Community growth and human capital in Italy using a spatial approach: Is there a quality effect of university efficiency?

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Efficiency in Education Workshop, 19-20 September 2014, London

Summary

- Motivation
- Aims, contributions and main findings
- Some literature review
- Data
- Empirical models and analysis
- Results
- Conclusion

Motivation

- HEIs play a crucial role in the knowledge-based economy, as institutions able to supply education, knowledge and services, which contribute substantially to the wealth creation (Potì and Reale, 2005);
- HEIs are important engines of regional and national economic development. They provide management training and contribute to the expansion of life-long learning (Lambert and Butler, 2006);
- Substantial reforms have been taken place in the last years in order to make "higher education not just bigger but also better" (Giannakou 2006);
- The organization of tertiary education systems world-wide is therefore under continuous scrutiny by the policymakers in order to improve the efficiency and relevance of the education provided;

Motivation (cont'd)

- Several are the contribution that universities can make in order to increase local development:
  - Knowledge creation and regional innovation through research and technology transfer represent a relevant channel;
  - Knowledge transfer through education and human resources development, which is linked to the teaching function of the universities;
  - Social, cultural and community development, which is linked to the public role of the universities;
  - Promoting enterprise, business development and growth, all activities linked to the possibility of busting a more entrepreneurial culture and a more favourable business environment;
- The connection between universities and regional (local) growth has been increasingly analyzed by academics;

Motivation (cont'd)

- Investment in tertiary education may affect geographical distribution of economic activity as well as its level;

Aims and Contributions

- Explore whether tertiary education institutions sustain, through the development of human capital and skills, the community (local) economic growth;
- Among the several channels through which the HEI's activities might contribute to sustain regional economies we emphasize a wider set of aspects concerning higher education institutions rather than research activities;
- Local human capital levels might increase through the production of highly skilled graduates and consequently of highly educated workforce;

Aims and Contributions (cont'd)

- We contribute to the existing research shedding further light on the effects that universities might have on raising the ratio of local income per capita including the spatial interaction and spatial structure into our analysis;
  - Whether the closer an area is to an efficient university the higher is the effect of the level of efficiency of the university on the economic development of that area;
- Propose the HEI efficiency scores as a proxy of human capital influencing economic development;

Main findings

- The results reveal the presence of some geographical effects by macro-areas;
  - The institutions in the Central-North area outperforms those in the Southern area;
- University belonging to the private sector are more efficient than those belonging to the public sector;
- We find evidence that the residuals from the OLS regression exhibit spatial autocorrelation;
- We find evidence of effects of university efficiency on the productivity of local areas;
- The average productivity of labour is higher in municipalities that are closer to the more efficient universities;

Some evidence on the role of university on local development

- Universities research activities contribute to the creation of knowledge spillovers within the regional environment leading to an improvement of regional economies (Goldstein et al., 2004);
- HEIs should focus more on research activities and funding in order to respond to regional needs (Goddard, 2004);
- New product development, industry formation, job creation and access to advanced professional and management services (Walshok, 1997);
- Empirical evidence from firm surveys (Mansfield, 1995 and 1997; Cohen et al, 2002, Veugelers and Cassiman, 2005) confirms the importance of university research for corporate innovation performance;
- Knowledge transfers from academia has been investigating through licensing (Shane, 2002), academic spin-off activities (Shane 2002) and citation to academic patents (Henderson et al. 1998);

The other side of the coin

- What about the teaching mission of the universities?
- Highly skilled and well educated individuals are one of the main outputs of universities and at the same time are considered as the ultimate drive of economic development (Florida et al. 2008);
- Local human capital levels might increase through the production of highly skilled graduates and consequently of highly educated workforce (Florida, 1999);
- More skilled and educated workers have a higher chance of being involved in the implementation of new technologies as found by Bartel and Lichtenberg (1987) and Woznaik (1987);
- The provision of graduates is the main contribution of the universities to innovation (Etzkowitz and Leydesdorff, 2000);

The other side of the coin (cont'd)

- This mechanism works especially if graduates remain in the area in which the university is located and thus enter in the local labour market;
  - In general, there is evidence that graduates are very mobile (Whisler et al. 2008; Faggian, McCann, and Sheppard, 2007);
  - Even though they can still influence the local economic development (Faggian and McCann, 2009);
- However, as it turned out from an analysis on Italian graduates 3 and 5 years from graduation, about 90% of graduates reported working in the same region where they live and completed their university education (Bacci et al 2008);
- Productvity of labour is higher in regions that have received larger university-based investments as measured by the number of researchers employed on staff or the number of students enrolled (Andersson et al. 2004);

Data

- The dataset refers to 72 universities (61 public and 11 private) from 2003/2004 to 2007/2008 (CNVSU);
- We identify 686 SLL (akin to UK's Travel-to-Work-Areas) made by ISTAT (Italian Statistical Office);
  - SLL is a group of municipalities adjacent to each other geographically and statistically comparable;
- We also use data on 110 "province" (the NUTS3-type classification);

Location of universities in Italy

Figure : Distribution of the universities

First step: Efficiency of the universities

- We apply a directional distance function approach in order to handle negative variables (undesiderable outputs);
- Traditionally, DEA assumes non-negativity of the inputs and outputs;
  - However, the application of efficiency analysis, dealing with negative data, has been increasingly taken into account in the literature;
  - Even though, to the best of our knowledge, it is almost new in the higher education environment;
- The main indicators which have been used in the literature for evaluating the efficiency of HEIs are positive or desirable outputs (i.e. number of graduates);
- In the last decades, the problem of interrupted careers (i.e. drop out, thus a non-desirable output) has become an increasing concern in tertiary education;

First step: Efficiency of the universities

- We focus on technical efficiency obtained using variable return to scale technologies (Portela et al. 2004), and through an output oriented model (Agasisti, 2009);
- INPUTS:
  - Number of professor;
  - Number of enrolments with a score higher than 9/10 in secondary school;
  - Number of enrolments who attended a lyceum;
  - Total number of students;
- OUTPUTS:
  - Number of enrolments who drop out at the end of the 1st year;
  - Number of graduates weighted by their degree classification;

Efficiency scores

Table : Technical Efficiency – Directional distance efficiency scores by geographical areas and by ownership

	03/04	**04/05**	**05/06**	**06/07**	**07/08**
Geographical area					
North-West	0.8023	0.6937	0.7188	0.7875	0.7879
North-East	0.7718	0.7124	0.7188	0.7222	0.7277
Central	0.8013	0.7618	0.7632	0.7973	0,7937
South	0.5494	0.5096	0.5348	0.6287	0.6193
Ownership					
Public	0.6567	0.6098	0.6117	0.6829	0.6799
Private	1.0000	0.8724	0.9711	0.9574	0.9510

Second step: the effect of HEIs efficiency on local GDP

- The Spatial Autoregressive model Model (SAR)

$$Y_{it} = \rho W_{it} Y + X_{it}\beta + \epsilon_{it} \tag{1}$$

- Y_{ij} is the worker productivity (output per worker) in municipality i in year t;
- $W_{it}Y$ is the spatially lagged dependent variable included as independent variable to account for the effect of neighboring (i.e. SLL) observation;
- $W_{ij} = \frac{1}{d_{ij}}$ represents the inverse distance weighed matrix;
- d is the distance between i and j;
- X_{ij} represents the efficiency score of HEIs mesured in the first step;
- ρ is a spatial autoregressive parameter that measures the strenght of spatial interactions between neighbors;

Second step: the effect of HEIs efficiency on local GDP (cont'd)

- The Spatial Error Model (SEM)

$$Y_{it} = \beta X_{it} + \epsilon_{it} \tag{2}$$

$$\epsilon_{it} = \lambda W_{it} \varphi + u_{it} \tag{3}$$

- Y_{ij} is the worker productivity (output per worker) in municipality i in year t;
- φ is the spatially correlated part of the error term;
- $u \sim (0, \sigma^2 I_n)$ represents the spacially uncorrelated part;
- λ is a spatial autoregressive parameter that measures the strenght of spatial correlation between errors;
- u is the part of the error term that satiesfies the assumption of a normal regression model;

Second step: the effect of HEIs efficiency on local GDP (cont'd)

- The Spatial Durbin Model (SDM)

$$Y_{it} = \rho W_{it} Y + \beta X_{it} + \beta_1 W_{it} X_{it} + \epsilon_{it} \tag{4}$$

- Y_{ij} is the worker productivity (output per worker) in municipality i in year t;
- $W_{it}Y$ is the spatially lagged dependent variable included as independent variable to account for the effect of neighboring observation;
- $W_{ij} = \frac{1}{d_{ij}}$ represents the inverse distance weighed matrix;
- X_{ij} represents the efficiency score of HEIs mesured in the first step;
- $W_{it}X_{it}$ is the spacially lagged independent variable to account for neighboring (i.e. university) observation;
- ρ is a spatial autoregressive parameter that measures the strenght of spatial interactions between neighbors;
- β_1 is a spatial autoregressive parameter that measures the strenght of spatial interactions between HEIs efficiency and neighbors;

Exploratory analysis

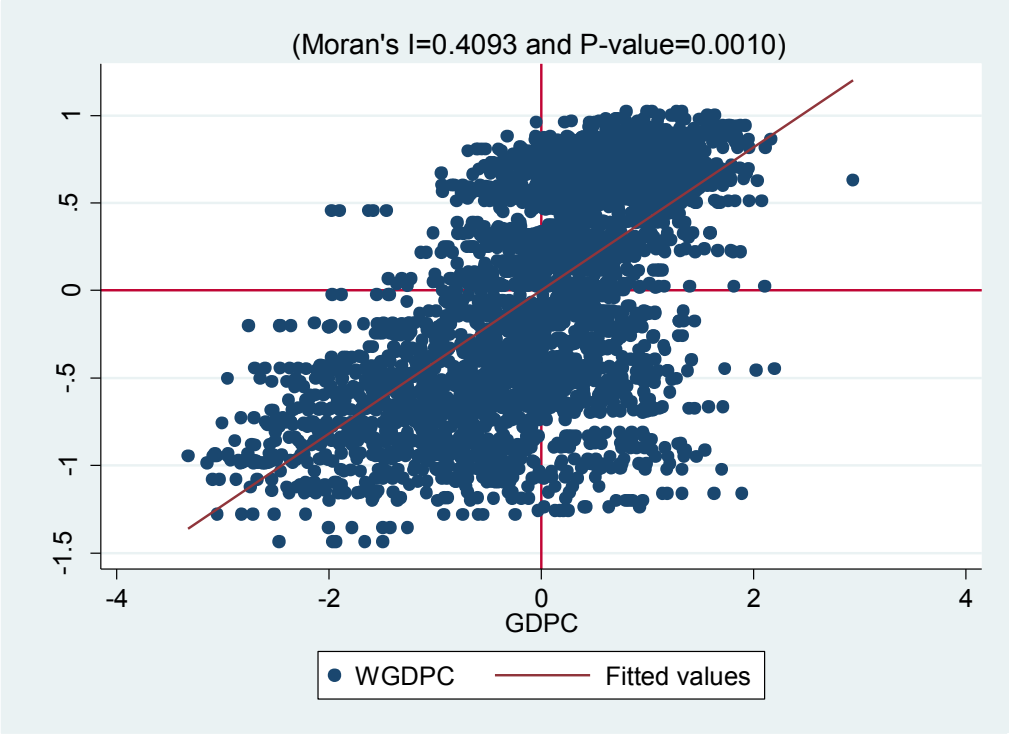
Table : Moran's I values for the dependent variable

	I	**E(I)**	**Sd(I)**	**Z**	**p-value**
Inverse Matrix	0.4093	-0.0003	0.0020	206.2137	0.0000
Inverse Matrix^2	0.4336	-0.0003	0.0033	133.0907	0.0000

* p<0.10, ** p<0.05, *** p<0.01

Visual representation of the existence of a spatial autocorrelation

Figure : Moran's scatter plot



Results

Table : Community productivity using basic regression models and gravity models

	OLS	**OLS**	**NLS**
EFF	0.0639***	0.0007	0.0005
	(0.0143)	(0.0159)	(0.0157)
EFF*W		0.3778***	0.4662***
		(0.0395)	(0.0464)
R	0.3442	0.3566	0.3586
Moran's I	0.101***	0.090***	0.089***

* p<0.10, ** p<0.05, *** p<0.01

Results

Table : Community productivity using spatial autoregressive models

	SEM	**SAR**	**SDM**
Eff	0.0137	0.0267*	0.0084
	(0.0162)	(0.0144)	(0.0163)
Eff*W			0.1005**
			(0.0422)
ρ		0.9159***	0.8804***
λ	0.9259***		
LR(ρ)	0.0000		
LR(λ)		0.0000	
LR(SEM vs SDM)	0.0035		
LR(SAR vs SDM)		0.0160	
Aic	-2266.71	-2269.44	-2273.24
Bic	-2217.59	-2220.32	-2217.98
Wald (λ)	0.0000		
Wald (ρ)		0.0000	0.0000
Likelihood	1141.35	1142.90	1145.62

* p<0.10, ** p<0.05, *** p<0.01

Results (cont'd)

Table : Community productivity using instrumental variables

	SDM (1)	**SDM(2)**
EFF	-0.2855***	-0.2059
	(0.2735)	(0.2343)
EFF*W	0.4283	0.2734
	(0.4228)	(0.3151)
ρ	0.8565***	0.8894***
	(0.935)	(0.0701)
Endogen	0.4712	0.2844
Overid	0.5246	0.6364

* p<0.10, ** p<0.05, *** p<0.01

Exploratory analysis

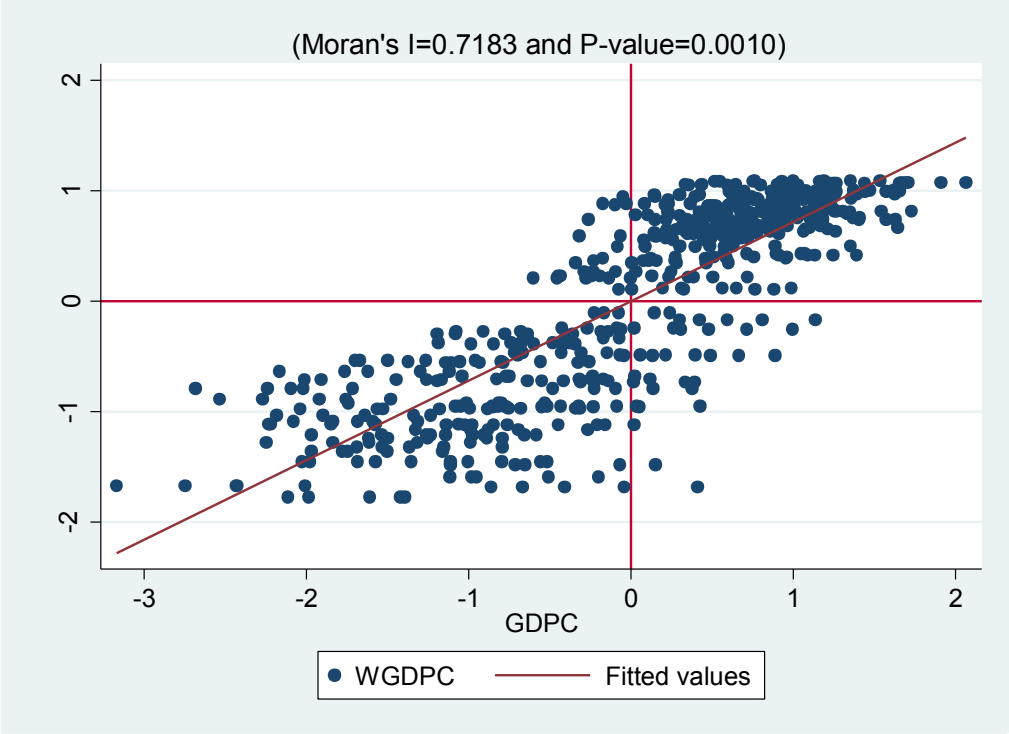
Table : Moran's I values for the dependent variable

	I	**E(I)**	**Sd(I)**	**Z**	**p-value**
Inverse Matrix	0.7183	-0.0018	0.0115	62.5787	0.0000
Inverse Matrix^2	0.7268	-0.0018	0.0130	55.8456	0.0000

* p<0.10, ** p<0.05, *** p<0.01

Visual representation of the existence of a spatial autocorrelation

Figure : Moran's scatter plot



Results

Table : Community productivity using basic regression models and gravity models

	OLS	**OLS**	**NLS**
EFF	0.2040***	0.0085	-0.0100
	(0.0278)	(0.0295)	(0.0270)
EFF*W		0.7502***	0.9606***
		(0.0679)	(0.0767)
R	0.4477	0.5276	0.6130
Moran's I	0.349***	0.359***	0.353***

* p<0.10, ** p<0.05, *** p<0.01

Results

Table : Community productivity using spatial autoregressive models

	SEM	**SAR**	**SDM**
Eff	0.00472 **	0.0654***	0.0355*
	(0.0209)	(0.0180)	(0.0163)
Eff*W			0.1390***
			(0.0422)
ρ		0.8822***	0.8256***
λ	0.9089***		
LR(ρ)	0.0000		
LR(λ)		0.0000	
LR(SEM vs SDM)	0.0001		
LR(SAR vs SDM)		0.0052	
Aic	-1334.982	-1230.821	-1236.62
Bic	-1296.193	-1196 .341	-1197.831
Wald (λ)	0.0000		
Wald (ρ)		0.0000	0.0000
Likelihood	676.49	623.41	627.30

* p<0.10, ** p<0.05, *** p<0.01

Results (cont'd)

Table : Community productivity using instrumental variables

	SDM (1)	**SDM(2)**
EFF	-0.3670	0.0135
	(0.3271)	(0.1788)
EFF*W	0.8154	0.0855
	(0.6253)	(0.2855)
ρ	0.6364***	0.8287***
	(0.1852)	(0.1028)
Endogen	0.2441	0.6588
Overid	0.1332	0.0249

* p<0.10, ** p<0.05, *** p<0.01

Summary and Conclusion

- We investigate the spatial and economic effects of university efficiency on local growth;
- By framing the analysis al SLL level, we focus on very local effects of university efficiency on productivity;
- Firstly, we use Data Envelopment Analysis (DEA) to calculate an index of efficiency for each university;
- Secondly, a parametric approach is used to evaluate the relationship between teaching efficiency and the local growth;

Summary and Conclusion

- Both measures of spatial dependence, ρ and λ are highly significant, and the statistical insignificance of the LR test confirm that the SDM model controls adequately for the spatial autocorrelation in the data;
- We find a significant and statistically positive effect of the universities quality (i.e. being more efficient) on local GDP;
- Productivity gains are larger in areas in which the more efficienct universities are located;
- This result could be interpreted as evidence of knowledge transfer arising from the presence of a particular highly quality institution in that area;

A final comment

- Problem 1: What about controls?
- Problem 2: Is the university efficiency exogenous?

- Thanks!