
Regional Gaps on Municipal Educational Performance in Colombia, 2007-2012

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We are grateful to ICFES --a public institution in charge of monitoring primary and secondary education in Colombia-- and to Universidad Nacional de Colombia. Both institutions sponsored the research project “Convergencia espacial en el rendimiento educativo en Colombia, 2000-20012”. The results shown here are derived from that research project.

Introduction

- The empirical and theoretical literature on the field of economics stresses the positive impact of education on individual's income, and on the economic performance of countries and regions.
- Thus, regional disparities as reflected by the gaps in income level or life quality might be highly related to regional gaps on education.
- The purpose of this paper is to determine if there are regional differences in municipal educational quality in Colombia, as measured through a standardized test applied to high school senior students in the period 2007-2012.
 - Also, it will determine the neighbourhood effect on the probability of a given municipality to move up in the (empirical) distribution of municipal education quality

Research Questions

- Is there any evidence of convergence in municipal education quality in Colombia between 2007 and 2012?
- What is the probability of any given municipality of moving up or moving down in the distribution of education quality?
- What is the probability of a municipality of moving up or moving down in terms of education quality, given the position of its neighbours?
 - Are there convergence clubs in municipal education quality?

Methodology

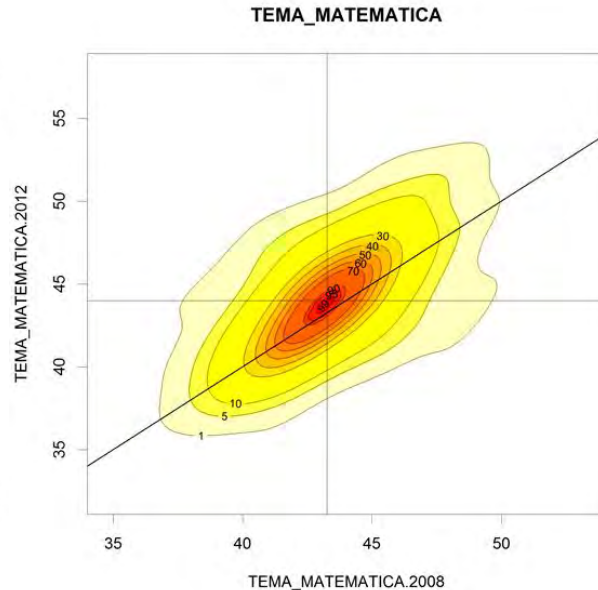
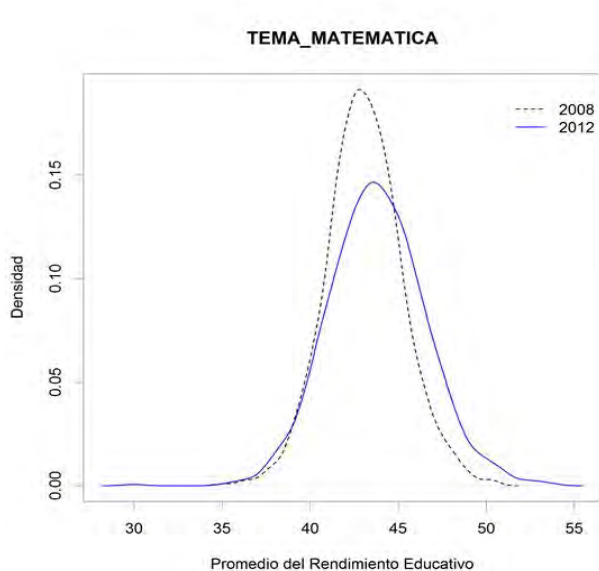
- Stochastic Kernel Distributions
- Classic Markov Probability Matrices
- Univariate and bivariate ESDA (Exploratory Data Analysis)
- Spatial Markov Probability Matrices

Data

We use the results at the municipal level of a standardized test applied to senior high school students in Colombia as a measure of education quality. This standardized test encompasses six basic subjects: biology, chemistry, physics, philosophy, math and language.

For the sake of brevity, we will focus mainly on the analysis carried out on the math test.

Kernel Distributions: Math



Nationwide, there is a slight increase in the overall municipal education quality, as the classic kernel distribution shifts to the right. Nonetheless, at the same time the distribution flattens, implying that there is an increased dispersion and that tails gain weight. These are clear signs of divergence.

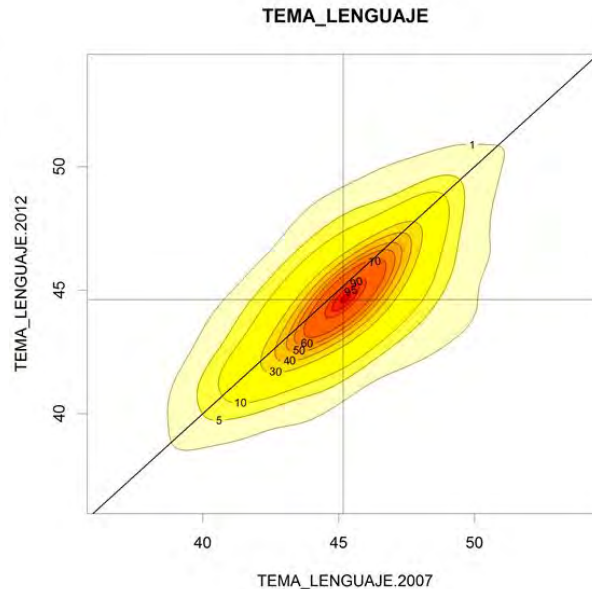
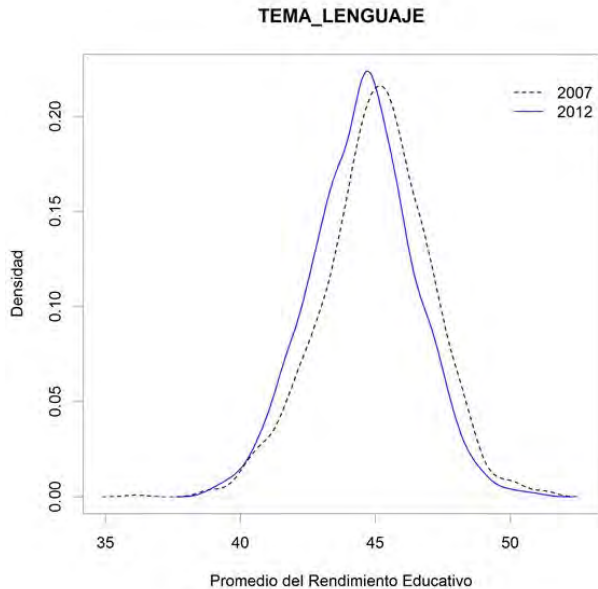
Moreover, the kernel contour map shows that those municipalities with an initial advantage are widening their lead.

Classic Markov Matrix: Math period (2008-2012)

MATHEMATICS					
Probability Matrix	1	2	3	4	5
1	0.584746	0.263771	0.092161	0.038136	0.021186
2	0.271889	0.307604	0.228111	0.134793	0.057604
3	0.09881	0.241667	0.270238	0.261905	0.127381
4	0.045455	0.093434	0.222222	0.34596	0.292929
5	0.021592	0.02969	0.090418	0.192982	0.665317
Overall Probability of	<i>Moving Up</i>	0.3145	<i>Moving Down</i>	0.2523	

The Classic Markov Matrices showcase a high degree of persistence on the tails of the distribution (quantiles 1 and 5). Moreover, it can be seen that probabilities in the upper triangle are higher than those on the lower triangle. This fact translates into a higher probability of moving up. However, as we will see shortly, Classic Markov Matrices do not convey a good enough picture.

Kernel Distributions: Language



The classic kernel distribution shows signs of stability, as it barely moves to the left.

The kernel contour map essentially follows the diagonal line, and the mass of the distribution concentrates at the center of the graph.

Both facts are clear signs of persistence of the education quality distribution. Namely, there is no convergence.

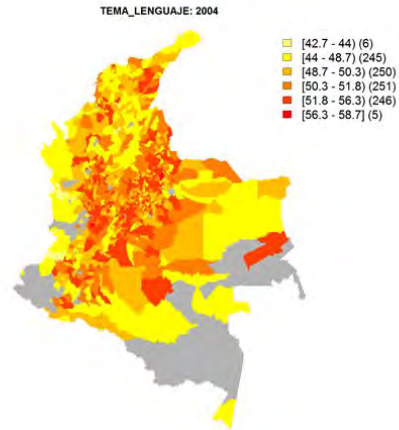
Classic Markov Matrix: Language

		Language				
Probability Matrix		1	2	3	4	5
1	0.503305	0.274788	0.133144	0.063267	0.025496	
2	0.291139	0.285297	0.225901	0.148004	0.049659	
3	0.160156	0.25	0.292969	0.207031	0.089844	
4	0.069676	0.158979	0.245339	0.314033	0.211973	
5	0.037365	0.076696	0.112094	0.241888	0.531957	
Overall Probability of	<i>Moving up</i>	0.2878	<i>Moving down</i>	0.3261		

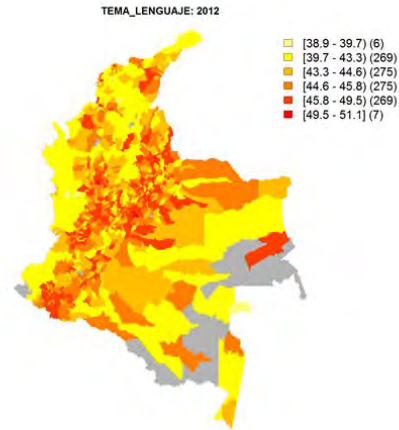
The kernel distribution above showcased a slight movement to the left. This fact is reflected in the higher global probability of moving down. Moreover, municipalities at the third or second quantiles are the ones with the highest chances of declining. Conversely, municipalities in the fourth and fifth quintiles have a much lower probability of moving down the distribution.

ESDA: Boxmaps

Boxmap Language, 2004



Boxmap Language, 2012

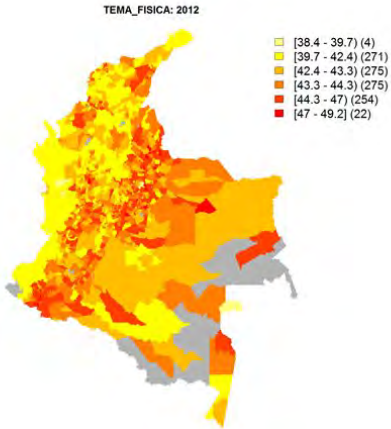


Areas with low education quality are located in the west (Pacific) coast and the north (Atlantic) coast.

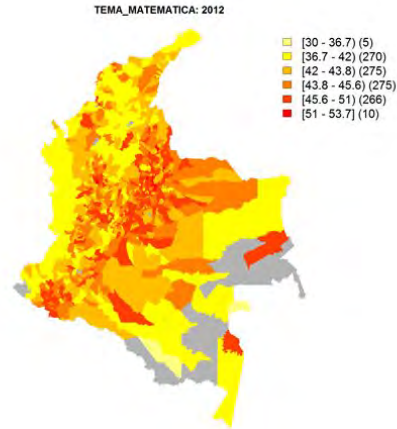
Conversely, municipalities with a high education quality locate in the interior Andean region.

ESDA: Boxmaps

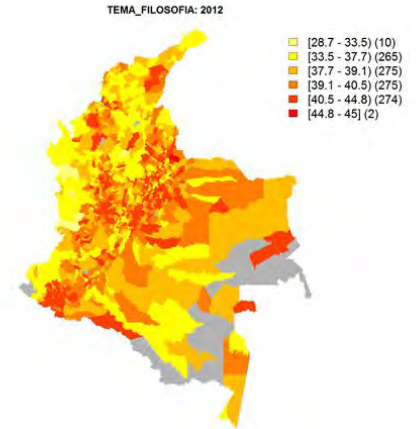
Boxmap Physics, 2012



Boxmap Mathematics, 2012



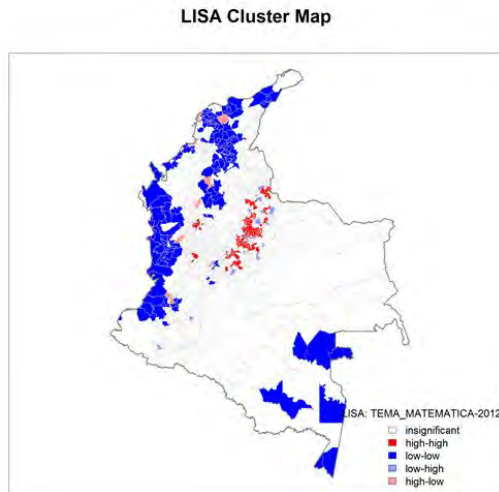
Boxmap Philosophy, 2012



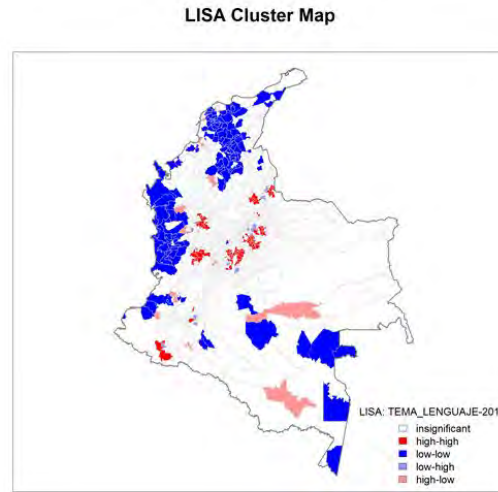
Spatial patterns are pretty robust.

ESDA: Cluster Maps

Mathematics, 2012



Language, 2012



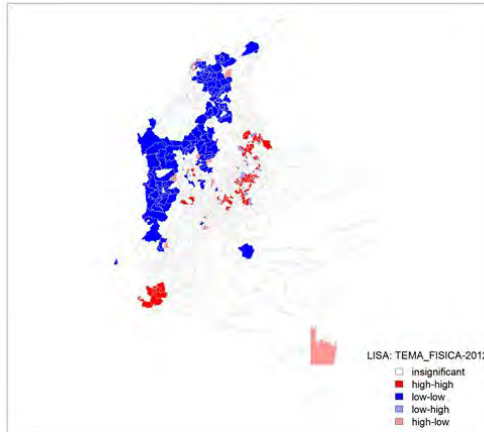
The boxmaps before suggest the presence of pockets of positive spatial association, namely, municipalities cluster together in neighbourhoods of a similar education quality level.

The Local Indicators of Spatial Association (LISA) confirm this hypothesis, as the cluster maps show.

ESDA: Cluster Maps

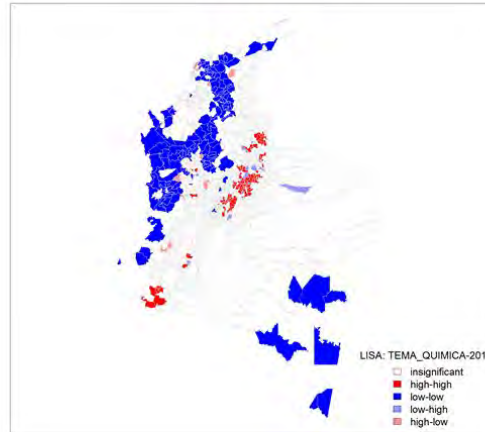
Physics, 2012

LISA Cluster Map



Chemistry, 2012

LISA Cluster Map



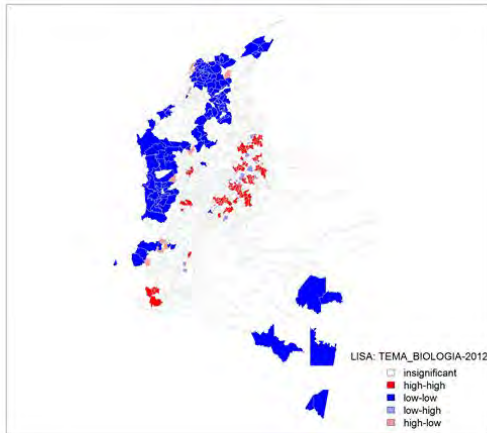
Indeed, the Low-Low clusters or neighbourhoods of low education quality comprise the west (Pacific) and north (Atlantic) coasts.

It is a little bit surprising that Cali's metro area, the third most important urban agglomeration in Colombia, is classified in this cluster.

ESDA: Cluster Maps

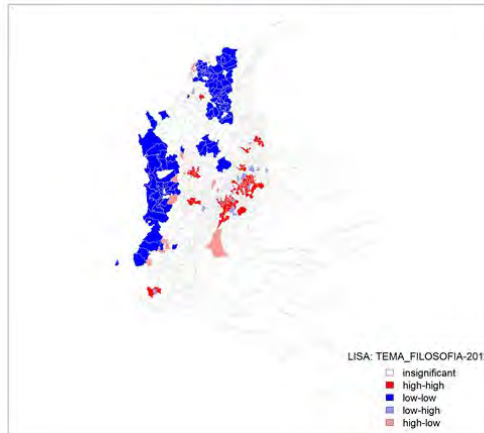
Biology, 2012

LISA Cluster Map



Philosophy, 2012

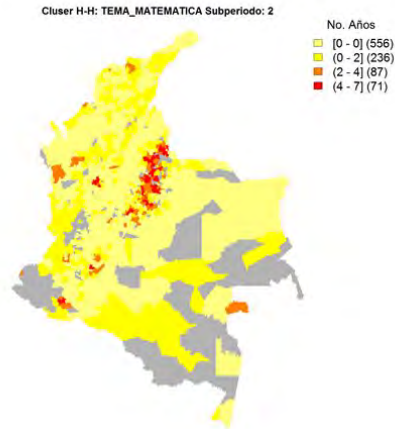
LISA Cluster Map



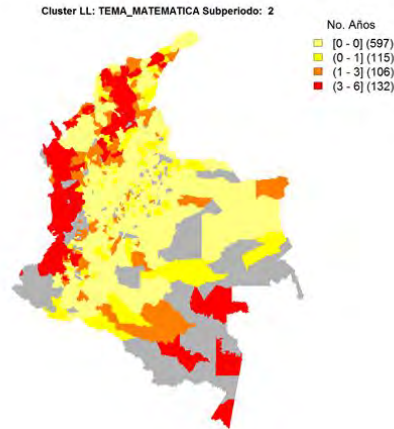
The High-High clusters or neighbourhoods of high education quality are located mainly around Colombia's two main cities -Medellín and Bogotá- and around the Eastern Andean mountain range.

ESDA: Persistence Maps

Mathematics: persistence of the high-high cluster



Mathematics: persistence of the low-low cluster

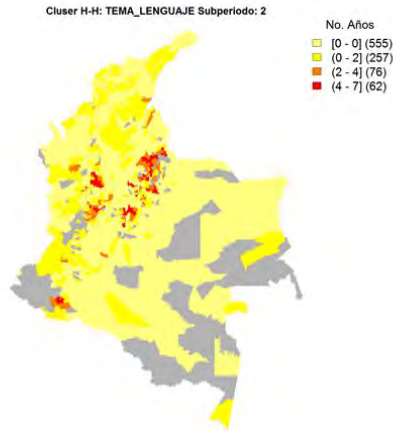


Areas in the high-high cluster $\frac{2}{3}$ (or more) of the time:

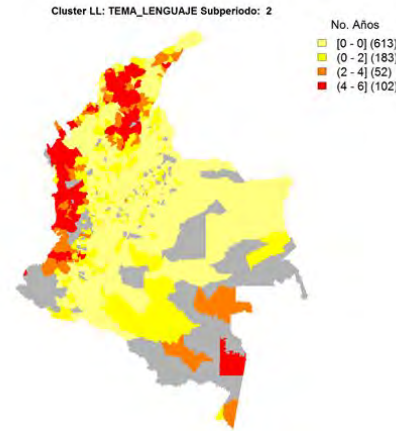
- Bogotá's metro area
- Medellín's metro area
- Bucaramanga's metro area

ESDA: Persistence Maps

Language: persistence of the high-high cluster



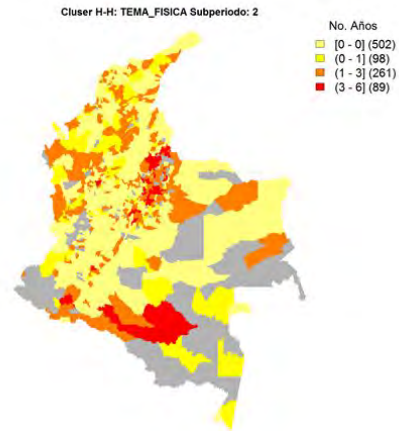
Language: persistence of the low-low cluster



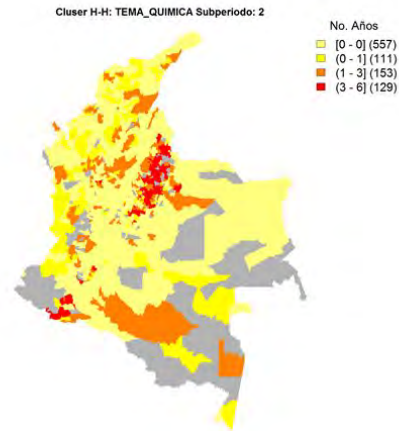
The periphery in terms of education quality again is located persistently in the Pacific (west coast) and Atlantic (northern coast) regions. These are classified in the low-low cluster half the time or more.

ESDA: Persistence Maps

Physics: persistence of the high-high cluster



Chemistry: persistence of the low-low cluster



Persistence maps show clearly that there are no signs of convergence.

Spatial Markov Matrices: Math

Mathematics					
Neighbourhood's education quality quantile: 1					
Probability Matrix	1	2	3	4	5
1	0.843	0.13	0.018	0	0.009
2	0.452	0.407	0.104	0.037	0
3	0.103	0.431	0.241	0.19	0.034
4	0.051	0.077	0.256	0.385	0.231
5	0	0.1	0	0.45	0.45
Overall Probability of:	<i>Moving up</i>	0.16	<i>Moving down</i>	0.202	
Neighbourhood's education quality quantile: 2					
Probability Matrix	1	2	3	4	5
1	0.586	0.226	0.135	0.038	0.015
2	0.327	0.345	0.19	0.113	0.024
3	0.116	0.271	0.364	0.171	0.078
4	0.064	0.11	0.303	0.394	0.128
5	0	0.035	0.158	0.298	0.509
Overall Probability of:	<i>Moving up</i>	0.262	<i>Moving down</i>	0.31	

Convergence club: the probability of moving down when the neighbours showcase a low education quality (quantile 1 or 2) surpasses the probability of moving up.

Note, for instance, that a municipality in the third quantile, which is surrounded by neighbours in the first quantile, has a meager 3.4% chance of climbing to the fifth quantile.

Spatial Markov Matrices: Math

Neighbourhood's education quality quantile: 4					
Probability Matrix	1	2	3	4	5
1	0.308	0.231	0.231	0.077	0.154
2	0.196	0.38	0.174	0.174	0.076
3	0.081	0.176	0.351	0.236	0.155
4	0.013	0.094	0.168	0.376	0.349
5	0.019	0.032	0.101	0.253	0.595
Overall Probability of:	<i>Moving up</i>	0.3	<i>Moving down</i>	0.275	
Neighbourhood's education quality quantile: 5					
Probability Matrix	1	2	3	4	5
1	0.091	0.545	0.273	0	0.091
2	0.125	0.25	0.219	0.234	0.172
3	0.032	0.126	0.232	0.4	0.211
4	0.026	0.125	0.184	0.322	0.342
5	0.03	0.033	0.089	0.155	0.694
Overall Probability of:	<i>Moving up</i>	0.27	<i>Moving down</i>	0.265	

In contrast, a municipality in the third quantile and surrounded by neighbours in the fifth quantile has a 21.1% probability of moving up to that quantile.

In a neighbourhood of medium or high education quality, the overall probability of improving surpasses the probability of going down.

Ergodic (long run) distribution: Math

Initial Distribution

Matemática	1	2	3	4	5
Neighbourhood 1	0.404	0.337	0.169	0.079	0.011
Neighbourhood 2	0.190	0.332	0.239	0.185	0.054
Neighbourhood 3	0.057	0.281	0.250	0.318	0.094
Neighbourhood 4	0.058	0.168	0.318	0.295	0.162
Neighbourhood 5	0.000	0.080	0.280	0.370	0.270

Long run Distribution

Matemática	1	2	3	4	5
Neighbourhood 1	0.636	0.2	0.063	0.061	0.04
Neighbourhood 2	0.269	0.224	0.232	0.174	0.101
Neighbourhood 3	0.124	0.224	0.257	0.203	0.192
Neighbourhood 4	0.075	0.137	0.184	0.258	0.347
Neighbourhood 5	0.043	0.117	0.157	0.235	0.449

63.6% of municipalities surrounded by a neighbourhood of very low education quality would end up in that situation..

44.9% of municipalities surrounded by neighbours in the upper quantile would end up with a very high education quality.

This adds support to the convergence clubs hypothesis.

Spatial Markov Matrices: Language

Language					
Neighbourhood's education quality quantile: 1					
Probability Matrix	1	2	3	4	5
1	0.753	0.204	0.03	0.013	0
2	0.394	0.35	0.169	0.075	0.012
3	0.218	0.269	0.218	0.244	0.051
4	0.071	0.143	0.357	0.268	0.161
5	0.059	0.118	0.118	0.353	0.353
Overall Probability of: <i>Moving up</i>		0.236	<i>Moving down</i>	0.214	
Neighbourhood's education quality quantile: 2					
Probability Matrix	1	2	3	4	5
1	0.473	0.28	0.153	0.073	0.02
2	0.242	0.357	0.238	0.145	0.018
3	0.132	0.236	0.305	0.218	0.109
4	0.032	0.129	0.306	0.298	0.234
5	0.025	0.1	0.062	0.338	0.475
Overall Probability of: <i>Moving up</i>		0.339	<i>Moving down</i>	0.29	

Neighbourhood's education quality quantile: 4					
Probability Matrix	1	2	3	4	5
1	0.312	0.359	0.172	0.094	0.062
2	0.142	0.327	0.212	0.212	0.106
3	0.093	0.134	0.337	0.279	0.157
4	0.024	0.126	0.222	0.319	0.309
5	0.017	0.072	0.138	0.276	0.497
Overall Probability of: <i>Moving up</i>		0.33	<i>Moving down</i>	0.303	
Neighbourhood's education quality quantile: 5					
Probability Matrix	1	2	3	4	5
1	0.279	0.256	0.186	0.116	0.163
2	0.11	0.178	0.274	0.219	0.219
3	0.074	0.215	0.339	0.24	0.132
4	0.028	0.11	0.282	0.287	0.293
5	0.028	0.037	0.077	0.246	0.612
Overall Probability of: <i>Moving up</i>		0.244	<i>Moving down</i>	0.33	

Likewise, here we find that seen that the neighbourhood effect is important, as it determines the probability of moving up or down the distribution.

Ergodic (long run) distribution: Math

Initial Distribution

Lenguaje	Subperiodo 2				
	1	2	3	4	5
Neighbourhood 1	0.493	0.226	0.116	0.089	0.075
Neighbourhood 2	0.235	0.255	0.275	0.137	0.098
Neighbourhood 3	0.063	0.271	0.285	0.264	0.118
Neighbourhood 4	0.085	0.148	0.211	0.317	0.239
Neighbourhood 5	0.065	0.124	0.163	0.288	0.359

Long run Distribution

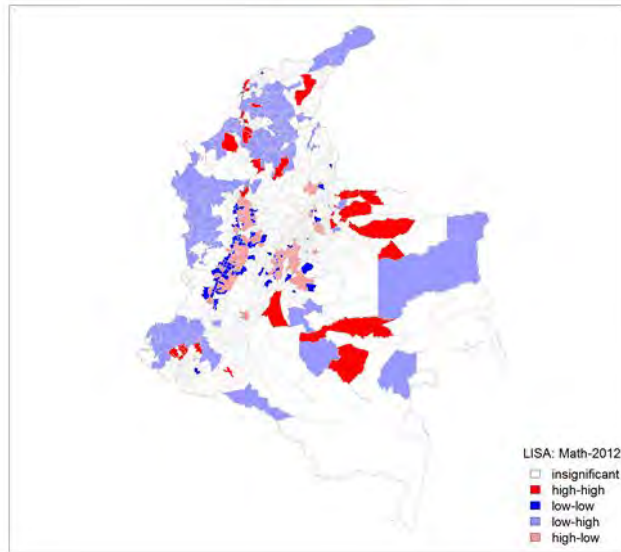
Lenguaje	Subperiodo 2				
	1	2	3	4	5
Neighbourhood 1	0.518	0.238	0.118	0.09	0.036
Neighbourhood 2	0.181	0.228	0.225	0.211	0.155
Neighbourhood 3	0.144	0.239	0.245	0.21	0.162
Neighbourhood 4	0.079	0.164	0.219	0.263	0.275
Neighbourhood 5	0.064	0.125	0.214	0.243	0.354

In the long run $51.8\% + 23.8 = 75.6\%$ of municipalities would end up in the two lower quintiles, if their neighbours belong to the lowest quintile.

Conversely, those municipalities surrounded by neighbourhoods in the highest quintile would end up mostly in two upper quintiles ($24.3\% + 35.4\% = 59.5\%$).

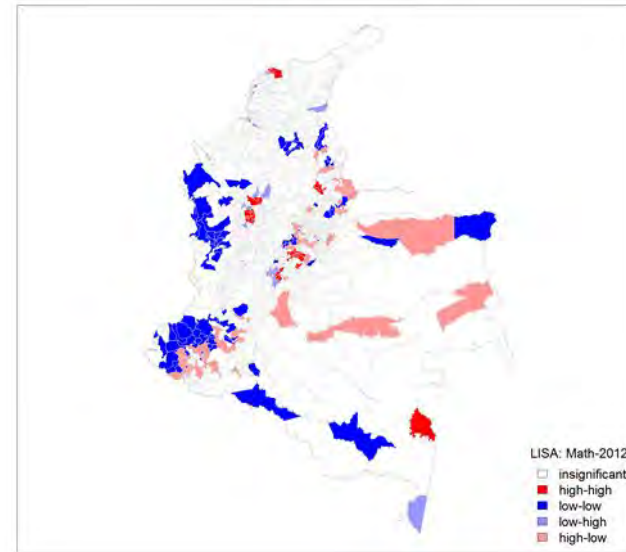
Bivariate LISA cluster Map: Math

LISA Cluster Map



Bivariate LISA: Math score vs. Poverty

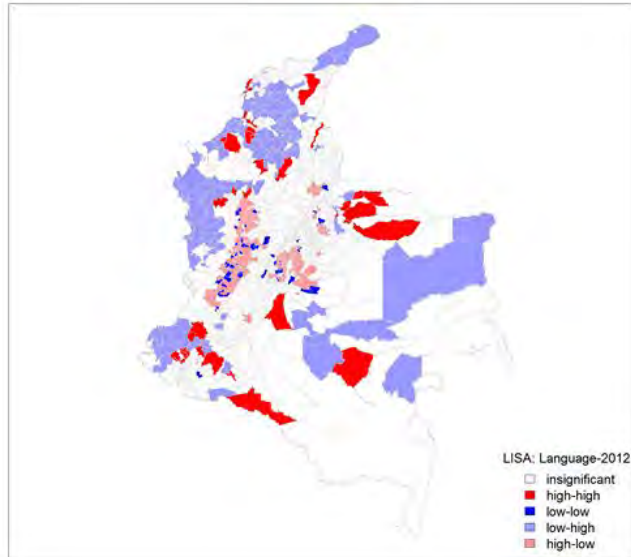
LISA Cluster Map



Bivariate LISA: Math score vs. Per capita energy consumption

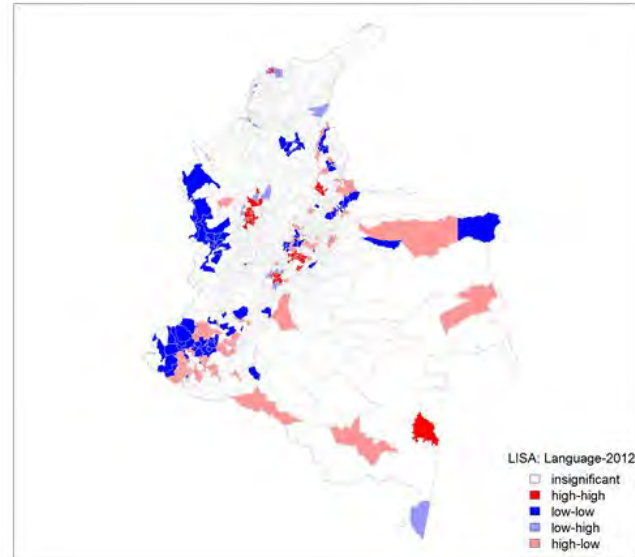
Bivariate LISA cluster Map: Language

LISA Cluster Map



Bivariate LISA: Language score vs. Poverty

LISA Cluster Map



Bivariate LISA: Language score vs. Per capita energy consumption

Spatial Regression: lag spatial model

<i>Coeficientes</i>	<i>Matemáticas</i>	<i>Lenguaje</i>	<i>Física</i>	<i>Química</i>	<i>Biología</i>	<i>Filosofía</i>
<i>NBI</i>	-0.015	-0.046	-0.009	-0.008	-0.018	-0.017
	0.000	0.000	-0.017	-0.032	0.000	0.000
<i>Alfabetismo</i>	2.330	7.842	2.174	4.660	4.431	5.167
	-0.017	0.000	-0.034	0.000	0.000	0.000
<i>Precipitación</i>	0.000	0.000	0.000	0.000	0.000	0.000
	-0.455	-0.637	-0.243	-0.445	-0.105	-0.802
<i>Altura</i>	0.000	0.000	0.000	0.000	0.000	0.000
	-0.010	-0.001	-0.367	0.000	0.000	0.000
<i>Formación bruta de capital fijo</i>	0.000	0.000	0.000	0.000	0.000	0.000
	-0.845	-0.630	-0.475	-0.618	-0.590	-0.657
<i>Regalías</i>	0.000	0.000	0.000	0.000	0.000	0.000
	-0.934	-0.730	-0.001	-0.014	-0.001	-0.170
<i>Rho</i>	-0.016	0.093	-0.026	0.051	0.050	0.045
<i>p-valor</i>	0.355	0.000	0.120	0.003	0.002	0.019

Isles of high education quality

Municipalities in the High-Low cluster

<i>Municipio</i>	<i>NBI</i>	<i>ALFABE</i>	<i>PRECIP</i>	<i>ALTU</i>	<i>FBC</i>	<i>REGA</i>
<i>Caucasia (Antioquia)</i>	52.4	0.856	2120	50	8344.44	4419.58
<i>Turbaco (Bolívar)</i>	49.6	0.895	1398	180	3291.93	0
<i>Argelia (Cauca)</i>	100	0.958	1812	2700	2484.74	0
<i>Santander de Quilichao (Cauca)</i>	33.6	0.934	1619	1076	4311.68	3.1
<i>El Carmen de Atrato (Choco)</i>	31.7	0.822	2850	1592	1288.38	98.16
<i>San Juan del Cesar (La Guajira)</i>	44.8	0.81	842	213	1097.94	0

High-Low cluster averages vs. Nationwide averages

	<i>NBI</i>	<i>ALFABE</i>	<i>PRECIP</i>	<i>ALTU</i>	<i>FBC</i>	<i>REGA</i>
<i>Cluster Alto-Bajo</i>	52.02	0.8755	1774	968.5	2888	753.50
<i>Nivel Nacional</i>	43.94	0.854	1913	1138	5465	820.30

Concluding Remarks

- Generally speaking, it can be seen that kernel distributions move slightly or get flatter (because of increased dispersion).
- Moreover, although classic Markov Matrices showcase a high mobility in intermediate quantiles, it can be seen that the probabilities of staying in extreme quantiles are pretty high.
 - The highest barriers to mobility are on the tails of the distribution, not in its center.
- Hence, it is clear that kernel distributions and classic Markov Matrices do not support the convergence hypothesis among municipalities in terms of education quality in Colombia.

Concluding Remarks

- The spatial distribution of municipal education quality shows sharp patterns. It is clear that municipalities in the west (Pacific) coast and the north (Atlantic) coast have the lowest education quality levels. Conversely, municipalities with a high education quality are located around Colombia's big cities on the Andean region.
- Results suggest that location has a heavy influence on the chances a municipality has of improving or declining in terms of education quality. For instance, a municipality with a high education quality neighbourhood has a lower chance of moving down and an increased chance of moving up in education's quality distribution.
- Finally, results show a high degree of overlap between areas of high poverty and low education quality. The overlap with areas of high economic activity is weaker.

Thanks!

Matrices de Markov Espaciales: Física

FISICA	Subperiodo 2				
Cuantil de Desempeño del Vecindario: 1					
Probability Matrix	1	2	3	4	5
1	0.677	0.217	0.05	0.039	0.018
2	0.376	0.338	0.191	0.051	0.045
3	0.18	0.3	0.27	0.18	0.07
4	0.105	0.224	0.25	0.289	0.132
5	0.145	0.109	0.109	0.236	0.4
Probabilidad global de:	<i>ascender</i>	0.261	<i>descender</i>	0.254	
Cuantil de Desempeño del Vecindario: 2					
Probability Matrix	1	2	3	4	5
1	0.442	0.309	0.149	0.066	0.033
2	0.225	0.346	0.251	0.12	0.058
3	0.244	0.174	0.279	0.198	0.105
4	0.081	0.213	0.265	0.228	0.213
5	0.057	0.1	0.171	0.271	0.4
Probabilidad global de:	<i>ascender</i>	0.352	<i>descender</i>	0.311	

Cuantil de Desempeño del Vecindario: 4					
Probability Matrix	1	2	3	4	5
1	0.273	0.221	0.208	0.156	0.143
2	0.126	0.283	0.276	0.213	0.102
3	0.099	0.244	0.25	0.273	0.134
4	0.079	0.113	0.237	0.328	0.243
5	0.069	0.103	0.149	0.276	0.402
Probabilidad global de:	<i>ascender</i>	0.336	<i>descender</i>	0.351	
Cuantil de Desempeño del Vecindario: 5					
Probability Matrix	1	2	3	4	5
1	0.2	0.22	0.22	0.12	0.24
2	0.116	0.233	0.256	0.209	0.186
3	0.082	0.118	0.245	0.245	0.309
4	0.055	0.127	0.164	0.291	0.364
5	0.03	0.06	0.122	0.17	0.618
Probabilidad global de:	<i>ascender</i>	0.291	<i>descender</i>	0.291	

Para los municipios en el cuantil inferior no deja de ser ventajoso tener buenos vecinos, es decir, vecinos de alto desempeño educativo, puesto que sus chances de escalar son apreciables bajo este escenario (del 80%).

Distribución de largo plazo: Física

Distribución Inicial

Física	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.336	0.350	0.161	0.109	0.044
Vecindario 2		0.172	0.357	0.185	0.191	0.096
Vecindario 3		0.130	0.273	0.224	0.217	0.155
Vecindario 4		0.110	0.221	0.201	0.260	0.208
Vecindario 5		0.078	0.085	0.194	0.264	0.380

Distribución Ergódica

Física	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.436	0.252	0.141	0.101	0.07
Vecindario 2		0.234	0.244	0.225	0.163	0.134
Vecindario 3		0.163	0.191	0.221	0.255	0.17
Vecindario 4		0.112	0.184	0.225	0.264	0.216
Vecindario 5		0.065	0.114	0.174	0.21	0.437

Los municipios en vecindarios de muy bajo desempeño educativo aparentemente tenderían a concentrarse en los dos cuantiles más bajos (en un 68.8%).

Matrices de Markov Espaciales: Química

QUIMICA	Subperiodo 2				
Cuantil de Desempeño del Vecindario: 1					
Probability Matrix	1	2	3	4	5
1	0.789	0.149	0.032	0.019	0.011
2	0.343	0.407	0.174	0.047	0.029
3	0.17	0.295	0.25	0.182	0.102
4	0.115	0.213	0.213	0.262	0.197
5	0.105	0.105	0.158	0.342	0.289
Probabilidad global de:	<i>ascender</i>	0.217	<i>descender</i>	0.219	
Cuantil de Desempeño del Vecindario: 2					
Probability Matrix	1	2	3	4	5
1	0.608	0.215	0.077	0.066	0.033
2	0.245	0.354	0.224	0.13	0.047
3	0.145	0.22	0.266	0.272	0.098
4	0.067	0.179	0.261	0.336	0.157
5	0.074	0.074	0.132	0.324	0.397
Probabilidad global de:	<i>ascender</i>	0.311	<i>descender</i>	0.293	

Cuantil de Desempeño del Vecindario: 4					
Probability Matrix	1	2	3	4	5
1	0.426	0.352	0.13	0.019	0.074
2	0.152	0.355	0.232	0.196	0.065
3	0.062	0.216	0.392	0.227	0.102
4	0.033	0.105	0.221	0.376	0.265
5	0.012	0.064	0.121	0.191	0.613
Probabilidad global de:	<i>ascender</i>	0.284	<i>descender</i>	0.28	
Cuantil de Desempeño del Vecindario: 5					
Probability Matrix	1	2	3	4	5
1	0.281	0.25	0.188	0.188	0.094
2	0.172	0.103	0.224	0.328	0.172
3	0.069	0.146	0.223	0.308	0.254
4	0.034	0.062	0.198	0.395	0.311
5	0.015	0.032	0.085	0.106	0.762
Probabilidad global de:	<i>ascender</i>	0.262	<i>descender</i>	0.232	

Síntomas de persistencia: en vecindarios de bajo desempeño educativo la probabilidad de permanecer en el cuantil inferior excede el 63%. En vecindarios de alto desempeño la probabilidad de permanecer en el cuantil superior excede el 60%.

Distribución de largo plazo: Química

Distribución Inicial

Química	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.393	0.337	0.157	0.079	0.034
Vecindario 2		0.178	0.292	0.330	0.151	0.049
Vecindario 3		0.066	0.282	0.305	0.230	0.117
Vecindario 4		0.038	0.182	0.340	0.270	0.170
Vecindario 5		0.043	0.065	0.174	0.435	0.283

Distribución Ergódica

Química	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.528	0.226	0.11	0.081	0.055
Vecindario 2		0.266	0.223	0.19	0.205	0.116
Vecindario 3		0.172	0.225	0.206	0.225	0.172
Vecindario 4		0.093	0.19	0.227	0.226	0.264
Vecindario 5		0.052	0.072	0.145	0.219	0.512

El 75.4% de los municipios en un vecindario de muy bajo desempeño educativo se ubicarían en los dos cuantiles inferiores, mientras el 73.1% los municipios en vecindarios de muy alto desempeño educativo se ubicarían en los dos cuantiles superiores.

Matrices de Markov Espaciales: Biología

BIOLOGIA Subperiodo 2					
Cuantil de Desempeño del Vecindario: 1					
Probability Matrix	1	2	3	4	5
1	0.826	0.147	0.022	0.002	0.002
2	0.402	0.458	0.101	0.028	0.011
3	0.127	0.286	0.333	0.238	0.016
4	0.118	0.147	0.235	0.294	0.206
5	0.136	0.091	0.091	0.136	0.545
Probabilidad global de:	<i>ascender</i>	0.169	<i>descender</i>	0.176	
Cuantil de Desempeño del Vecindario: 2					
Probability Matrix	1	2	3	4	5
1	0.547	0.27	0.101	0.047	0.034
2	0.277	0.377	0.227	0.1	0.018
3	0.095	0.289	0.343	0.209	0.065
4	0.015	0.149	0.291	0.351	0.194
5	0.017	0.133	0.217	0.267	0.367
Probabilidad global de:	<i>ascender</i>	0.294	<i>descender</i>	0.311	

Cuantil de Desempeño del Vecindario: 4					
Probability Matrix	1	2	3	4	5
1	0.309	0.327	0.127	0.182	0.055
2	0.09	0.297	0.279	0.225	0.108
3	0.076	0.208	0.294	0.289	0.132
4	0.019	0.099	0.254	0.319	0.31
5	0.011	0.033	0.116	0.254	0.586
Probabilidad global de:	<i>ascender</i>	0.337	<i>descender</i>	0.291	
Cuantil de Desempeño del Vecindario: 5					
Probability Matrix	1	2	3	4	5
1	0.281	0.25	0.188	0.188	0.094
2	0.172	0.103	0.224	0.328	0.172
3	0.069	0.146	0.223	0.308	0.254
4	0.034	0.062	0.198	0.395	0.311
5	0.015	0.032	0.085	0.106	0.762
Probabilidad global de:	<i>ascender</i>	0.262	<i>descender</i>	0.232	

Presentan las mejores chances de escalar aquellos municipios en vecindarios de alto y muy alto rendimiento educativo, lo que va en dirección de un proceso general de ampliamento de las disparidades regionales en el desempeño educativo.

Distribución de largo plazo: Biología

Distribución Inicial

Biología	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.477	0.292	0.085	0.085	0.062
Vecindario 2		0.188	0.365	0.218	0.141	0.088
Vecindario 3		0.048	0.361	0.265	0.247	0.078
Vecindario 4		0.039	0.195	0.338	0.240	0.188
Vecindario 5		0.042	0.119	0.263	0.212	0.364

Distribución Ergódica

Biología	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.628	0.226	0.073	0.042	0.03
Vecindario 2		0.224	0.269	0.237	0.174	0.097
Vecindario 3		0.118	0.202	0.253	0.238	0.189
Vecindario 4		0.055	0.142	0.216	0.271	0.316
Vecindario 5		0.039	0.092	0.159	0.249	0.461

La hipótesis del club de convergencia no parece ser contradicha por la distribución ergódica en la tabla, puesto que en el vecindario inferior el 85.4% de los municipios se ubican en los dos cuantiles de bajo desempeño, mientras el 71% de los municipios en vecindarios de alto desempeño educativo se ubican en las dos categorías superiores.

Matrices de Markov Espaciales: Filosofía

FILOSOFIA	Subperiodo 2				
Cuantil de Desempeño del Vecindario: 1					
Probability Matrix	1	2	3	4	5
1	0.701	0.194	0.066	0.024	0.014
2	0.438	0.312	0.193	0.051	0.006
3	0.2	0.289	0.322	0.133	0.056
4	0.096	0.212	0.212	0.269	0.212
5	0.07	0.14	0.07	0.302	0.419
Probabilidad global de:	<i>ascender</i>	0.257	<i>descender</i>	0.201	
Cuantil de Desempeño del Vecindario: 2					
Probability Matrix	1	2	3	4	5
1	0.464	0.305	0.119	0.086	0.026
2	0.245	0.34	0.219	0.136	0.06
3	0.146	0.255	0.343	0.159	0.096
4	0.099	0.143	0.242	0.304	0.211
5	0.06	0.108	0.145	0.301	0.386
Probabilidad global de:	<i>ascender</i>	0.318	<i>descender</i>	0.323	

Cuantil de Desempeño del Vecindario: 4					
Probability Matrix	1	2	3	4	5
1	0.312	0.273	0.286	0.039	0.091
2	0.142	0.22	0.326	0.177	0.135
3	0.054	0.262	0.262	0.188	0.233
4	0.024	0.095	0.262	0.341	0.278
5	0.032	0.102	0.116	0.282	0.468
Probabilidad global de:	<i>ascender</i>	0.336	<i>descender</i>	0.332	
Cuantil de Desempeño del Vecindario: 5					
Probability Matrix	1	2	3	4	5
1	0.283	0.245	0.189	0.132	0.151
2	0.152	0.163	0.25	0.239	0.196
3	0.041	0.149	0.273	0.281	0.256
4	0.015	0.115	0.2	0.31	0.36
5	0.036	0.052	0.099	0.234	0.579
Probabilidad global de:	<i>ascender</i>	0.28	<i>descender</i>	0.311	

Distribución de largo plazo

Distribución Inicial

Filosofía	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.462	0.238	0.133	0.133	0.035
Vecindario 2		0.186	0.244	0.276	0.244	0.051
Vecindario 3		0.104	0.274	0.252	0.207	0.163
Vecindario 4		0.071	0.200	0.271	0.282	0.176
Vecindario 5		0.045	0.142	0.201	0.328	0.284

Distribución Ergódica

Filosofía	Subperiodo 2					
		1	2	3	4	5
Vecindario 1		0.48	0.234	0.145	0.083	0.058
Vecindario 2		0.221	0.247	0.219	0.182	0.131
Vecindario 3		0.154	0.228	0.231	0.223	0.164
Vecindario 4		0.075	0.171	0.234	0.238	0.282
Vecindario 5		0.059	0.109	0.177	0.256	0.399

Las distribuciones ergódicas sugieren una situación de persistencia de las disparidades existentes, puesto que el 71.4% de los municipios en vecindarios de muy bajo rendimiento educativo se posicionan en los cuantiles 1 y 2, mientras el 65.5% de los municipios en vecindarios de muy alto rendimiento se ubican en los cuantiles 4 y 5.