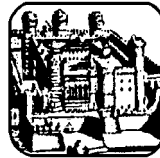


UNIVERSITÀ DEGLI STUDI DI NAPOLI
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ISTITUTO DI STUDI ECONOMICI



IS THERE A CLUB CONVERGENCE
AMONG ITALIAN REGIONS?

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IS THERE A CLUB CONVERGENCE AMONG ITALIAN REGIONS? ♥

RITA DE SIANO* – MARCELLA D’UVA**

Abstract

In this paper we investigate the “convergence clubs” hypothesis applying the stochastic notion of convergence to groups of Italian regions. In order to avoid the group selection bias problem, we applied the innovative regression tree technique to select endogenously the most important variables in achieving the best identification of groups on the base of a number of economic indicators. Tests on stochastic convergence show the presence of a strong convergence process of each region towards the average of the group it belongs for all the Italian regions.

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2. *Methodology*

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1. Theoretical Background and Empirical Literature

The evolution of per capita income disparities has been studied by many authors at both national and regional levels, but empirical studies on convergence often did not show univocal results. The presence of increasing returns of scale explained the failure of convergence among economies with different initial conditions in studies by Romer (1988) and De Long (1988), for example. On the contrary, controlling human capital variables Baumol (1986) and Barro (1991), among others, found convergence among similar countries. When initial conditions were considered in determining the steady state of each economy the convergence notion was referred to as *conditional convergence*.

A large strand of the empirical literature use a cross-section notion of convergence in order to verify the existence of a negative relationship between initial per capita income and its growth rate. However, if economies show multiple long run equilibria, cross-sectional tests tend to spuriously reject the null hypothesis of no convergence (Bernard and Durlauf, 1996). As a consequence, in these cases a different notion of convergence might be used, applying a time series approach for instance. Carlino and Mills (1993) define and explore a stochastic definition of convergence using a time series analysis: if per capita income disparities follow a stationary process there is stochastic convergence in progress among economies.

The objective of our study is to investigate the presence of “convergence clubs” among Italian regions applying the stochastic notion of convergence (De Siano and D’Uva, 2006a) to groups of regions sorted according to a number of economic indicators through the *Classification and Regression Tree Analysis* (CART) in the period 1981-2003 (De Siano and D’Uva, 2006b, 2004). Unlike other partitioning methods, CART allows a regression to be performed together with a classification analysis on the same “learning” dataset, without requiring any specification of the functional form for the predictor variables which are selected endogenously. The innovative element of our study consists in the application of an endogenous selection method to group Italian regions (regression tree technique) instead of following some *a priori* criteria (initial level of GDP, education, technology, capital accumulation, etc.), as in the great part of literature.

The paper is organised as follows: section 2 introduces the methodology of the empirical analysis, section 3 presents the dataset and the descriptive analysis results, section 4 shows the econometric analysis results and section 5 concludes. In the appendix we present the economic indicators used in the analysis and the regression tree.

2. Methodology

The empirical analysis is conducted through three phases. The first consists of seeking the splitting variables to group regions. The process starts with the following cross-section regressions:

$$y_i = \alpha + \beta \text{Gdp81}_i + \Pi X_i + \varepsilon_i \quad (2.1)$$

where $y_i = \log \text{GDP}^{2003} - \log \text{GDP}^{1981}$ is the regional growth rate in the period 1981-2003, GDP81_i is the initial level of per capita GDP (in terms of logarithm) and X_i is a vector of control variables; the initial values of productive specialization indexes and the economic indicators listed in the appendix are our control variables.

The second phase consists in grouping Italian regions through the *Classification and Regression Tree Analysis* (CART) on the basis of initial levels of per capita GDP and other statistically significant economic indicators, selected through the estimation of the above cross-section regression. This method, first described by Breiman *et al.* (1984), provides binary recursive partitioning using non-parametric approach, avoiding problems of arbitrary choices. The main result of this procedure is the construction of homogeneous groups of regions using as predictors those control variables which minimize the *intra*-group heterogeneity. The final outcome is a tree with “terminal nodes” as much homogeneous as possible where the average value of the node represents the predicted value of the dependent variable. In our analysis the regression tree is carried out through the least squares method using the regional GDP growth rate as dependent variable and a number of economic indicators as explicative variables.

The third step of the work is aimed to test the stochastic notion of convergence in each group, as identified by CART, using the Carlino and Mills (1993) model. This method implies that if the logarithm of a region per capita income relative to the average of the group it belongs does not contain a unit root the region converges. The model (Ben-David, 1994; Qing Li, 1999) is the following:

$$y_{i,t}^j = \alpha_i + \beta_i t + \varphi y_{i,t-1} + \varepsilon_{i,t} \quad (2.2)$$

where $y_{i,t}^j$ is the log of region i per capita income in year t , j indicates the group the region belong to and ε is white noise error with 0 mean. Summing the equation 2.2 over j for each group and dividing the outcome by the number of regions within the group, we obtain:

$$\bar{y}_t = \bar{\alpha} + \bar{\beta} t + \varphi \bar{y}_{t-1} + \varepsilon_t \quad (2.3)$$

where \bar{y}_t is the group's average per capita income in year t (the group superscript is suppressed).

Subtracting equation 2.3 from 2.2 we have:

$$RI_{i,t} = A + Bt + \varphi RI_{i,t-1} + \varepsilon_t \quad (2.4)$$

where $RI_{i,t}$ is the logarithm of region i per capita income relative to the group's average at time t ($y_{i,t}^j - \bar{y}_t$).

For each region of the sample we apply the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) using the ADF regression of equation 2.4:

$$\Delta RI_t = \mu + \beta t + \alpha RI_{t-1} + \sum_{j=1}^k c_j \Delta RI_{t-j} + \varepsilon_t \quad (2.5)$$

Finally, considering the low power of the ADF test in the case of short time series, we run also the Kwiatkowski-Phillips-Schmidt-Shin (1992) test (KPSS) for trend stationarity. The null hypothesis of the KPSS test is the trend stationarity against the unit root alternative¹. The combined analysis of KPSS and ADF tests results leads on the following possibilities (Qing Li, 1999):

- rejection by ADF tests and failure to reject by KPSS → strong convergence;
- failure to reject by both ADF and KPSS → weak convergence;
- rejection by KPSS test and failure to reject ADF → no convergence;
- rejection by both ADF and KPSS tests invites to perform further analyses.

3. Data description

The sample consists of all Italian regions at NUTS2 level (20) in the period 1981-2003. We use annual per capita GDP in terms of Purchasing Power Parity (PPP), initial number of employees in the NACE92 productive branches², economic indicators listed in the appendix and the following initial productive specializations indexes (SP) for each region (i) and all the considered branches (j):

$$SP_{ij} = \frac{E_{ij}}{\sum_{j=1}^n E_{ij}} \bigg/ \frac{\sum_{i=1}^m E_{ij}}{\sum_{j=1}^n \sum_{i=1}^m E_{ij}} \quad (3.1)$$

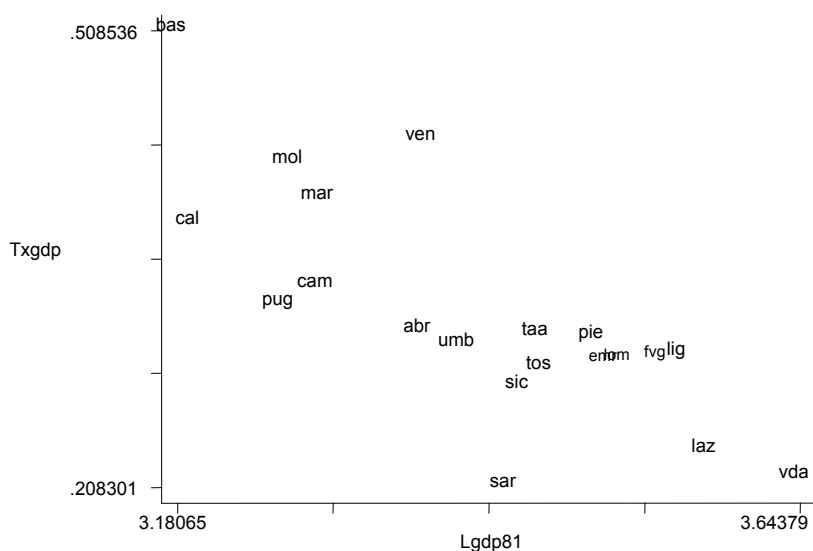
where E indicates the number of employees. Data are from the Eurostat New Cronos Regio, Istat and Crenos databases.

The dynamic analysis of Italian regions per capita GDP during the period shows a mean growth rate equal to 32%. In particular, Veneto, Marche, Abruzzo, Molise, Basilicata e Calabria show the highest growth rate of the period (Txgdp in the graph 1) while Valle D'Aosta, Sardegna,

¹ If the KPSS statistic is larger than the critical values the null hypothesis is rejected.

² Agricultural-forestry and fishery, manufacturing, fuel and power products, non-metallic minerals and minerals, food-beverages-tobacco, textiles-clothing-leather and footwear, chemical products, metal products-machinery-equipment and electrical goods, building and construction, transport and communication, credit and insurance services.

Lazio, for example, initially among the richest (Lgdp81 in the graph is per capita GDP level in 1981), display sluggish growth.



Graph 1. Dynamic analysis of per capita Gdp

4. Empirical results

This section presents the econometric analysis results. Table 1, in particular, shows the cross-section regressions (2.1) outcomes with respect to those economic indicators which result to be statistically significant in explaining regional growth.

Table 1. Cross section regressions results

Variable	Π	R^2	Variable	π	R^2
Lgdp81	-0,44 (0,08)	0,61	Juvenile unemployment rate	-0,003 (0,001)	0,69
Specialization in machinery	0,07 (0,03)	0,68	Male juvenile unemployment rate	-0,003 (0,001)	0,68
Telephone	0,05 (0,001)	0,72	Female juvenile unemployment rate	-0,002 (0,001)	0,70
Number of PRA motor vehicles x1000	3,33 (1,62)	0,68	Total employment rate	0,006 (0,002)	0,74
Total activity rate	0,007 (0,002)	0,72	Industry productivity	0,00001 (4,53e-06)	0,71
Male (M) activity rate	0,007 (0,004)	0,68	Manufacturing productivity	0,00001 (4,01e-06)	0,73
Female (F) unemployment rate	-0,04 (0,001)	0,73	Machinery productivity	6,44e-06 (3,21e-06)	0,68
Differential of F and M unemployment rate	-0,006 (0,002)	0,72	Market services productivity	9,56e-06 (3,12e-06)	0,74
Female unemployment rate	-0,004 (0,001)	0,73	Transport productivity	3,43e-06 (1,43e-06)	0,70

Standard errors are in parenthesis.

The second phase of the econometric analysis, run through CART methodology, enabled us to build a tree with terminal nodes including regions showing a more homogeneous behaviour of per capita GDP growth rate on the base of the above economic indicators. In our investigation per capita income growth rate represents the dependent variable while initial level of GDP and specialization in Metal products, Machinery-equipment and electrical goods result to be the splitting variables endogenously chosen among all the significant regressors.

The final tree (see appendix), grown by the CART methodology, displays three terminal nodes which initial economic condition and structural evolution is described in what follows.

Group 1

This group includes 8 regions, namely Veneto, Marche, Abruzzo, Molise, Campania, Puglia, Basilicata and Calabria, mainly located in the South area of the country. These regions are characterized by the highest estimated mean value of GDP growth rate (39%), despite the lowest initial per capita income level (average equal to 9836,67 euros) and a strong specialization in Agriculture sector (4,13), together with the second agricultural and forestry surface (0,95), and in the Construction (1,69) and Textile (1,47) branches. Besides, they show also the second highest level of specialization in Non-metallic minerals and mineral products (1,04), food and beverages compartment (0,76), Transport and communication services (0,52) and Metal products, Machinery-equipment and electrical goods (0,49). The low specialization in industrial productivities explains the relatively low energy consumption level (IEI= 0,55). This group results mainly net importer (NI/GDP=13% except for Veneto) during the considered period.

The initial endowment of physical capital per worker is relatively high especially in energy, market and non market services branches while the level of human capital (measured by the percentage of BA and high school degrees and the secondary school participation rate) is the lowest among the groups. Labour productivity is the highest in the energy and transport and communications and non market services branches, while is the second highest in market services and particularly in the credit and insurance branch. The level of enterprises expenditure in Research and Development activities is the minimum among the three groups while those of fixed investment and expenditure in public works are the highest. The structure of the credit market is characterize by the lowest number of bank branches per squared kilometre and the lowest credit-GDP ratio (20%).

As regards the concentration of enterprises, measured by the number of business per squared kilometre, we can say that this group presents the second level among the groups in all classes of dimension.

The description of the initial situation of these economies is completed with information inferred from a few labour market indicators. The activity and occupation rates (39,5% and 33,35%, respectively) are the lowest while the general unemployment rate (10,4%) and the juvenile one (22,7%) are the highest among the groups (the female juvenile unemployment rate is 32,3% while the male one is 16,5%).

As regards the evolution of the productive factors during the whole period, the capital-labour ratio increases in all sectors and branches, with a remarkable variation in agriculture, energy and industry. In particular, the increase in the market services is the highest while in manufacturing and construction is the second high. At the same time fixed investment decrease in almost all regions with a mean variation equal to -13,3%.

The capillarity of bank branches has increased so as the availability of credit with a change of the credit-GDP ratio (+241,5%), besides the credit per branches showed a considerable increase too (97,4%). As regards productive enterprises only small and medium ones became more numerous while large and very large ones decreased around 20-30%.

Group 2

This group contains 7 regions, namely Valle d'Aosta, Trentino Alto Adige, Toscana, Umbria, Lazio, Sicilia and Sardegna, belonging indifferently to the three areas of the country, with a mean per capita GDP level equal to 13552,68 euros and the lowest growth rate (26,1%). They result to be strongly specialized in Agriculture (2,17, even if they have the smallest agricultural and forestry surface) and Building and construction (1,54) (especially the two islands) as long as in Chemical (1,62), Non-metallic minerals and mineral products (1,22), Textile (1,26), Energy (1,002), Food and beverages (0,851), and Credit and insurance (0,69) compartments where the group shows the highest level of specialization. The relatively high specialization in the industrial activities goes together with a high energy consumption level (IEI= 0,58), besides they result to be the second group in producing energy through renewable resources (EFR=0,47).

The initial endowment of physical capital per worker is the highest (capital-labour ratio equal to 0,213). This ratio increases when looking at the energy (especially for the two islands) and market services compartments. Besides, the level of human capital is relatively high too, percentages of BA and high school degrees are the second highest as long as the rate of participation to the secondary school. This group shows also the highest level of high-human capital employed and the highest number of graduates employed among the three groups. Labour productivity is quite high in all the compartments of activities: the group shows the second level in almost all the compartments. The expenditure in R&D activities is higher than that of the first group. Investments represent the 23,5%

of GDP while the impact of public works is equal to 2,3% of GDP. The credit-GDP ratio is equal to 26% while the number of bank branches on the territory is the smallest (0,00021 per squared kilometre). Also the enterprises concentration is smaller than in the other groups with the initial minimum representation of business for each class of dimension.

In 1981 the activity rate was 39,8% (male rate = 54,8%), with an occupation rate equal to 34%, while the unemployment rate was 7,7% (male 3,6%, female 16,7%) with the highest differential between male and female rates (13,01%). Relatively high is also the juvenile unemployment rate: 20% with a peak of 28,7% for the female labour force.

Among these regions Trentino Alto Adige, Sicilia and Sardegna result to be net importer while the rest are net exporter. By the end of the period Valle d'Aosta and Umbria become net importer too.

During the whole period these regions show a considerable increase of the capital-labour ratio(+41,7%), even if this change is the smaller among the three groups. In spite of this they present the highest increase of this ratios in the agricultural, energy, construction and non market services compartments. The increase of high-level human capital is the lowest while considerable is the increase of high school degrees.

As regards the concentration of enterprises it should be said that the only increase is registered among the small business while all other class of dimension show a considerable decrease (large enterprises, especially).

Credit accessibility, measured by the number of bank branches per squared kilometre increases but not in the measure showed by the other two groups. Notwithstanding this the credit-GDP ratio increases remarkably (+282,8%) as the availability of credit per branch (+126,4%).

Except for Sicilia and Sardegna the level of fixed investment increases in all regions more than in the other groups.

Group 3

It is composed by 5 regions: Piemonte, Lombardia, Friuli-Venezia Giulia, Liguria and Emilia Romagna, located in Northern Italy. In 1981 these regions show: the second estimated mean value of GDP growth rate (29%), despite the highest initial per capita level (14302,91 euros); the highest specialization in transport and communications services and industrial sector, particularly in Manufacturing (1,13), Metal products, Machinery-equipment and electrical goods (1,073); consequently they present the highest level of energy consumption (IEI=0.61), the share of renewable sources is the lowest (0,28); the lowest specialization in agriculture (0,51) (even if they show the largest agricultural and forestry surface, 1,26, Lombardia above all), Non-metallic minerals and mineral products (0,90), food and beverages branches (0,74), the second highest level

in credit (0,61), energy (0,66) and chemical products (0,89). The initial number of telephones is the highest of the three groups. These regions are mainly exporter (NI/GDP= -3,2% except for Friuli Venezia Giulia).

The initial endowment of capital-labour ratio is generally low, when compared with the other groups, but it shows the minimum values in industry (0,11), particularly in energy (0,95) and manufacturing industries (0,10) and in market and non market services. The initial human capital level is relatively high, with the highest secondary school participation rate, percentage of BA and high school degrees. Labour productivity is absolutely the highest in all the sectors and compartments except for transport and communications branches and non market services together with the enterprises expenditure in Research and Development (0,6%). Otherwise the group shows the minimum value of fixed investment and expenditure in public works. The credit market in 1981 is characterized by the highest number of per squared kilometre bank branches and of credit-GDP ratio (35%). The highest firms concentration in the group is accompanied by the highest activity rates and the lowest female, male and juvenile unemployment rates in the labour market.

As regards the economic indicators variation in the period 1981-2003, this group, if compared with the others, presents the smallest improvement of the capital-labour ratio in agriculture (90,71), in building (50,91) and in market services (15,01), of the credit-GDP ratio (185,49) together with the credit per branch (68,6%), and a reduction of 1,37% for fixed investment. The accumulation of human capital is the lowest when measured by percentage of people with an high school degree (134,19%) and the second according to the percentage of people with a BA (151,71%).

As regards international trade, these regions remain net exporter while Friuli Venezia Giulia (net importer) becomes exporter and Liguria (net exporter) becomes net importer.

As regards the initial infrastructural endowments measured by number of airport, railroad ecc., the analysis shows that there are not significative differences among groups in 1981.

Results of the descriptive analysis might infer that better economic performances, in terms of regional economic growth, are related to the following features:

- higher increase of capital-labour ratio, especially in those sectors where regions were specialised and where they increased their competitive advantages;
- higher human capital accumulation process;
- easier and larger credit availability, measured not only by the increase of the number of bank branches/surface and the credit-GDP ratio but also by the average credit amount per branch;
- specialization in market services activity since these regions have performed better than the most industrialised ones.

The third phase of the analysis consisted in performing both KPSS and ADF tests in order to verify presence of the stochastic convergence process of regional per capita income towards its group average. The combined analysis of these tests shows the following results:

Table 2. Convergence test results: group 1

Regions group 1	ADF statistics	KPSS statistics $I=4$
Veneto	-4.12 **	0,0942
Marche	-4.76***	0,0845
Abruzzo	-4.64***	0,0824
Molise	-6.66***	0,0766
Campania	-3.98**	0,0446
Puglia	-3.74**	0,1294
Basilicata	-4.39**	0,0727
Calabria	-6.99***	0,0845

and * denote statistical significance using KPSS stationary critical values at the 5% level (0.146) and 1% level (0.216) respectively, using unit root critical values at the 5% (-3.645) and 1% (-4.469).

Table 3. Convergence test results: group 2

Regions group 2	ADF statistics	KPSS statistics $I=4$
Valle d'Aosta	-7.02***	0,0957
Trentino Alto Adige	-4.07**	0,0714
Toscana	-3.45**	0,1350
Umbria	-5.04***	0,0512
Lazio	-5.88***	0,1324
Sicilia	-4.20**	0,0493
Sardegna	-4.41**	0,0827

Table 4. Convergence test results: group 3

Regions group 3	ADF statistics	KPSS statistics $I=4$
Piemonte	-3.73**	0,0676
Lombardia	-7.10***	0,0814
Friuli Venezia Giulia	-3.92**	0,1002
Liguria	-4.70***	0,1066
Emilia Romagna	-3.77**	0,0853

Rejection by ADF and failure to reject by KPSS tests for all the Italian regions suggest the presence of a strong convergence process of each region towards the average of the group it belongs.

5. Concluding remarks

This study contributes to the empirical literature on Italian regions by testing the “club convergence” hypothesis applying the stochastic notion of convergence over the period 1981-2003, feature usually implied by growth models that exhibit multiple stable steady state equilibria (Azariadis and Drazen, 1990, Galor, 1996). In order to avoid the group selection bias problem, we applied the innovative regression tree technique to select endogenously the most important variables in achieving the best identification of groups. The results presented in this paper suggest that there

is not a uniform pattern of convergence across all regions while there is evidence of a strong convergence process characterizing regions within the group they belong to: poorest regions growing with the highest rate; wealthiest regions showing the second highest growth rate and a medium group with the lowest growth rate. This outcome may indicate the presence of multiple equilibria.

Finally, the descriptive analysis of the groups suggests that better economic performances might be explained by higher increases of capital-labour ratio, especially in those sectors where regions increased their competitive advantages, and of human capital accumulation. Easier and larger credit availability together with greater specialization in market services activity might favour regional growth too.

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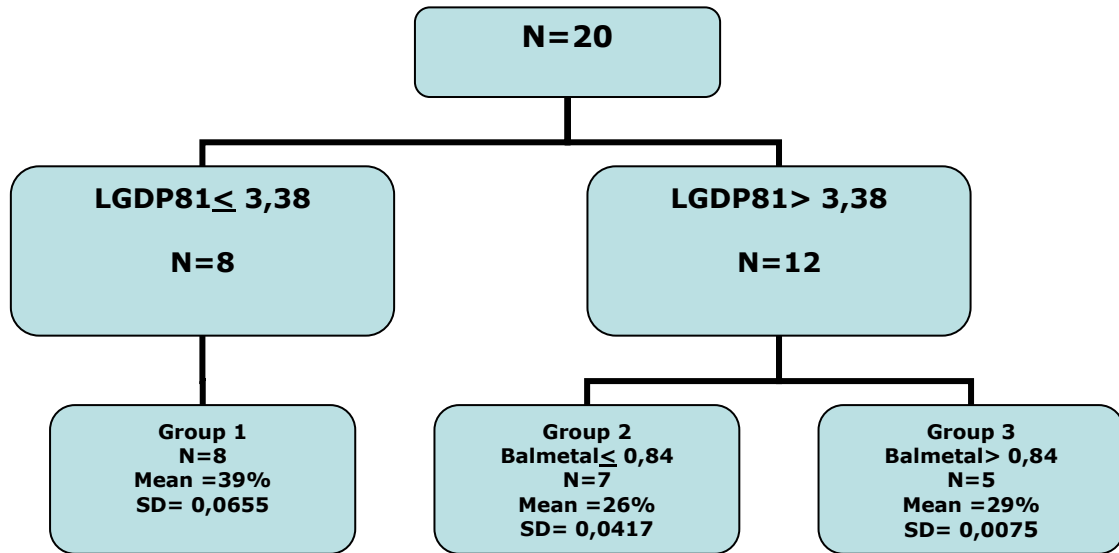
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APPENDIX

Economic indicators:

- AFS = agricultural and forestry surface/total surface;
- Number of telephones per 100 inhabitants;
- Number of airports per 1000 squared kilometres;
- Kilometres of railroad on surface;
- Kilometres of road on surface;
- Numbers of PRA registered motor vehicles per 1000 inhabitants;
- IEI (industry energetic intensity) = industry electric energy consumption/total consumption;
- RSE (renewable source energy)= hydroelectric plus geothermal-electric energy/total energy production;
- Economic dependence degree= net import/GDP;
- Capital accumulation intensity= gross fixed investment/GDP (%);
- Public works/GDP (%);
- Capital labour ratio=total gross capital stock/units of labour;
- Labour productivity= value added/units of labour;
- Enterprises expenditure in R&D/ GDP (%);
- Secondary school participation rate = enrolled in the secondary schools/ population in age class 15-19 (%);
- Population with an high school degree/ total population (%);
- Population with a BA/ total population (%);
- Active BA population/ total population (%);
- Banking concentration = number of bank branches on surface;
- Cooperative banks concentration = number of cooperative bank branches on surface;
- Credit intensity = credit /GDP (%);
- Micro firms concentration = number of firms (workers<10)/surface;
- Small firms concentration = number of firm (10<workers<49)/surface;
- Medium firms concentration = number of firm(50<workers<99)/surface;
- Large firms concentration = number of firms (workers>100)/surface;
- Employment rate= number of employees/population (%);
- Total, female and male unemployment rate=job searching people/labour force (%);
- Differential of female and male unemployment rate (%);
- Male and female juvenile unemployment rates= job searching people in age class 14-29/labour force (14-29) (%);
- Differential male and female juvenile unemployment rates (%).

Regression Tree



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