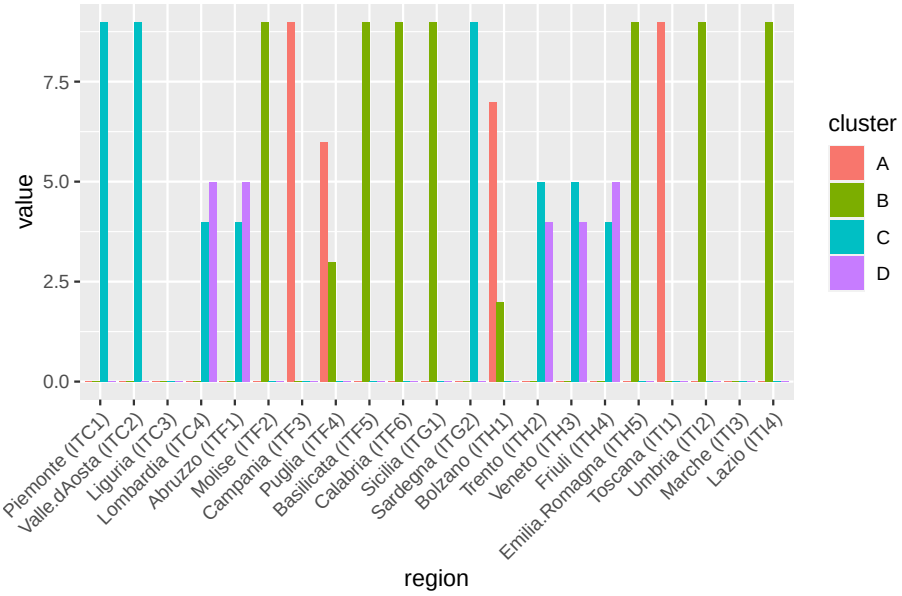

Figure 18: **Classification of Italian Regions into 4 Clusters**

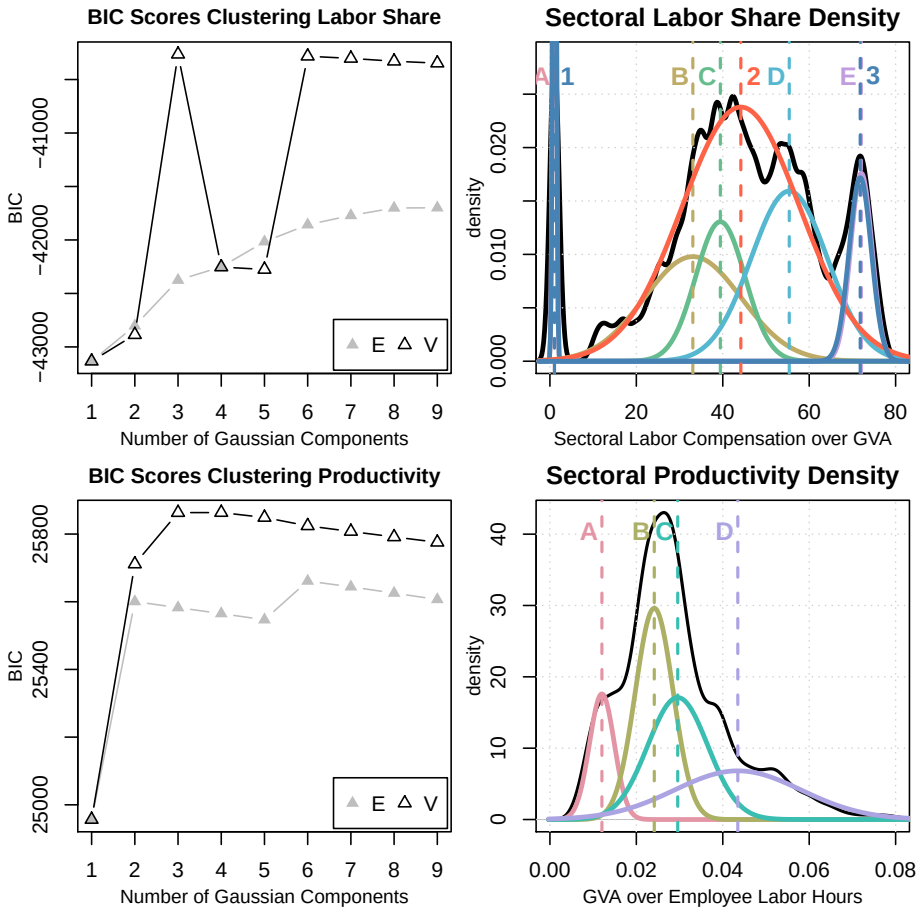

Figure 19: **Model-Based Clustering for Sectoral Indicators**

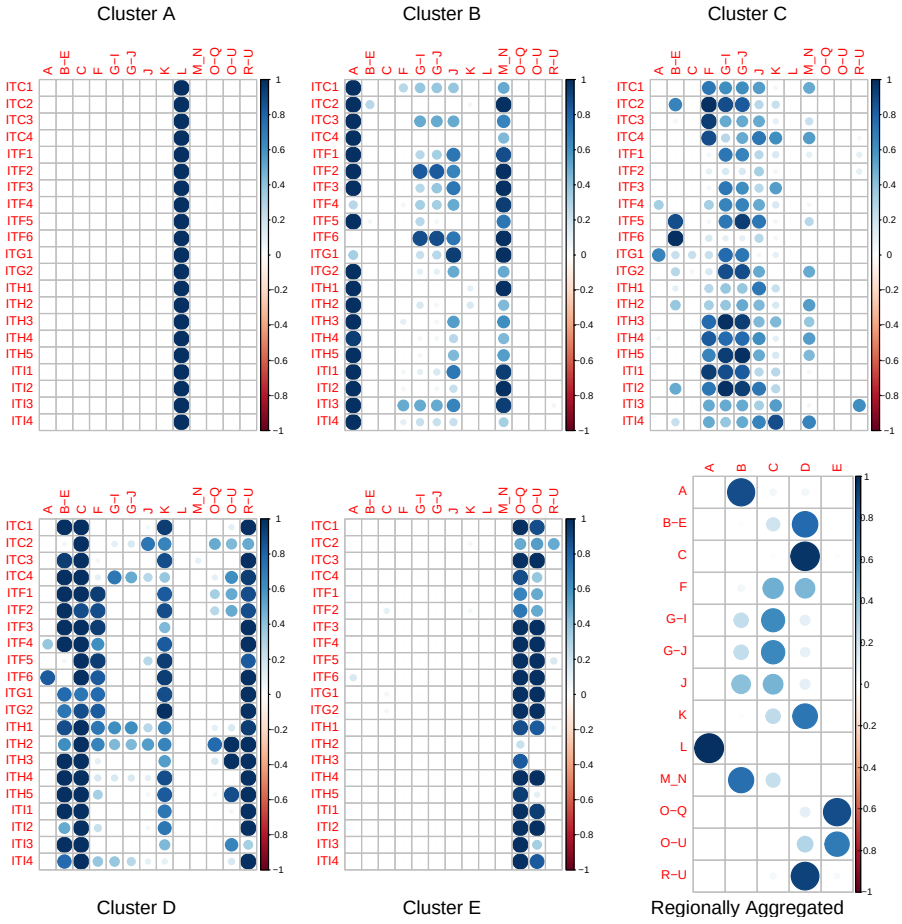

Figure 20: **Cluster Classification for Sectoral Labor Shares**

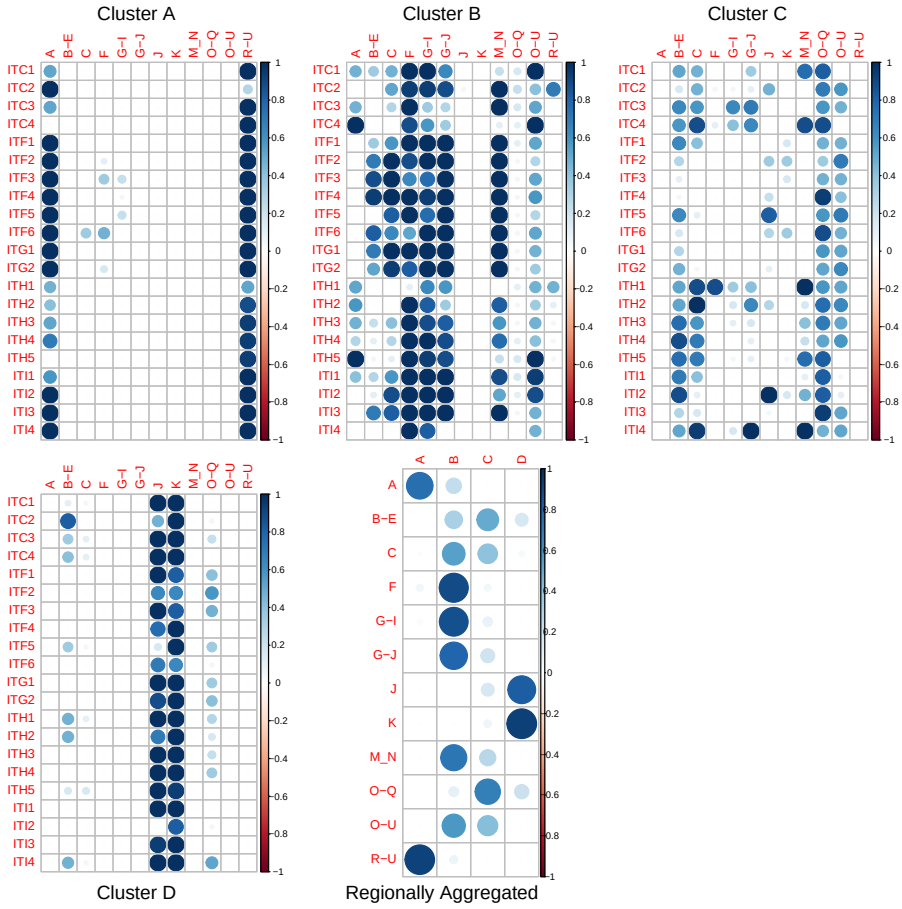

Figure 21: **Cluster Classification for Sectoral Productivity**

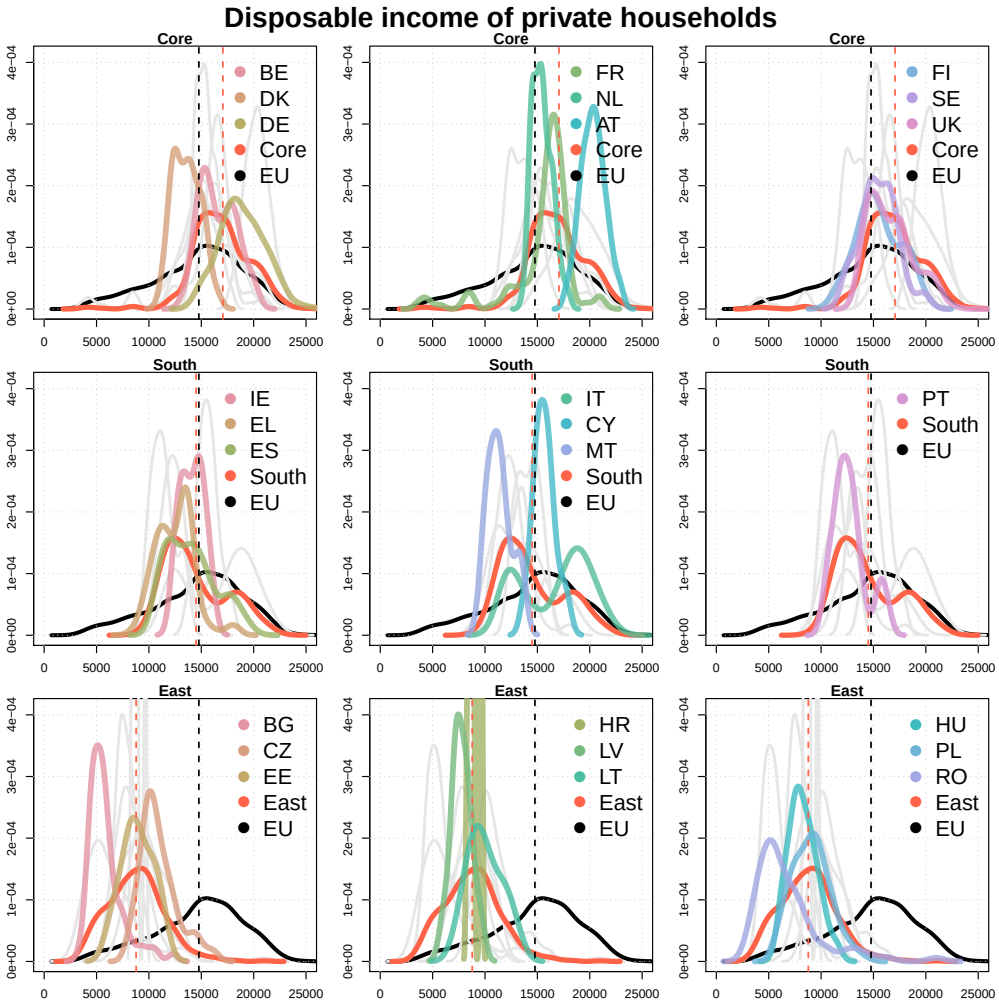

Figure 22: **Distributions of NUTS2 regional values of household disposable income, by country within three major subgroups (Core/North, South, and East)** the aggregate EU distribution is in black, subgroup distribution is in red, vertical black dashed line indicates EU average, red vertical dashed line indicates subgroup average.

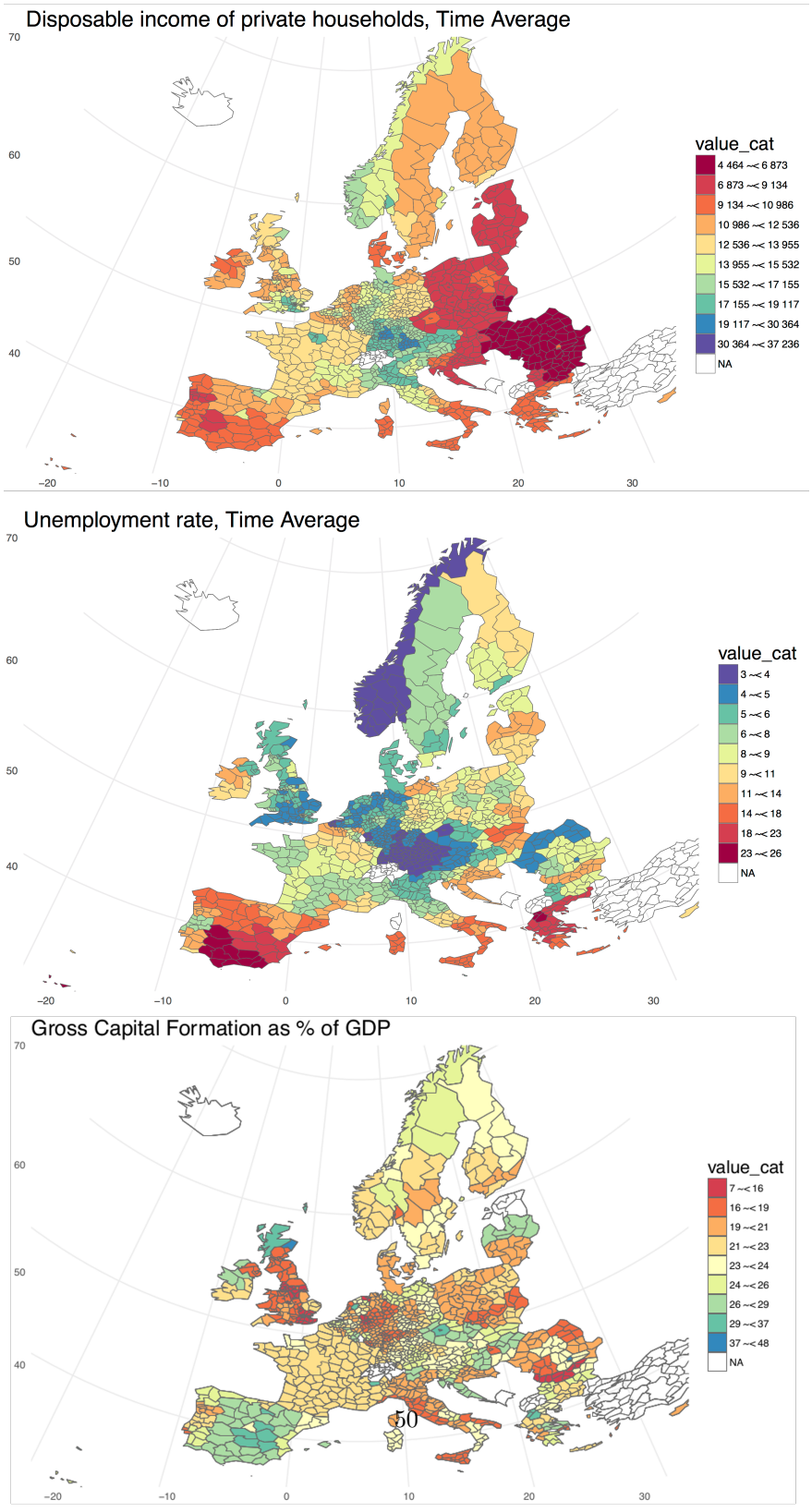

Figure 23: **European maps with NUTS2 regions showing the time averages of household disposable income, unemployment rate, and gross fixed capital formation as % of GDP** the clustering algorithm is simple K-means.