

Regional Efficiency, Innovation and Productivity

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Structure of the Paper

- Motivation
- Literature
- Data
- DEA analysis
- Knowledge Production Function Analysis
- Linking Regional Innovation and Productivity

Motivation

- Regional Innovation Systems (RIS) literature tries to find the factors that determine an area's innovative performance.
- Universities, private research centres and local P.A.'s interaction create the system itself;
- Is it possible to measure different regional innovation systems' performance, especially when looking at the impact on productivity?

Our idea

1. We try to assess if different methods of efficiency evaluations of RIS produce comparable results, and
2. We link the efficiency results to the productivity performance of regions

Literature

- We rely on the seminal work on Data Envelopment Analysis by Charnes, Cooper and Rhodes, (1978) and on the studies by Fritsch, M., (2002) and Fu, X., (2008) to measure RIS efficiency.
- Fritsch (2002) adopts the knowledge production function: $R\&D \text{ output} = f(\text{R\&D inputs})$, while FU (2008) links innovation performance indicators (input and output indicators) to gross value added through regression analysis.

DEA: Methodology

- We first run a DEA on a sample of OECD regions, on the basis of 3 alternative ordering criteria:
 1. For every country in the database, picked up the region in which the share of R&D over GDP was highest (input based criterion);
 2. For every country in the database, picked up the region in which the share of workers with Tertiary Education over total Labor force was highest (input based criterion);
 3. For every country in the database, picked up the region in which the number of patent application was highest (output based criterion).

DEA results: Regions with highest R&D/GDP

Country	Region	Efficiency rank
Belgium	Vlaams Gewest05	1.00000
United States	Maryland05	1.00000
United Kingdom	Estearn05	0.91092
Germany	Berlin05	0.57648
Italy	Lazio05	0.39296
Canada	Quebec05	0.37577
Austria	Wien04	0.33542
France	Midi-Pyrenees04	0.33269
Finland	Pohjois-Suomi05	0.28182
Greece	Attiki05	0.15367
Hungary	Kosep-Magyarország05	0.14463
Ireland	Border - Midlands And Western05	0.11883
Spain	Navarra04	0.07492
Portugal	Lisboa05	0.07456
Norway	Trøndelag05	0.05724
Sweden	Övre Norrland05	0.04545
Poland	Mazowieckie05	0.03763
Czech Republic	Stredni Cechy04	0.02308
Australia	Australian Capital Territory (Act)05	0.01372

DEA results: Regions with highest Tertiary Ed./Labor

Country	Region	Efficiency
France	Ile De France04	1.00000
Canada	Ontario05	0.53045
United Kingdom	London05	0.45143
Germany	Berlin05	0.20407
Sweden	Stockholm05	0.19743
Italy	Lazio05	0.13477
Austria	Wien04	0.12522
Ireland	Southern And Eastern05	0.12131
Belgium	Reg -Bruxelles-Cap -/Brussels Hfdst -Gew -05	0.06966
Norway	Oslo Og Akershus05	0.06713
Spain	Pais Vasco04	0.06631
Greece	Attiki05	0.06622
Hungary	Kosep-Magyarország05	0.06233
Portugal	Lisboa05	0.03213
Poland	Mazowieckie05	0.01622
Czech Republic	Praha04	0.01506
United States	District Of Columbia05	0.01451
Finland	Etela-Suomi05	0.01150
Australia	Australian Capital Territory (Act)05	0.00469

DEA results: Regions with highest Patent applications

Country	Region	Efficiency
United States	California05	1.00000
Germany	Baden-Wuerttemberg05	0.31578
Italy	Lombardia05	0.26089
France	Ile De France04	0.21858
Finland	Ita-Suomi05	0.15407
Canada	Ontario05	0.11594
United Kingdom	South East05	0.10388
Belgium	Vlaams Gewest05	0.09420
Spain	Cataluna04	0.07288
Australia	New South Wales05	0.05204
Sweden	Stockholm05	0.03209
Ireland	Southern And Eastern05	0.02652
Austria	Wien04	0.01841
Norway	Oslo Og Akershus05	0.01467
Greece	Attiki05	0.01447
Hungary	Kosep-Magyarorszag05	0.01362
Portugal	Lisboa05	0.00702
Poland	Mazowieckie05	0.00354
Czech Republic	Praha04	0.00329

Knowledge production function

- $\ln \text{R\&D output} = \ln a + b \ln \text{R\&D input} + e$
- Two inputs in two separate regressions
- Panel data analysis with pooled negative binomial regression and regional dummies to assess for regional differences in the R&D inputs productivity, in order to separate regional effect to compare with previous DEA analysis.

R&D expenditure as knowledge input

Dependent Variable: Patent Applications						
<i>Region/Independent variables</i>	<i>Coef.</i>	<i>Std. Err.</i>	<i>z</i>	<i>P> z </i>	<i>[95% Conf.</i>	<i>Interval]</i>
R&D expenditure	0.0000	0.0000	4.7500	0.0000	0.0000	0.0000
Vlaams Gewest	3.2554	0.9239	3.5200	0.0000	1.4447	5.0662
Ile De France	2.6718	0.7982	3.3500	0.0010	1.1075	4.2362
Lombardy	1.9871	0.8123	2.4500	0.0140	0.3951	3.5791
Stockholm	2.3275	1.0261	2.2700	0.0230	0.3164	4.3387
South East (UK)	2.0400	0.9231	2.2100	0.0270	0.2308	3.8493
Southern And Eastern (IR)	1.7003	0.9306	1.8300	0.0680	-0.1236	3.5241
Kosep-Magyarorszag	1.5325	0.8426	1.8200	0.0690	-0.1190	3.1840
Ita-Suomi	1.4156	0.7957	1.7800	0.0750	-0.1440	2.9752
Baden-Wuerttemberg	1.5380	0.9152	1.6800	0.0930	-0.2557	3.3316
Oslo Og Akershus	1.0828	0.8390	1.2900	0.1970	-0.5615	2.7272
New South Wales	0.9059	0.8610	1.0500	0.2930	-0.7816	2.5933
California	1.0586	1.0418	1.0200	0.3100	-0.9833	3.1006
Ontario	0.8038	0.7944	1.0100	0.3120	-0.7532	2.3607
Wien	0.9055	0.9156	0.9900	0.3230	-0.8890	2.7000
Cataluna	0.5298	0.7810	0.6800	0.4970	-1.0008	2.0605
Praha	0.2633	0.8838	0.3000	0.7660	-1.4689	1.9956
Mazowieckie	-0.4541	0.8103	-0.5600	0.5750	-2.0423	1.1342
Lisboa	-0.5188	0.8272	-0.6300	0.5310	-2.1402	1.1025
constant term	1.6451	0.6665	2.4700	0.0140	0.3389	2.9514
Number of observations			130	Wald chi ² (19)		121.65
Number of groups			19	Prob > chi ²		0

Tertiary Education as knowledge input

Dependent Variable: Patent Applications						
<i>Region/Independent variables</i>	<i>Coef.</i>	<i>Std. Err.</i>	<i>z</i>	<i>P> z </i>	<i>[95% Conf.</i>	<i>Interval]</i>
Tertiary Education	0.0000	0.0000	7.6000	0.0000	0.0000	0.0000
Lombardia	3.2748	0.7329	4.4700	0.0000	1.8383	4.7112
Vlaams Gewest	2.1565	0.7242	2.9800	0.0030	0.7370	3.5759
Baden-Wuerttemberg	1.9485	0.7315	2.6600	0.0080	0.5148	3.3823
New South Wales	2.0927	0.8234	2.5400	0.0110	0.4788	3.7065
Stockholm	1.6683	0.6956	2.4000	0.0160	0.3050	3.0315
South East (UK)	1.3907	0.7307	1.9000	0.0570	-0.0415	2.8228
Oslo Og Akershus	1.3327	0.7454	1.7900	0.0740	-0.1282	2.7936
Cataluna	1.2438	0.7244	1.7200	0.0860	-0.1760	2.6637
Wien	1.0305	0.7242	1.4200	0.1550	-0.3889	2.4499
Kosep-Magyarorszag	1.0354	0.7540	1.3700	0.1700	-0.4425	2.5132
Ile De France	0.9819	0.7402	1.3300	0.1850	-0.4688	2.4326
Ita-Suomi	0.9539	0.7294	1.3100	0.1910	-0.4757	2.3835
California	0.8221	0.8297	0.9900	0.3220	-0.8041	2.4483
Southern And Eastern (IR)	0.3853	0.7283	0.5300	0.5970	-1.0421	1.8127
Ontario	0.0110	0.6753	0.0200	0.9870	-1.3126	1.3345
Praha	-0.5762	0.7361	-0.7800	0.4340	-2.0189	0.8665
Lisboa	-0.8844	0.7210	-1.2300	0.2200	-2.2976	0.5288
Mazowieckie	-1.3133	0.7181	-1.8300	0.0670	-2.7207	0.0941
constant term	2.4614	0.5315	4.6300	0.0000	1.4196	3.5032
Number of observations			159	Wald chi ² (19)		192.75
Number of groups			19	Prob > chi ²		0

Comparing two approaches

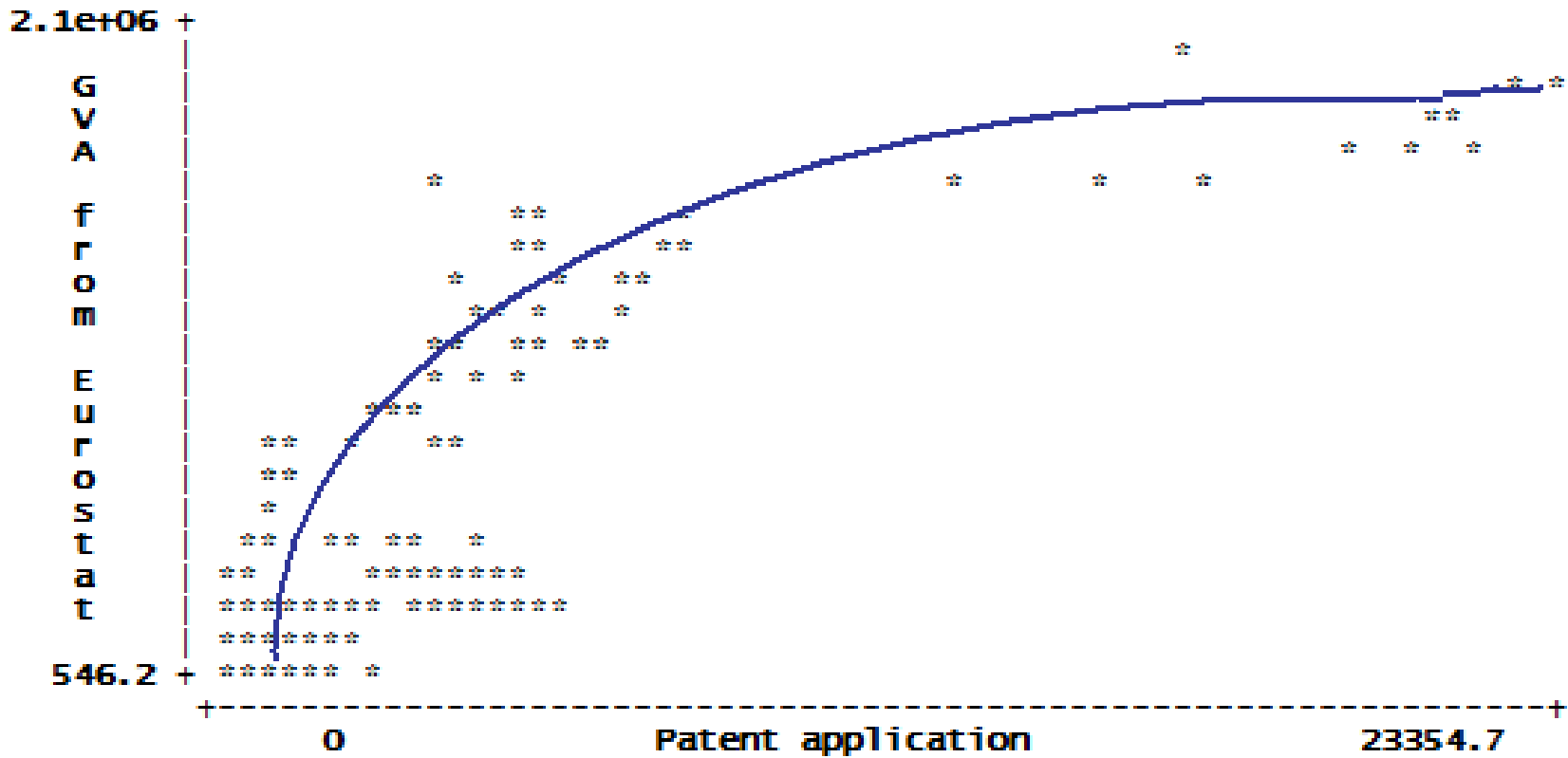
- When MLE is adopted, the relative importance of regions in their marginal contribution to patenting changes significantly with respect to the DEA analysis. So while California was at the top of the DEA ranking, its marginal contribution when R&D and Education are separately considered is weaker.
- Vlaams Gewest and Lombardy give the higher contribution to patenting thanks to R&D and Education, respectively. We could think of some relative comparative advantages here, with respect to the absolute advantages expressed by the DEA analysis.

Linking regional innovation and productivity

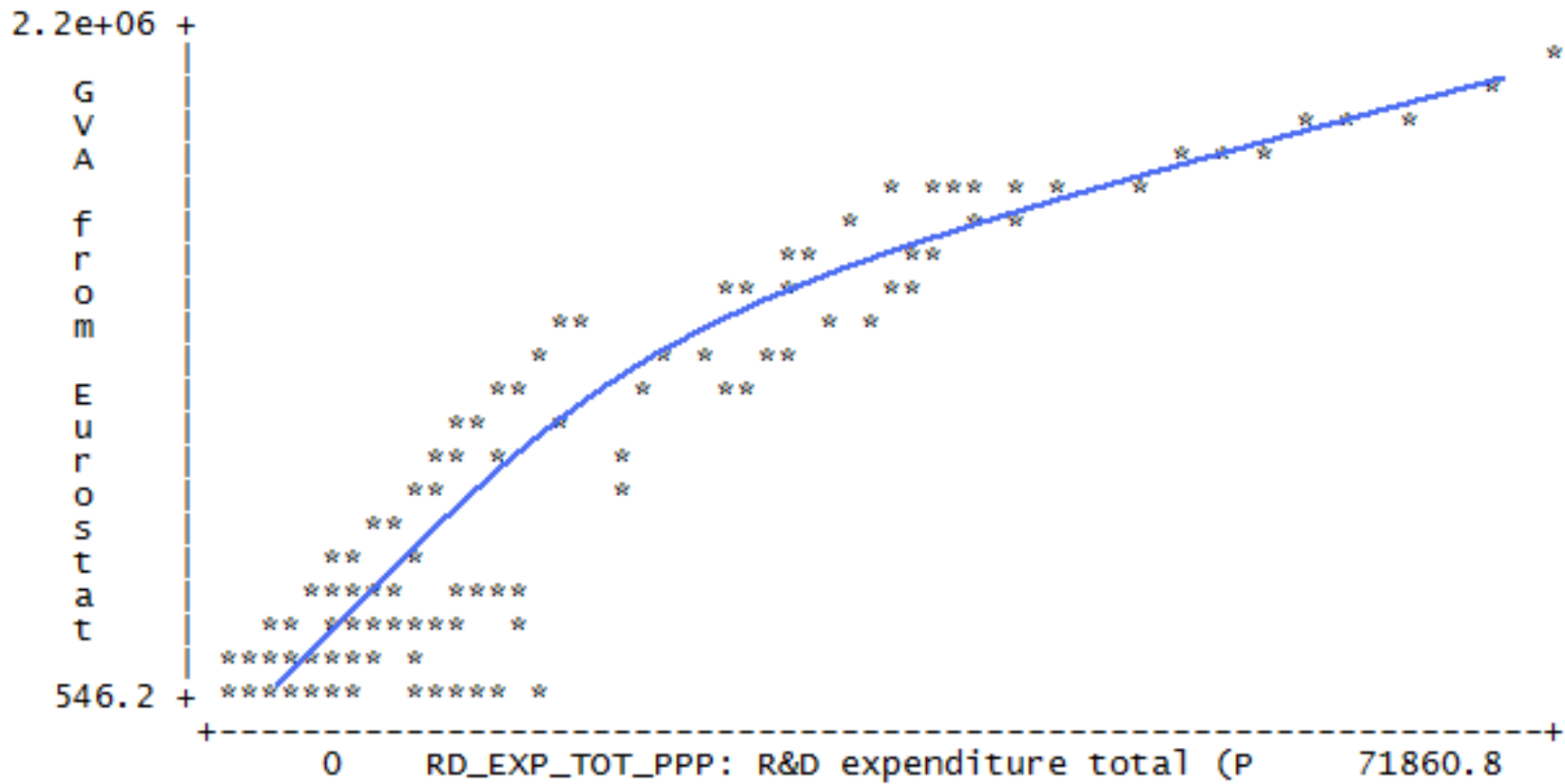
- OECD (2009) finds that there is a positive correlation (0.63) between labour productivity and patents, on a regional basis.
- We computed the correlations for
- patents and regional gross value added (1);
- regional gross value added and R&D expenditure (2);
- regional gross value added and tertiary education (3),

finding some non-linearities

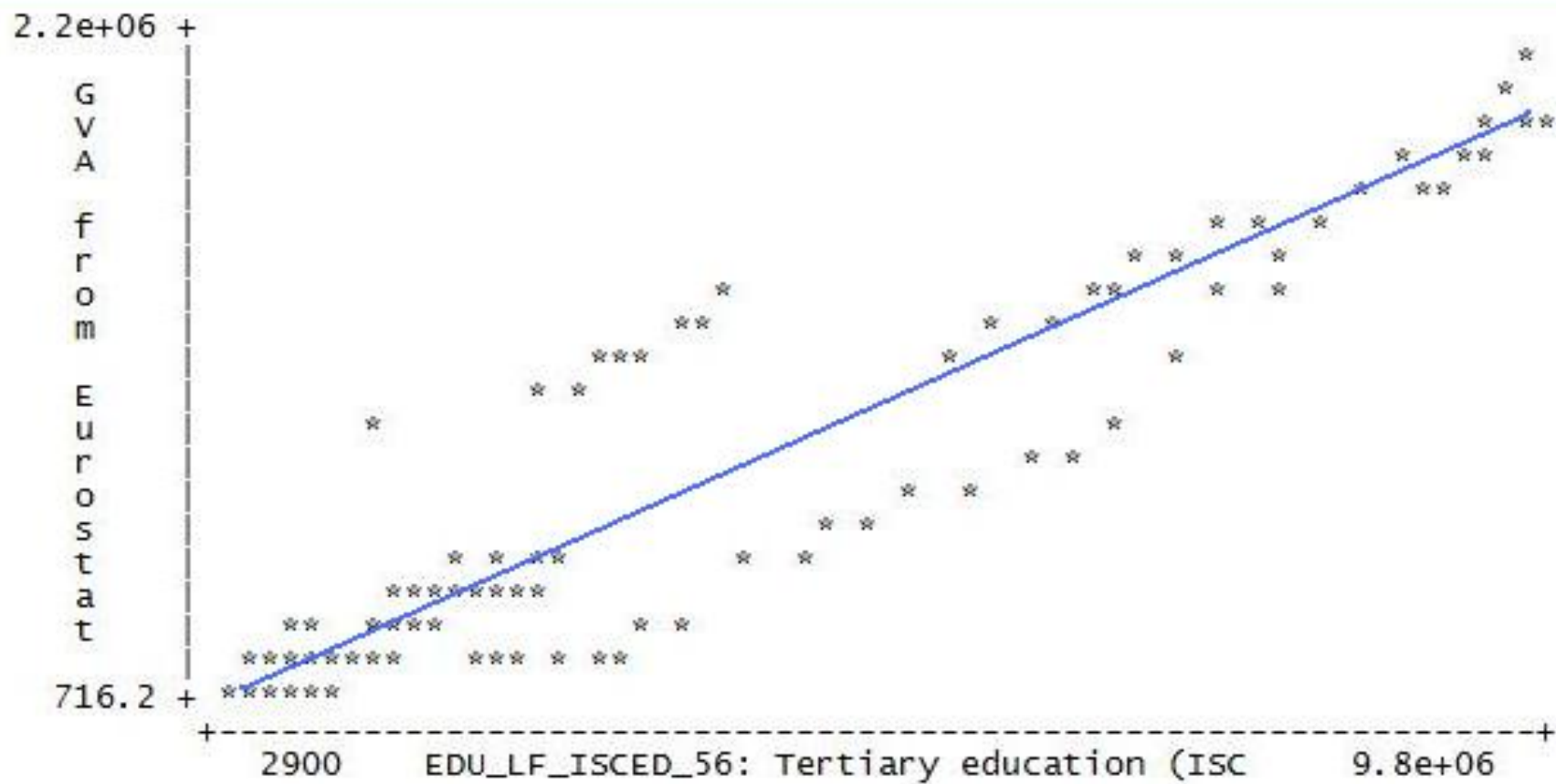
Regional GVA and Patent applications, EU, 1995 – 2007.



Regional GVA and R&D expenditure, EU, 1995 – 2007.



Regional GVA and Tertiary Education, EU, 1995 – 2007.



Linking innovation performance and productivity

- Following the model proposed by Fu (2008), we estimate the impact of innovation on regional economic growth by using input and output-related innovation indicators on regional gross value added.

The impact of patents, tertiary education and R&D on gross value added (1)

- We ran OLS and random effect estimations to find that the non-linearities are confirmed, but while Capital has always the correct sign and is significant, Employment is not.
- There could be inefficiencies in the labor market that hinder the reallocation of labor forces towards the more productive sectors, or there could be some undetected competition effect.

The impact of patents, tertiary education and R&D on gross value added (2)

- When the patenting activity is considered, no single region has a positive and significant effect on gross value added, while many have a significant negative effect, in virtually all the newly EU entered regions (Kosep-Magyarország, Praha, Mazowieckie) but also Ita Suomi, Stockholm and Wien.

The impact of patents, tertiary education and R&D on gross value added (3)

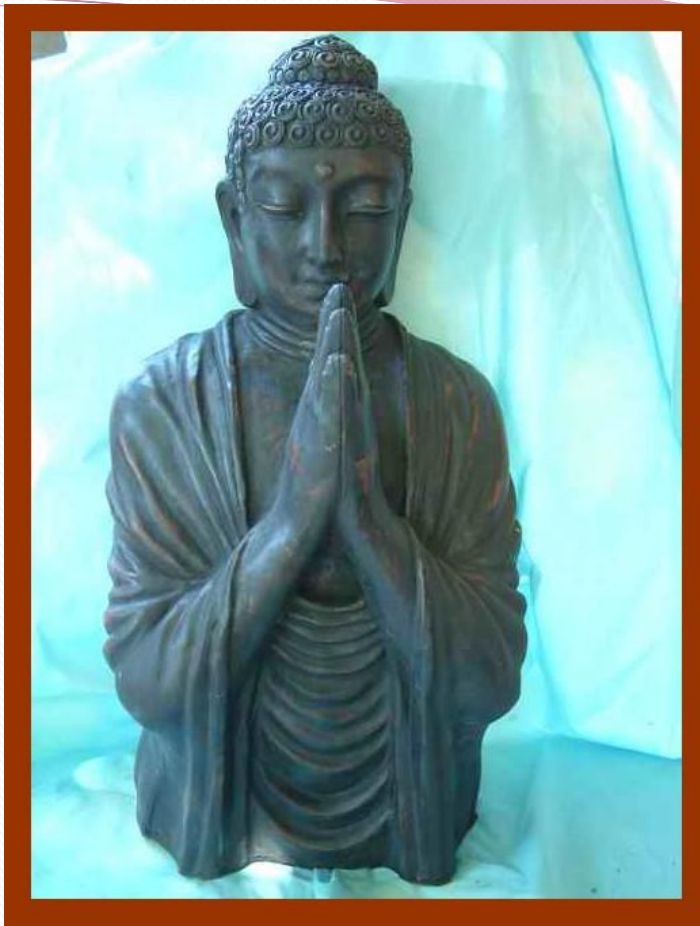
- There is in general no connection between the performance in terms of the output –patents – and the input measures in the knowledge production function.
- When tertiary education is considered , some regions do perform quite well and the results found under the DEA analysis (dummies for Lombardy, Stockholm and Wien) are confirmed. Quality in Education matters in a basic framework for the quantitative evaluation of the knowledge production function.

Conclusions

- As acknowledged, patents are quite an imperfect measure for innovation performance.
- DEA analysis and the econometric approach only partially provide consistent results, and mainly when outstanding regions as California, Ile de France or Baden –Wuerttemberg are considered. Mixed evidence concerns lower ranking regions.

Conclusions

- When linking value added and innovation indicators, results are mixed, although some regularities emerge in using Tertiary Education and some outstanding European regions as Lombardy.
- Efficiency can therefore be ranked for the best performing regions: for lower ranking regions or non-significant regions in the regressions, further research is necessary.



THANK YOU!