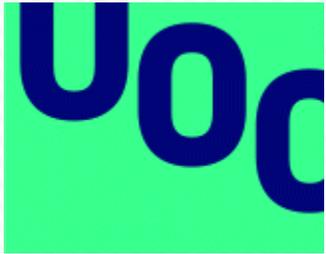




European  
Commission

# Regionalisation of ESIF payments 1989-2015



Rosaria Chifari, Samuele Lo Piano, Andrea Saltelli

2017.11.24

Seminar on Robustification of the Regional Payments Databases,  
Universitat Oberta de Catalunya

## The purpose of the project 'Regionalisation of ESIF payments 1989-2015 [...]'

- Given the DG REGIO database of COM payments at the NUTS2 level, produce a simulation of beneficiaries expenditure;
- Address the time lag between the actual beneficiaries expenditures and the reported COM payments;
- Provide a robustification and sensitivity analysis of the proposed distribution of expenditures.

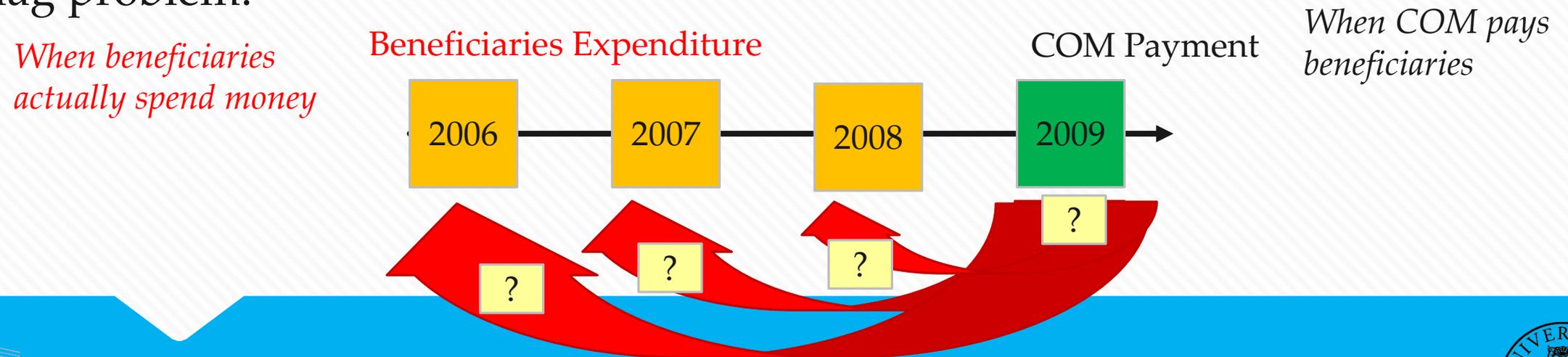


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# Problem setting

- Payments from the EC to e.g. regional authorities may not correspond to the actual expenditures incurred by the same authorities toward the beneficiaries. Thus, any analysis of the impact of the cohesion programmes is confronted with a time-lag problem.



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# Problem setting

- Payments from the COM to e.g. regional authorities do not corresponds to the actual expenditures incurred by the same authorities toward the beneficiaries. Thus, any analysis of the impact of the cohesion programmes is confronted with a time-lag problem.
- Is it possible to estimate via modelling a plausible distribution of beneficiaries expenditures given the COM payments?



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KYKLOS, Vol. 61 – 2008 – No. 1, 3–18

How does Sub-National Autonomy Affect the Effectiveness of Structural Funds?

ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)  
SciVerse ScienceDirect

Journal of Policy Modeling 34 (2012) 403–418

Structural funds and the economic divide in Italy

Journal of  
Policy  
Modeling

[www.elsevier.com/locate/jpm](http://www.elsevier.com/locate/jpm)

- Why is it important to work at NUTS2 level



ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)  
ScienceDirect  
European Economic Review

Spatial heterogeneity at the European Union: Do convergence

*...at NUTS2 level is it possible to test the effectiveness of the cohesion policies so, the analysis will be done at this level*

CONVERGENCE IN PORTUGAL AND  
STRUCTURAL FUNDS ON GROWTH?

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# The data

- **4** EU funding schemes: CF, EAGGF, ERDF, ESF – which amount to **95%** of the reimbursed COM payments (Cohesion Fund, European Agricultural Fund for Rural Development, European Regional Development Fund, European Social Fund)
- **4** programming periods: 1989-1993, 1994-1999, 2000-2006, 2007-2013

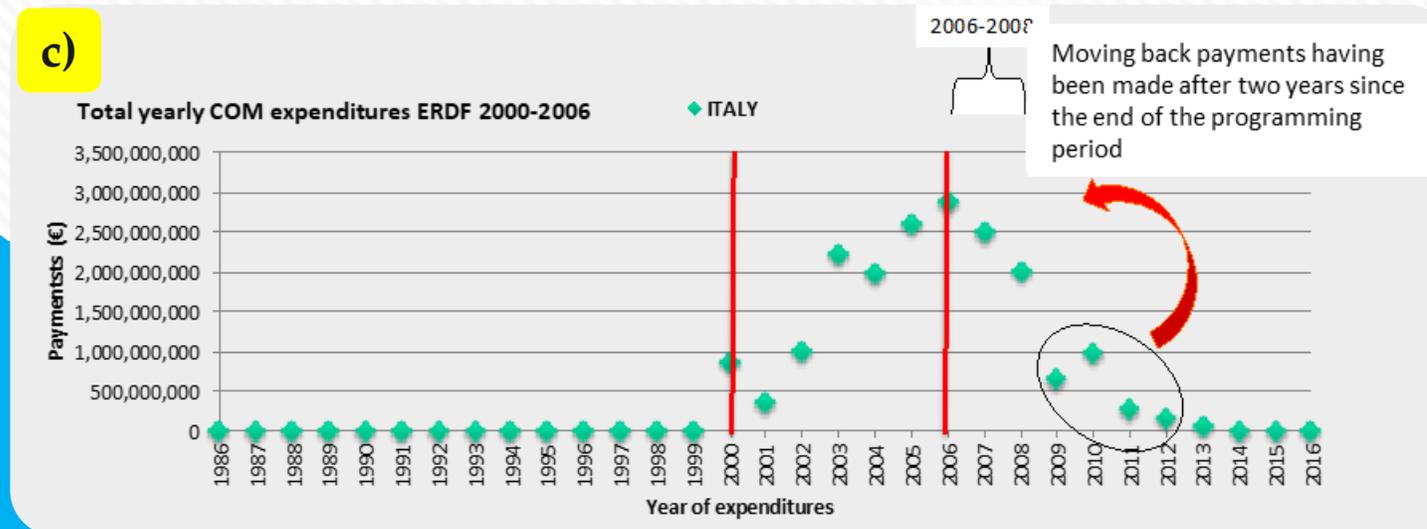


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# How to deal with the expenditures/payment time lag?

- Assuming on a yearly basis that beneficiaries expenditures = COM payments;
- Assuming that the expenditures take place at the end of the programming periods (when the majority of the COM payments are actually reimbursed);
- Trimming the right tails of the COM payments to e.g. two years after the end of the programming period (i.e. re-attributing only those payments to expenditures taking place on previous years)
- Re-attributing the COM payments over the entire programming period according to a set of plausible rules



ases,



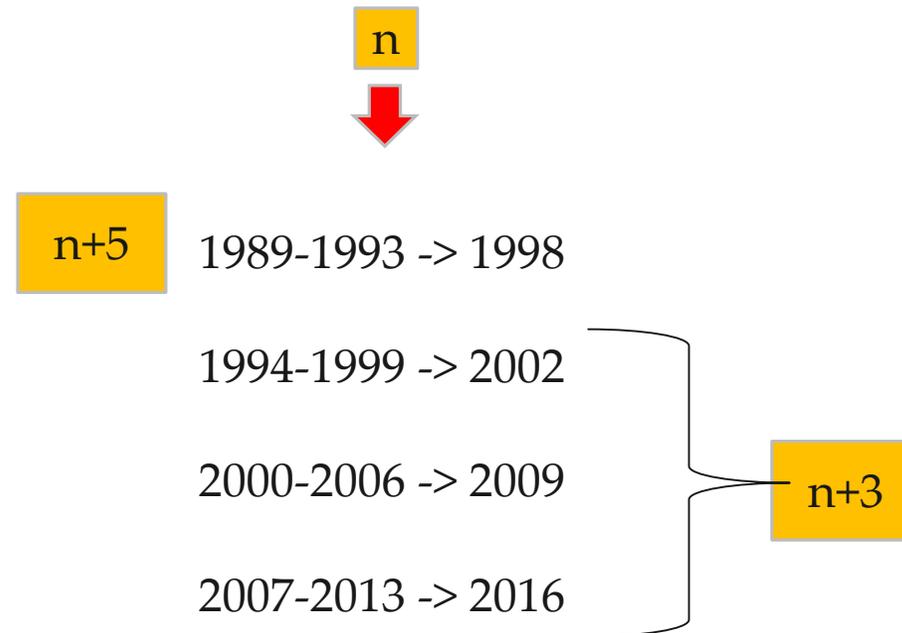
# How to deal with the expenditures/payment time lag?

a) Assume on a yearly basis beneficiaries expenditures = COM payments

Last eligible year of spending for each programming period:

*Rejected !!*

*Several COM payments are reimbursed beyond the last eligible year of spending*



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# Towards an algorithm for defining the distribution of beneficiaries expenditure

- It is needed to develop an algorithm for the actual expenditures re-attribution!!
- How do beneficiaries spend COM Funds?
- Can we come out with any rule of spending looking at the trend of COM payments? Does exist any reproducible pattern of spending?



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# Towards an algorithm for expenditure attribution: defining the spending pace

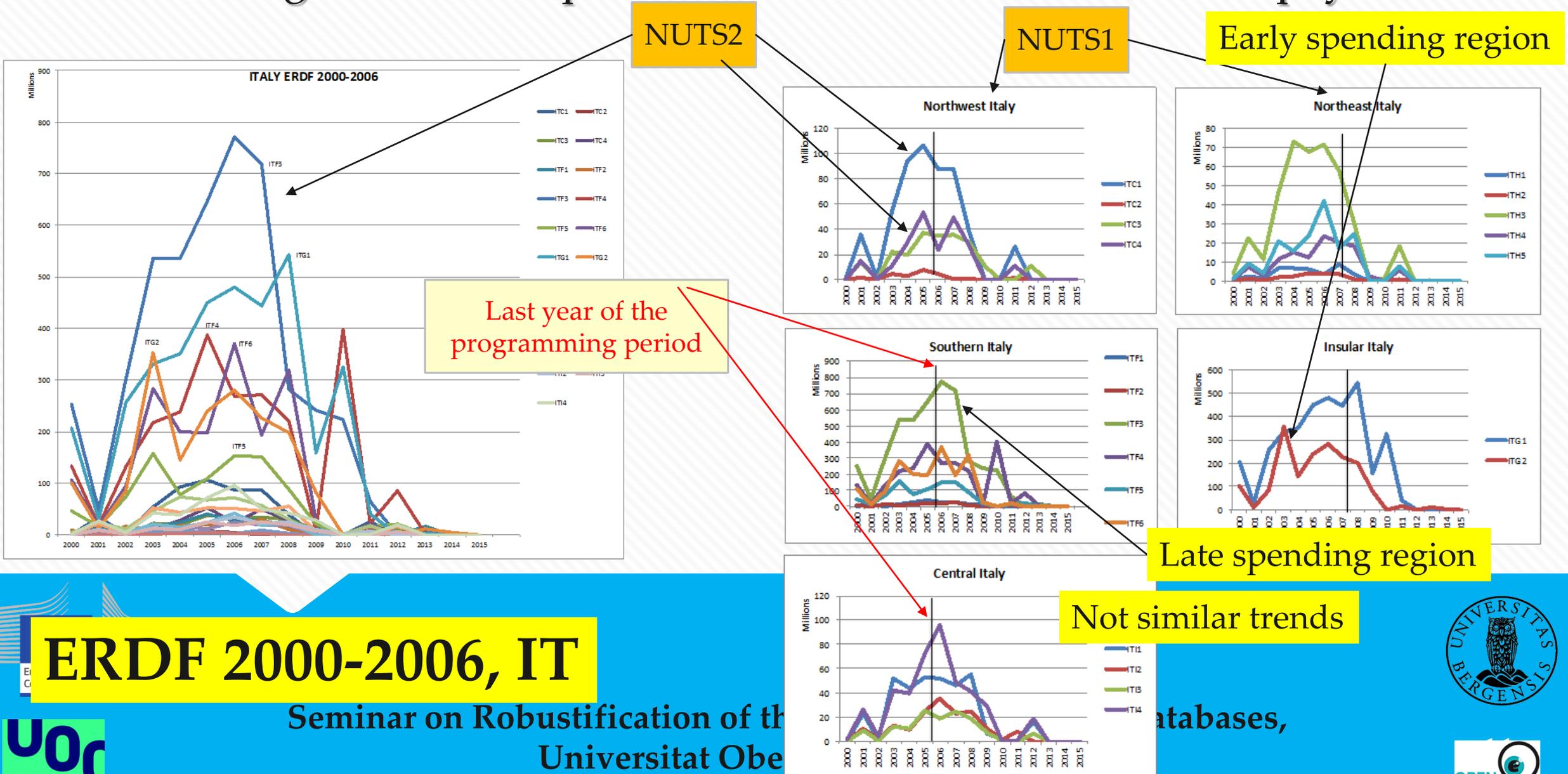
- What are the countries or regions that are faster in spending?
- How is it possible to define a spending pattern?
- Is this spending pace linked to the administrative capacity of the specific country or region?
- Is there any further quality aspect affecting the spending pace?
- Is it better to timely spend or it is important just to spend by the end of the programming period?



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# Towards an algorithm for expenditure attribution: trend of COM payments in IT



**ERDF 2000-2006, IT**

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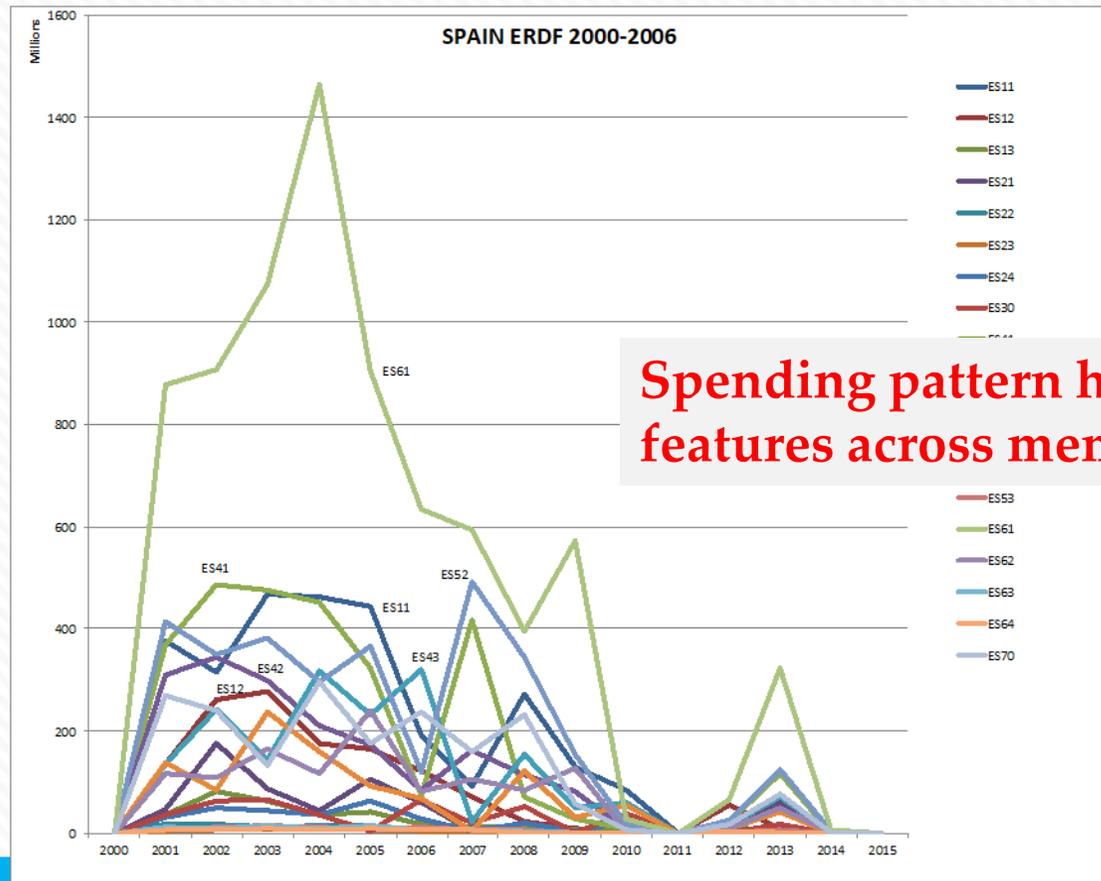
Late spending region

Not similar trends

databases,

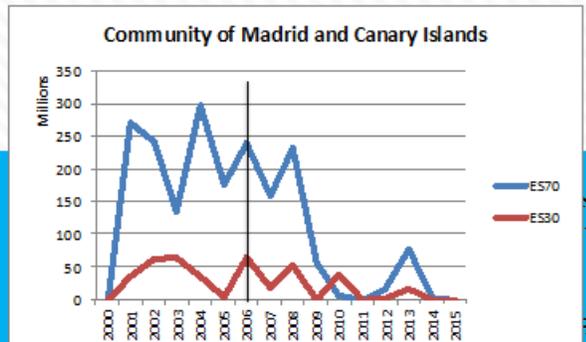
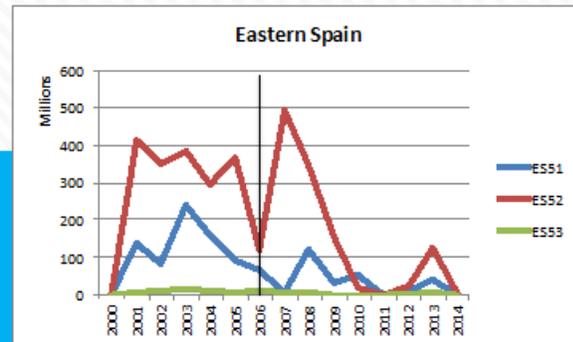
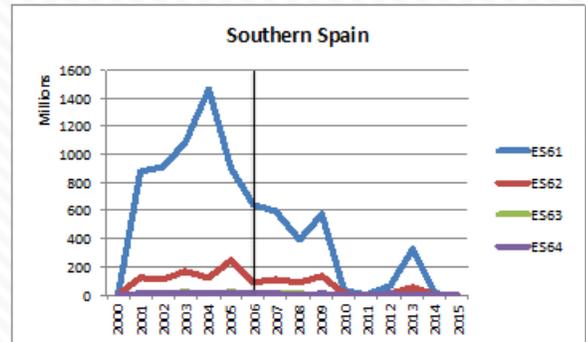
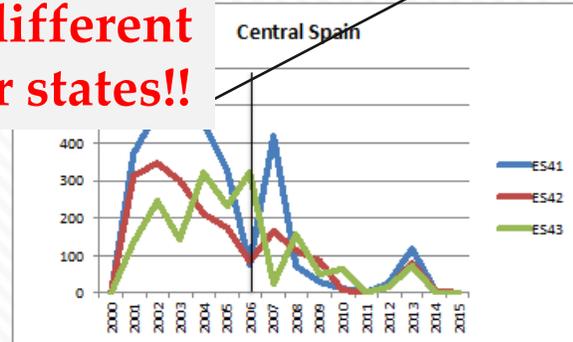
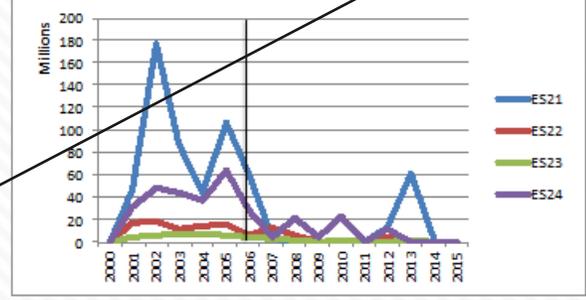
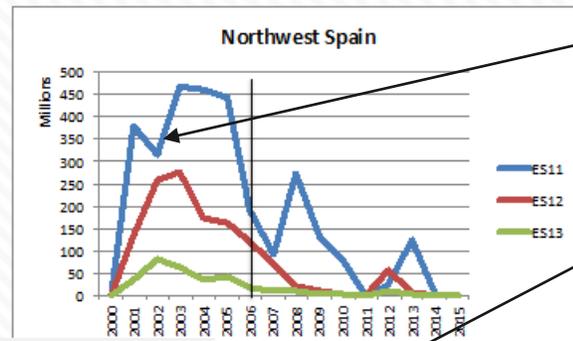


# Towards an algorithm for expenditure attribution: trend of COM payments in ES



Spending pattern has different features across member states!!

Early spending region



ERDF 2000-2006, ES

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**Let's try another assumption!!**

## Are late payments due to high spendings in infrastructure?

- Late COM payments <- high share of COM payments in the '**overlap**' year (i.e. first extra year, e.g. 2007 for PP 2000-2006)
- Late COM payments -> high share of payments for infrastructural activities

First year of the new programming period and the «extra» year of the previous one

### Infrastructure interventions:

- Tourism and Culture
- Energy
- Transport Infrastructure
- Environment and natural resources

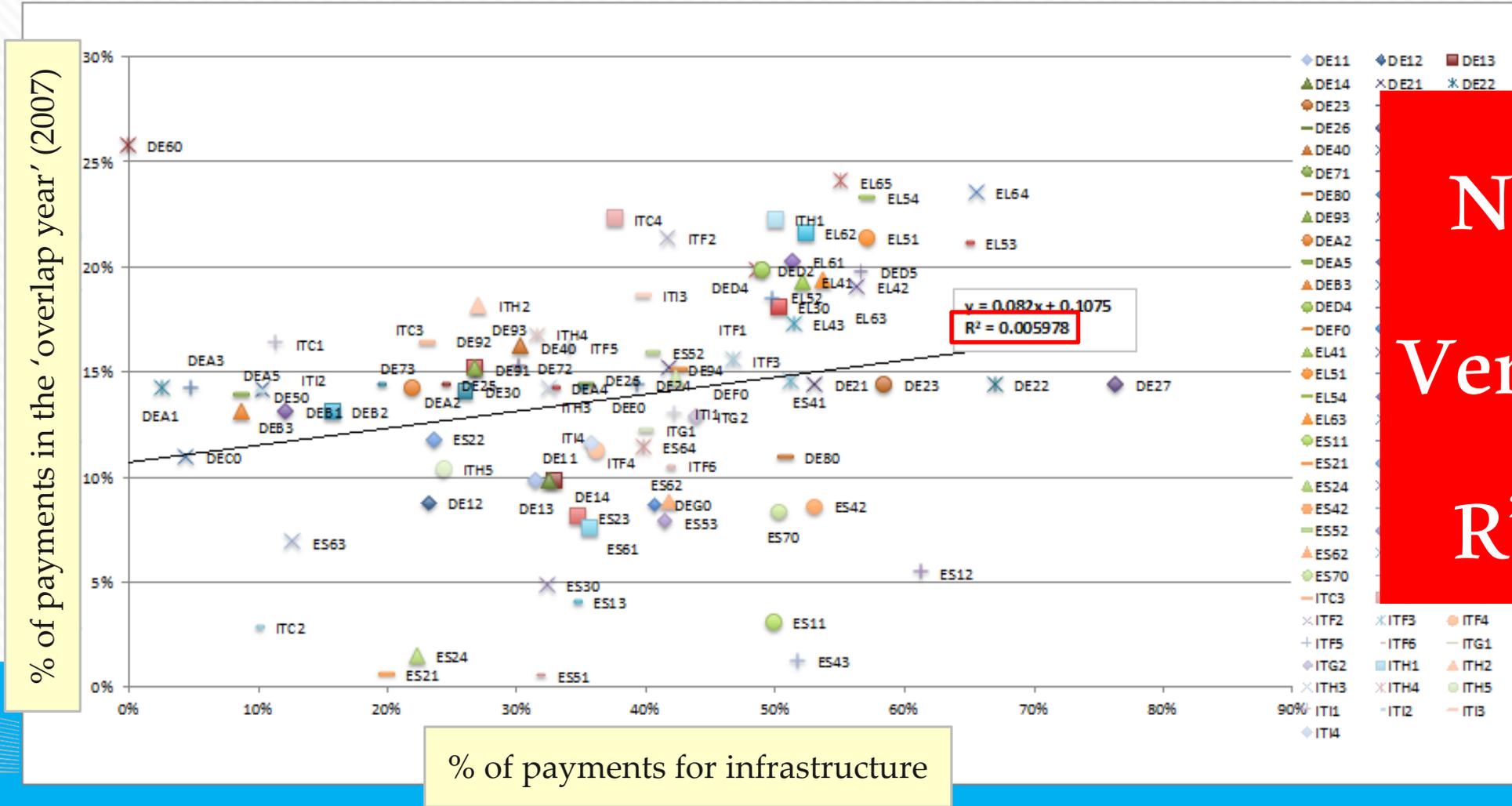
### Non-infrastructure interventions:

- RTD
- Business support
- IT Infrastructure and services
- Human resources
- Social Infrastructure
- Urban and rural regeneration
- Technical Assistance
- Other

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# Are late payments due to high spendings in infrastructure?



Nope!  
Very low  
 $R^2$  😞



ERDF 2000-2006 – DE, EL, ES, IT



# Let's include more years! Are payment patterns monotonous?

3 NUTS2 in Italy:

Piedmont (ITC1)

Lombardy (ITC4)

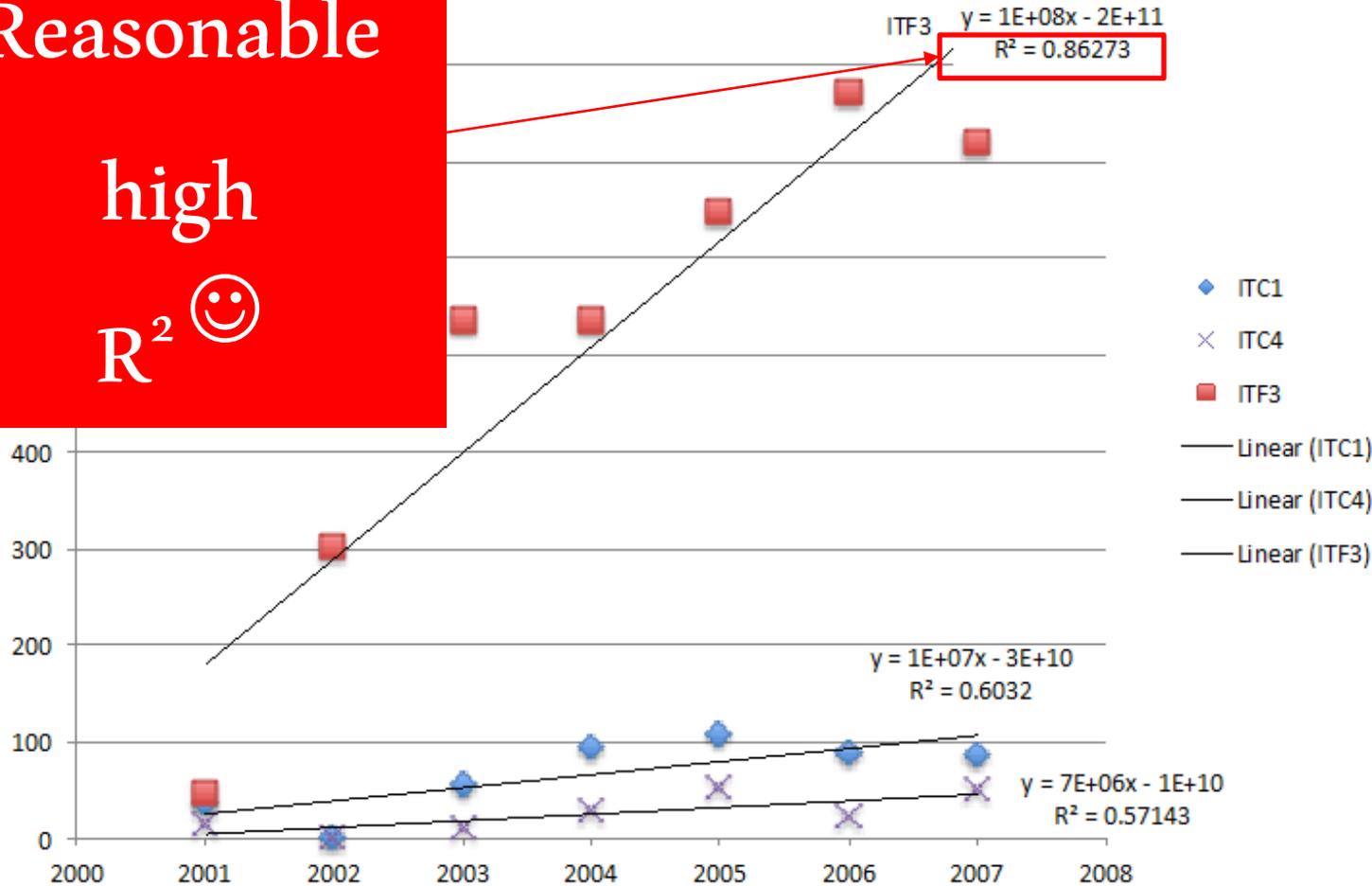
Campania (ITF3)

Reasonable

high

$R^2$  😊

ERDF expenditures between 2001 and 2007  
Programming period 2000-2006



ERDF 2000-2006



# Can one assume a monotonic spending pattern over the course of the PP?

Item	NUT2	Region	R <sup>2</sup>				
			2000-2010				
1	ES21	País Vasco	0.206	117	UKK3	Cornwall and Isles of Scilly	0.001
9	PT20	Região Autónoma dos Açores	0.488	124	ITF6	Calabria	0.002
2	IE02	Southern and Eastern	0.379	118	UKM2	Eastern Scotland	0.002
3	IE01	Border, Midland and Western	0.404	130	NL41	Noord-Brabant	0.002
4	ES13	Cantabria	0.247	119	UKD4	Lancashire	0.002
5	ES12	Principado de Asturias	0.248	150	FR62	Midi-Pyrénées	0.003
				121	NL23	Flevoland	0.003

Nope!  
Very low  
R<sup>2</sup> 😞

ERDF 2000-2006

## Promising approach

# Using cumulative figures

- Rank the different NUTS2 against a dummy constant-pace benchmark

F = COM payments

Constant pace reimbursement

programming period with eligibility  
time extension of 10 years

0.1=10%

1.0

CDF=Cumulative  
Distribution  
Function

Cumulative yearly  
COM payments

1995 1996 1997 1998 1999 2000 2001 2002 2003 2004

1995 1996 1997 1998 1999 2000 2001 2002 2003 2004

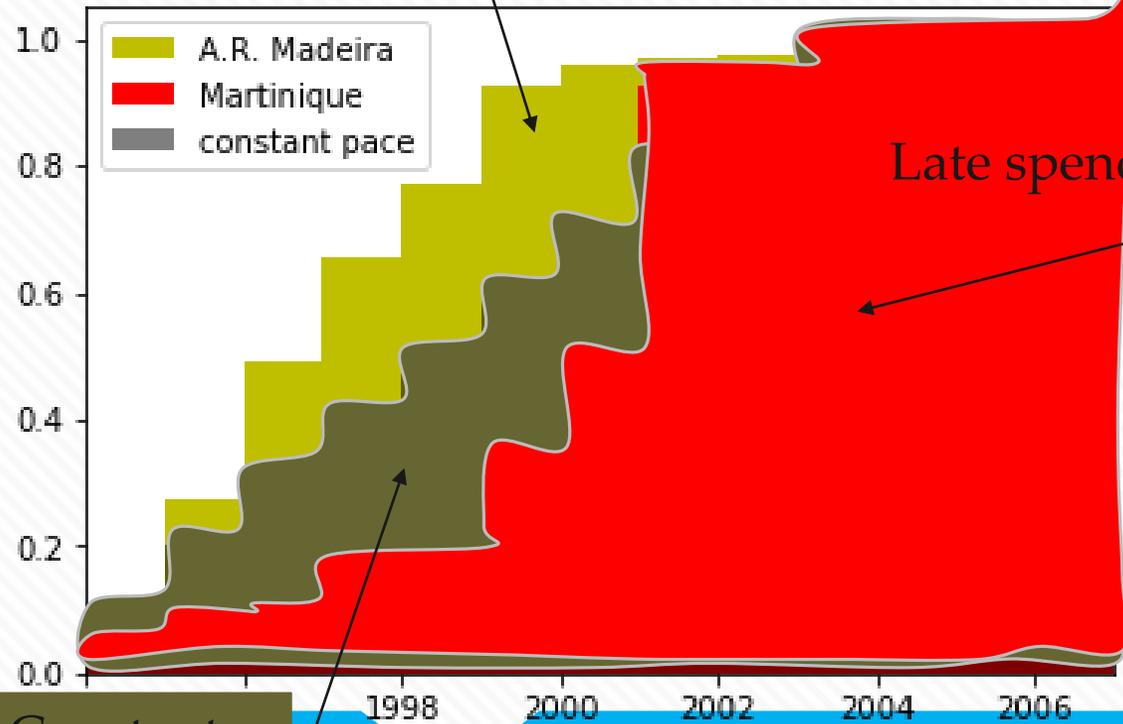
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# The cumulative reimbursement pace as a proxy for expenditures estimate

- Rank the different NUTS2 against a dummy constant-pace benchmark

Early spending pattern



Constant spending pattern

$$Area_z = \sum_{n=year} (Area_{z,n} - Area_{CE,n})$$

Index of regional specificity

$$\mu_z = \frac{Area_z - Area_{MAX}}{Area_{min} - Area_{MAX}}$$

$Area_{MAX}$ : region with the earliest-spending pattern

$Area_{min}$ : region with the latest-spending pattern

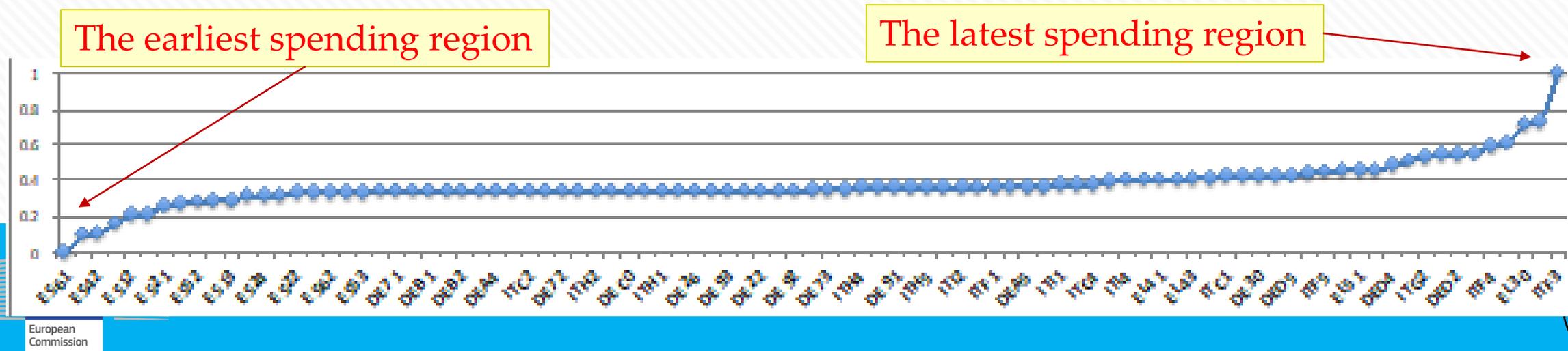
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# Normalization of the Index of regional specificity

$$\mu_z = \frac{Area_z - Area_{Max}}{Area_{min} - Area_{Max}}$$

- A shortcoming of the approach is the fact outliers and/or extreme values could distort the transformed indicator.



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# So how does a payment in a given year correlates with the expenditures

- It is assumed a share  $\phi_z$  in  $(0.2,1)$  of the payment reimbursed at a given year corresponds to an actual expenditure incurred in the same year for a given region (NUTS2 area):

$$\phi_z = \phi_{MAX} - \mu_z(\phi_{MAX} - \phi_{min})$$

- E.g. if  $\phi_z$  is 0.4 and the year is 2000, it means that 40% of the payment reimbursed in the year 2000 was really spent in 2000. The parameter  $\mu_z$  is deterministically determined, while  $\phi_{MAX}$  and  $\phi_{min}$  are random variables.

For the two extreme cases:

Early spending pattern	$\mu_z = 0; \phi_z = \phi_{MAX}$	$\longrightarrow$	$\phi_z = [0.8, 1]$
Late spending pattern	$\mu_z = 1; \phi_z = \phi_{min}$	$\longrightarrow$	$\phi_z = [0.2, 0.4]$



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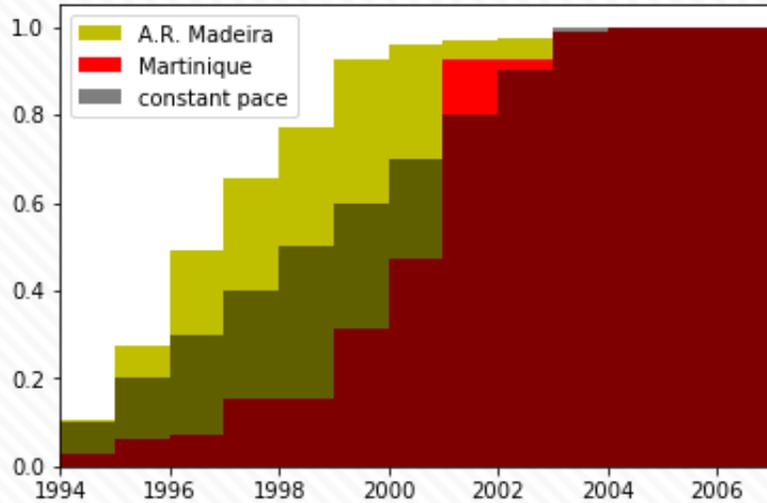
# How about the residual?

- The residual (60% in example) of the payment is assumed to correspond to expenditures incurred in the previous 'l' years according to the algorithm illustrated below:

$$A_{z,p+q-k} = \frac{(1 - \phi_z) \cdot 2^{k-1}}{\sum_{k=1}^l 2^{k-1}}$$

<i>l = number of years</i>	$A_{p+q-1}$	$A_{p+q-2}$	$A_{p+q-3}$	$A_{p+q-4}$
1	$(1 - \phi_z)$			
2	$2 \frac{(1 - \phi_z)}{3}$	$\frac{(1 - \phi_z)}{3}$		
3	$4 \frac{(1 - \phi_z)}{7}$	$2 \frac{(1 - \phi_z)}{7}$	$\frac{(1 - \phi_z)}{7}$	
4	$8 \frac{(1 - \phi_z)}{15}$	$4 \frac{(1 - \phi_z)}{15}$	$2 \frac{(1 - \phi_z)}{15}$	$\frac{(1 - \phi_z)}{15}$

# And how is the number of years on which the residual is spread determined?



$$m = \text{int}(\mu_Z * (q - 1)) + 1$$

$$l = \text{random}(1, m)$$

q= how many years would be available

m<=q -> how many we can take

m=1 -> early spender

m=q -> late spender

l = number of years actually taken

$$\mu_Z = 0; \Phi_Z = \Phi_{MAX} \longrightarrow A_{Z,p+q-1} = (1 - \Phi_{MAX}); A_{Z,p+q-2} = A_{Z,p+q-3} = A_{Z,p+q-4} = \dots = A_{Z,p} = 0$$

$$\mu_Z = 1; \Phi_Z = \Phi_{min} \longrightarrow$$

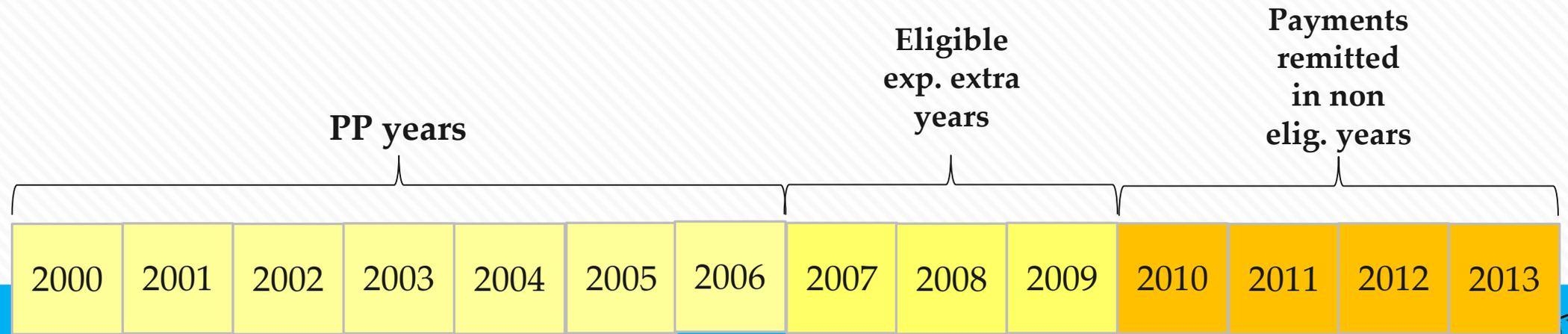
m	$A_{p+q-1}$	$A_{p+q-2}$	$A_{p+q-3}$	$A_{p+q-4}$
1	$(1 - \Phi_Z)$			
2	$2 \frac{(1 - \Phi_Z)}{3}$	$\frac{(1 - \Phi_Z)}{3}$		
3	$4 \frac{(1 - \Phi_Z)}{7}$	$2 \frac{(1 - \Phi_Z)}{7}$	$\frac{(1 - \Phi_Z)}{7}$	
4	$8 \frac{(1 - \Phi_Z)}{15}$	$4 \frac{(1 - \Phi_Z)}{15}$	$2 \frac{(1 - \Phi_Z)}{15}$	$\frac{(1 - \Phi_Z)}{15}$

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# 'Special' Years

- For those years beyond the expenses eligibility (i.e.  $n+3$ , or  $n+5$  for the PP 1989-1993), it has been assumed those payment corresponded to expenses only incurred in the previous years. Briefly, the expenses incurred in those years are zero and all the payments are attributed to previous years according to the algorithm described in the previous slide.



**PP 2000-2006**

on Robustification of the ... Payments Data  
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# 'Special' Years

- For anticipated payments (i.e. payments formally remitted before the commencement of the PP, it is assumed those corresponded to expenses incurred on those years.

Expenditures

=

Payment

Anticipated  
Payment

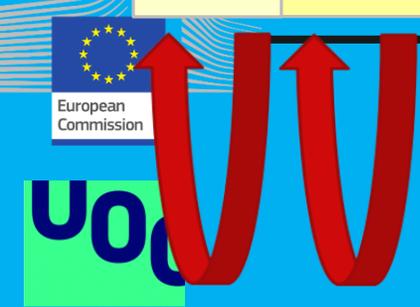
PP years

Eligible  
exp. extra  
years

Payments  
remitted  
in non  
elig. years



PP 2000-2006



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# Monte Carlo

- 1,000 Monte Carlo simulations have been performed by varying simultaneously the three random parameters over the course of the respective ranges ( $\Phi_{\max}$ ,  $\Phi_{\min}$  and  $l$ ).
- $\Phi_{\max}$  = max COM payment's amount which stays at time  $t$
- $\Phi_{\min}$  = min COM payment's amount that stays at time  $t$
- $l$  = how many years we go back to distribute the expenditures



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# Uncertainty Analysis and Sensitivity Analysis

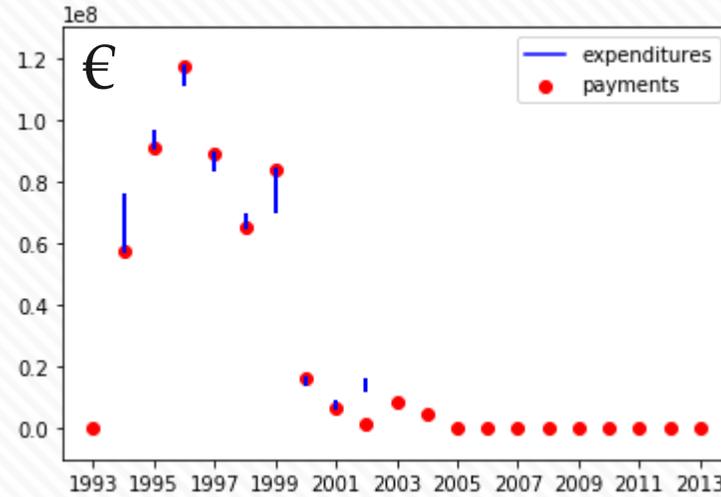
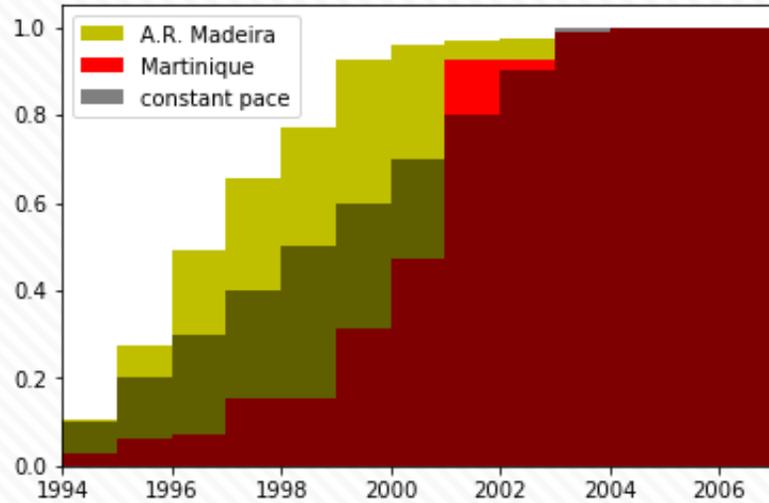
- The robustness of the assumptions is tested by applying an uncertainty analysis followed by a global sensitivity analysis.
- These assessments allow to determine how the uncertainty in the input parameters ( $\Phi_{\max}$ ,  $\Phi_{\min}$  and  $l$ ) reflects onto the output



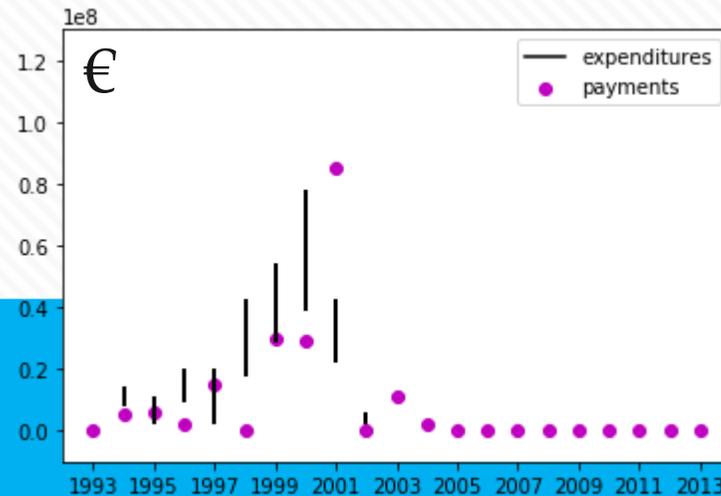
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# So how do the expenditures correlate with the reimbursed payments?



A. R. Madeira



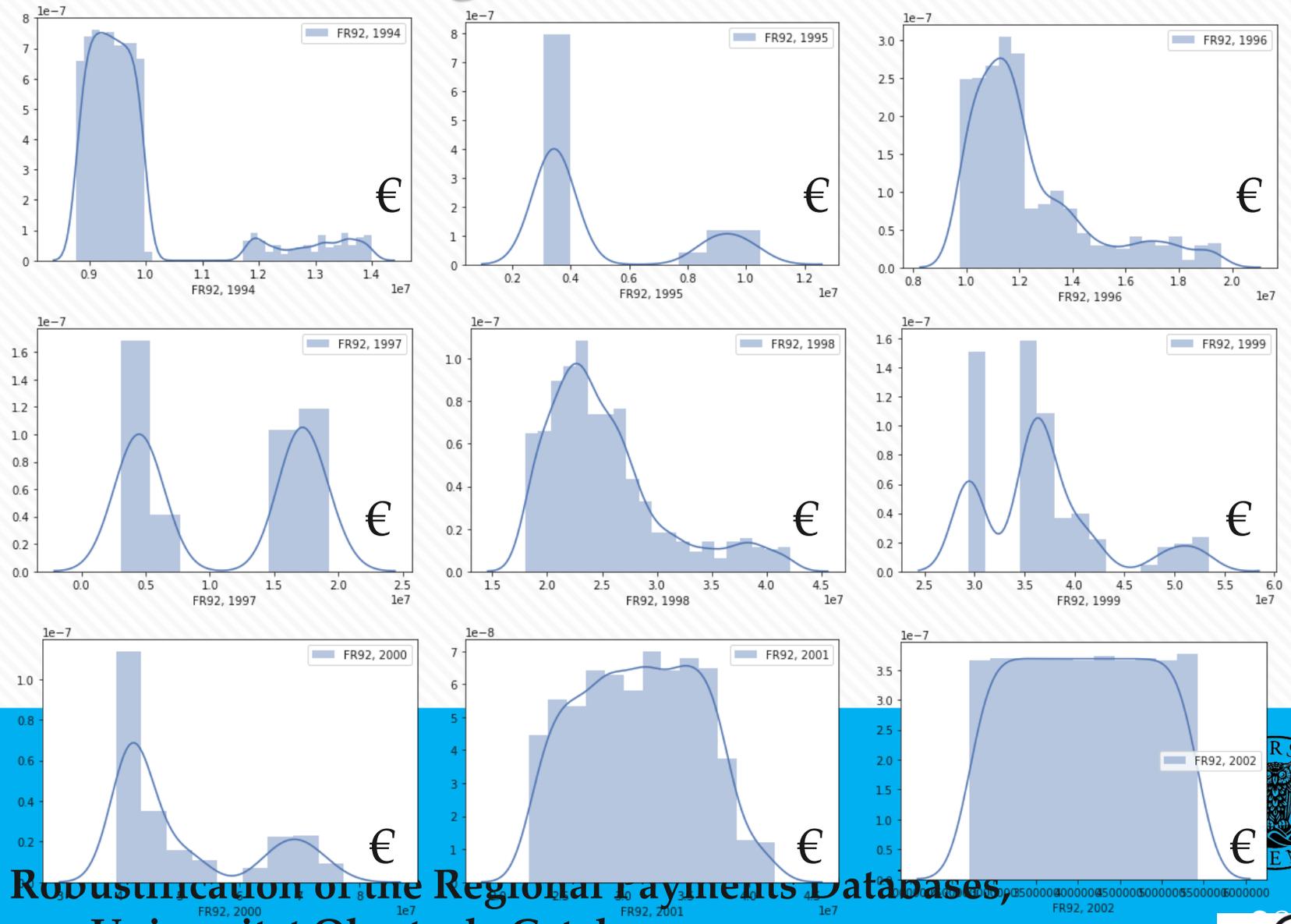
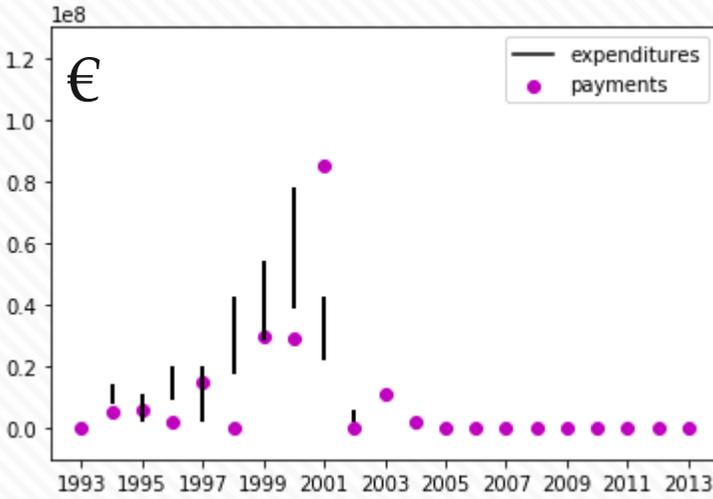
Martinique



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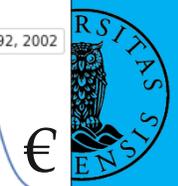
# What are the characteristics of the generated distributions (UA)?



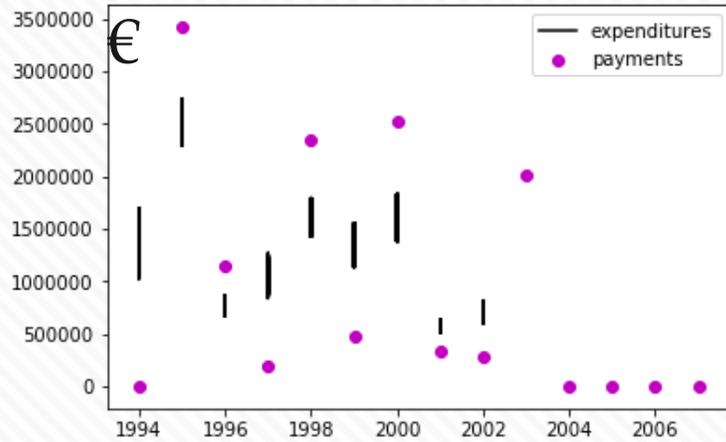
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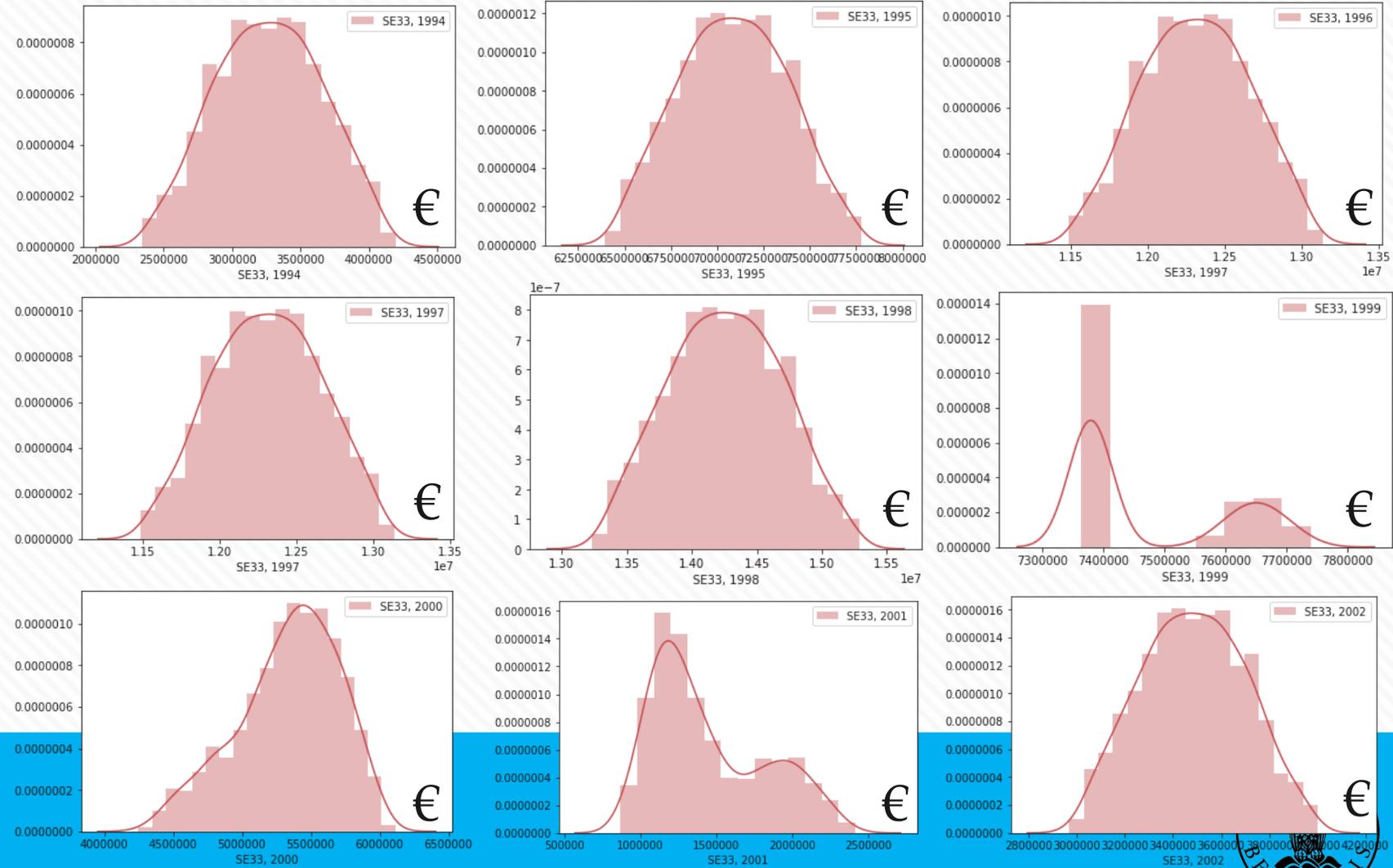
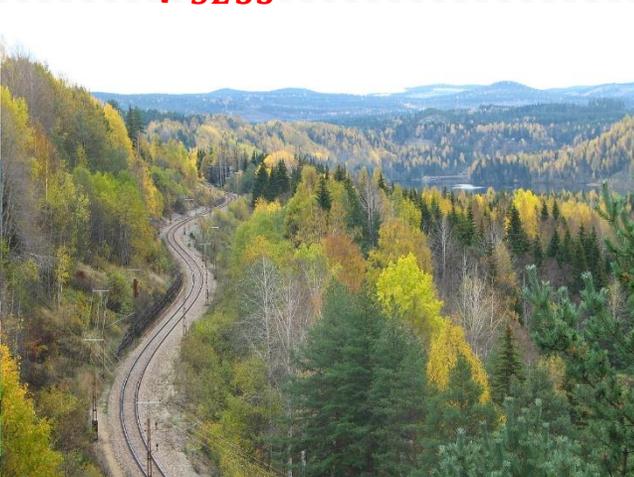


# What are the characteristics of the generated distributions?



Upper Norrland

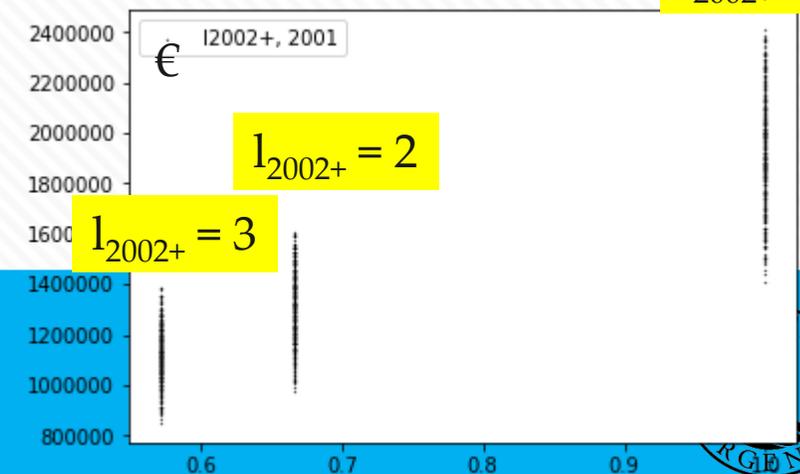
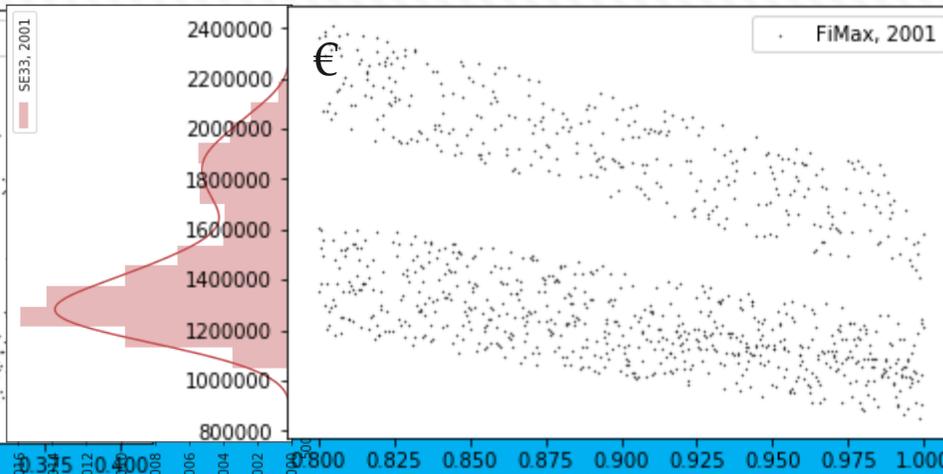
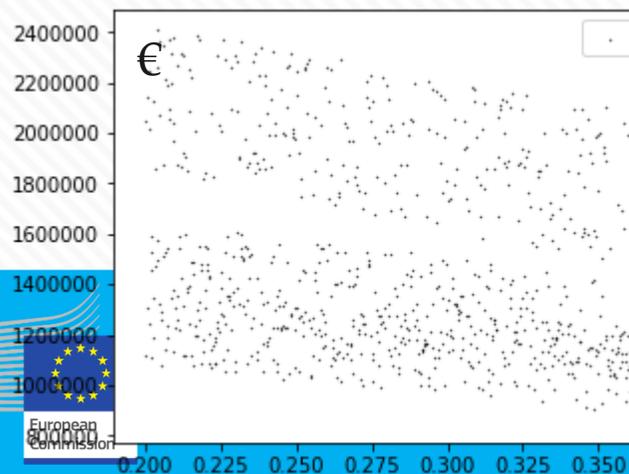
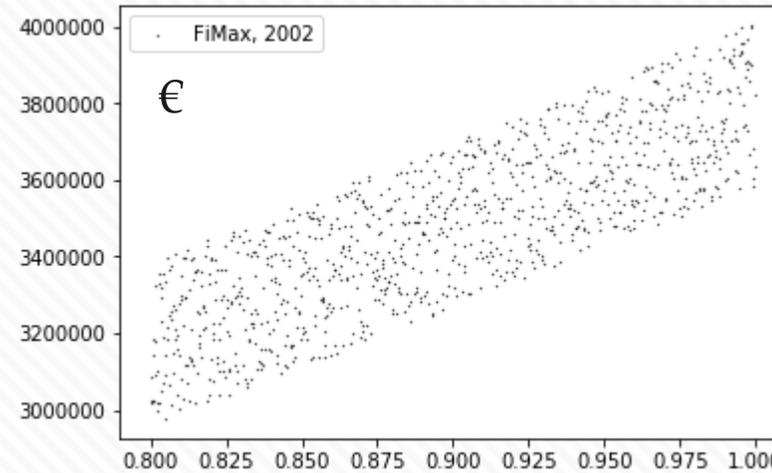
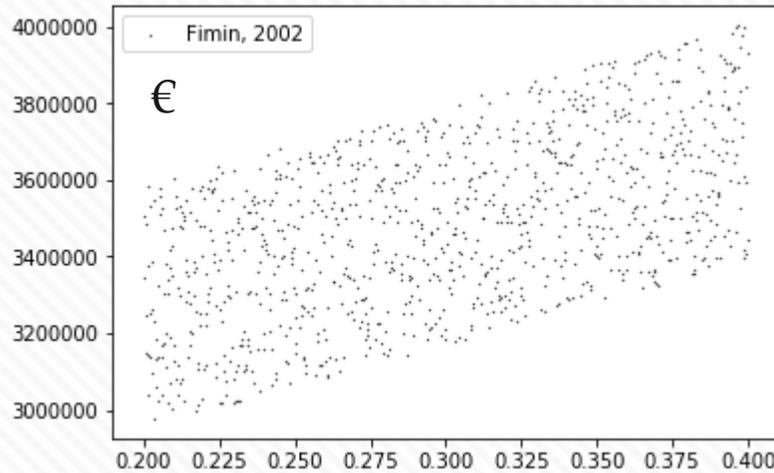
$$\mu_{SE33} = 0.40$$



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# SA: Upper Norrland (SE33), ERDF1994-1999

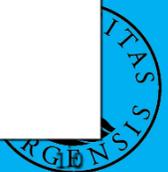


$I_{2002+} = 1$

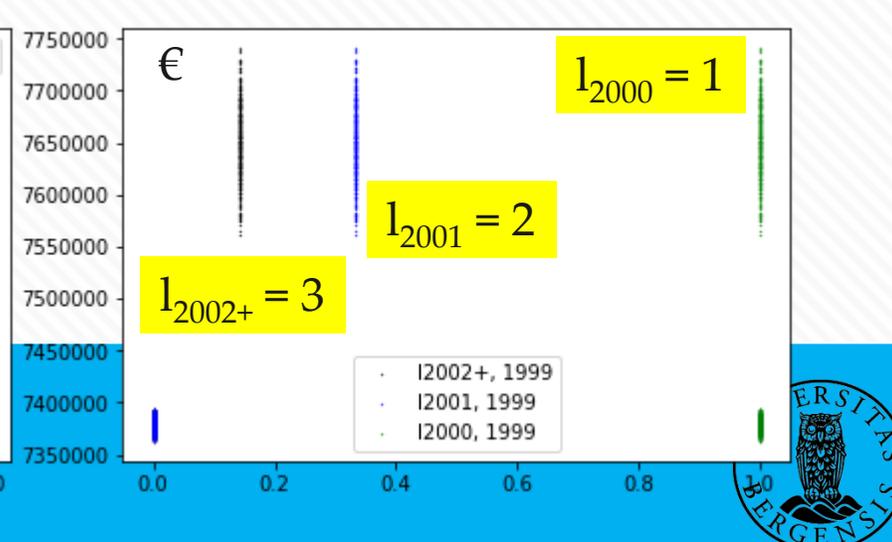
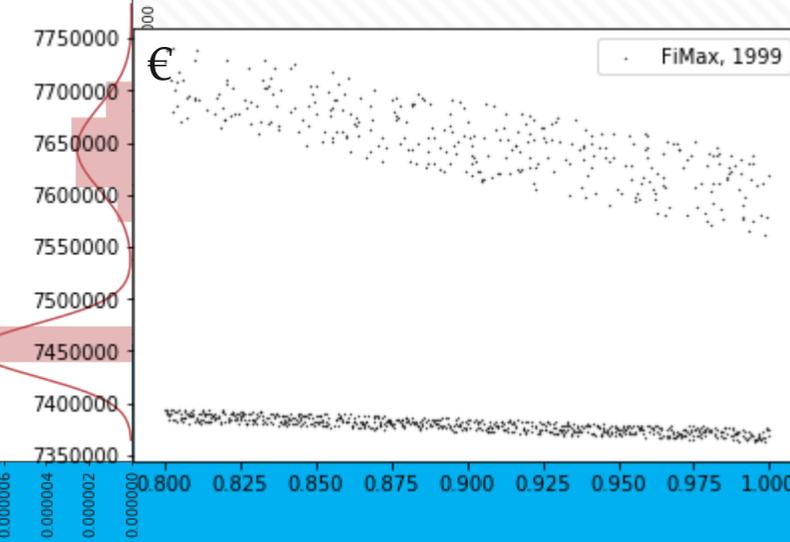
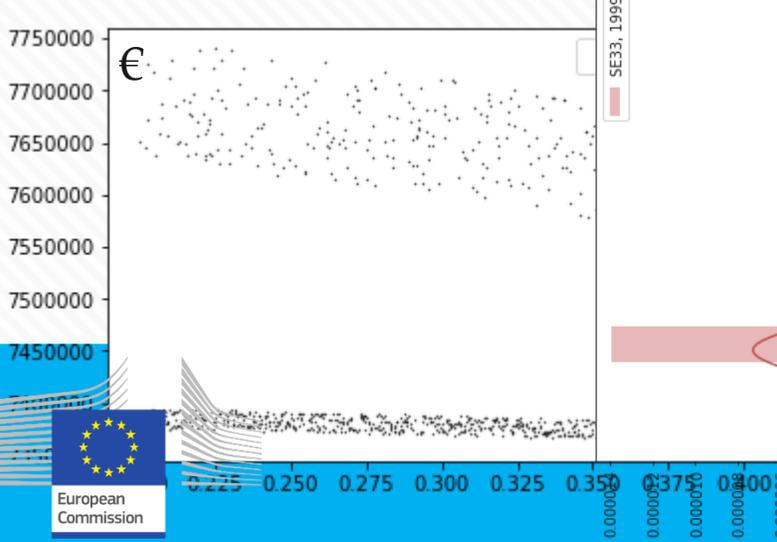
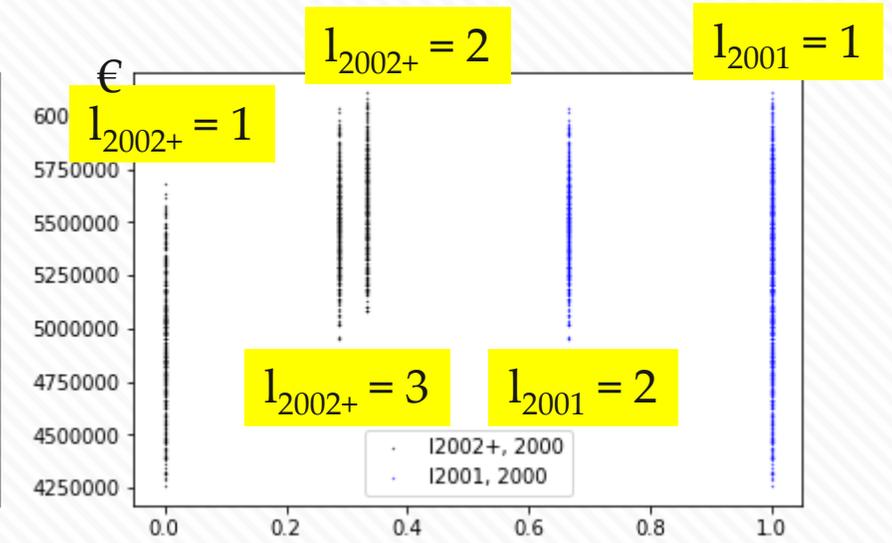
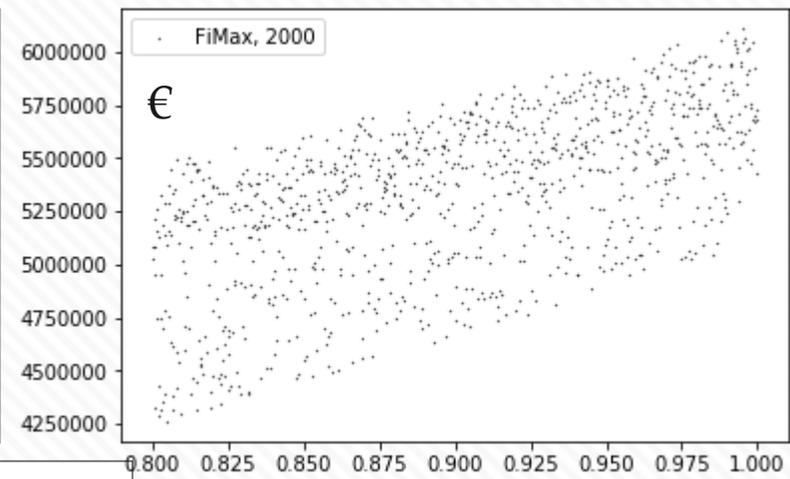
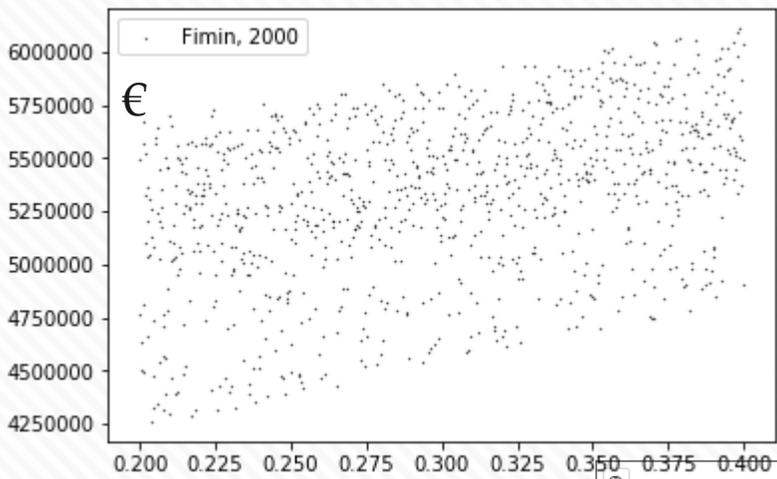
$I_{2002+} = 2$

$I_{2002+} = 3$

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# UA: Upper Norrland (SE33), ERDF1994-1999



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# Conclusion

Yearly distributions of the actual Beneficiaries' expenses incurred corresponding to the COM payment reimbursed have been generated for every NUTS2 area, funding scheme and programming period.

It is possible to generally note a less evident time gap between the payments reimbursed and the actual expenses incurred for the areas with a low index of specificity, i.e. showing an early spending pattern over the programming period duration. The opposite applies to the areas with a high regional index of specificity.

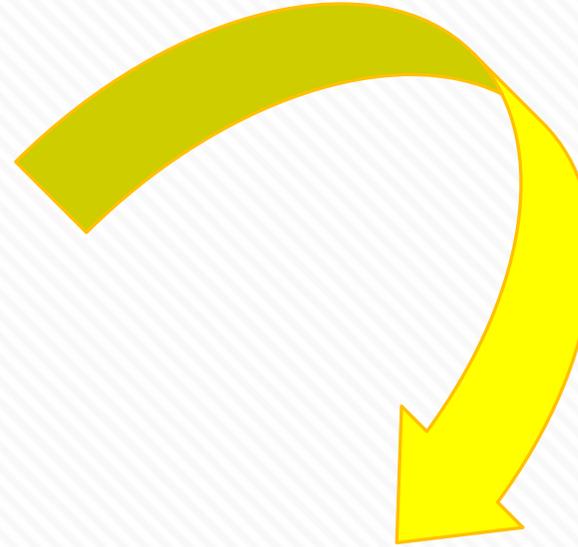


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# How have the results been delivered?

ProgrammingPeriod	Country	NUTS1Code	NUTS2Code	Year	ERDF_TOTAL
2007-2013	AT	AT1	AT11	2007	2500539.25
2007-2013	AT	AT1	AT12	2007	2912936
2007-2013	AT	AT1	AT13	2007	503037.25
2007-2013	AT	AT2	AT21	2007	1347768.75
2007-2013	AT	AT2	AT22	2007	3101237
2007-2013	AT	AT3	AT31	2007	1910870.375
2007-2013	AT	AT3	AT32	2007	276269.5938
2007-2013	AT	AT3	AT33	2007	695459.75
2007-2013	AT	AT3	AT34	2007	353202.5938
2007-2013	BE	BE1	BE10	2007	1151849.125
2007-2013	BE	BE2	BE21	2007	1096555.875



**Payment Database**

**Expenditure Estimates Database**

ERDF_TOTAL_SD	ERDF_TOTAL_SErr	ERDF_TOTAL_mean	NUTS2Code	Programming Period	year
152529.7434	4825.827517	3880882.311	AT11	2007-2013	2007
177739.0781	5623.41557	4517412.672	AT12	2007-2013	2007
30616.38018	968.6594015	785762.5207	AT13	2007-2013	2007
83975.10894	2656.85487	2298365.777	AT21	2007-2013	2007
191152.5093	6047.797753	5214993.739	AT22	2007-2013	2007
115900.1114	3666.917247	3082107.223	AT31	2007-2013	2007
16772.13938	530.6470066	436007.4317	AT32	2007-2013	2007
44325.12628	1402.384934	1212780.039	AT33	2007-2013	2007
21463.70543	679.0815876	575953.3104	AT34	2007-2013	2007
70295.44419	2224.049431	1902230.548	BE10	2007-2013	2007
76842.7855	2431.198143	1474788.258	BE21	2007-2013	2007



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ProgrammingPeriod	Country	NUTS1Code	NUTS2Code	Year	ERDF_TOTAL
2007-2013	AT	AT1	AT11	2007	2500539.25
2007-2013	AT	AT1	AT12	2007	2912936
2007-2013	AT	AT1	AT13	2007	503037.25
2007-2013	AT	AT2	AT21	2007	1347768.75
2007-2013	AT	AT2	AT22	2007	3101237
2007-2013	AT	AT3	AT31	2007	1910870.375
2007-2013	AT	AT3	AT32	2007	276269.5938
2007-2013	AT	AT3	AT33	2007	695459.75
2007-2013	AT	AT3	AT34	2007	353202.5938
2007-2013	BE	BE1	BE10	2007	1151849.125
2007-2013	BE	BE2	BE21	2007	1096555.875

Three statistical properties

- Mean
- Standard deviation
- Standard error on the mean

For each:

- NUTS2 area
- Programming period
- Funding scheme

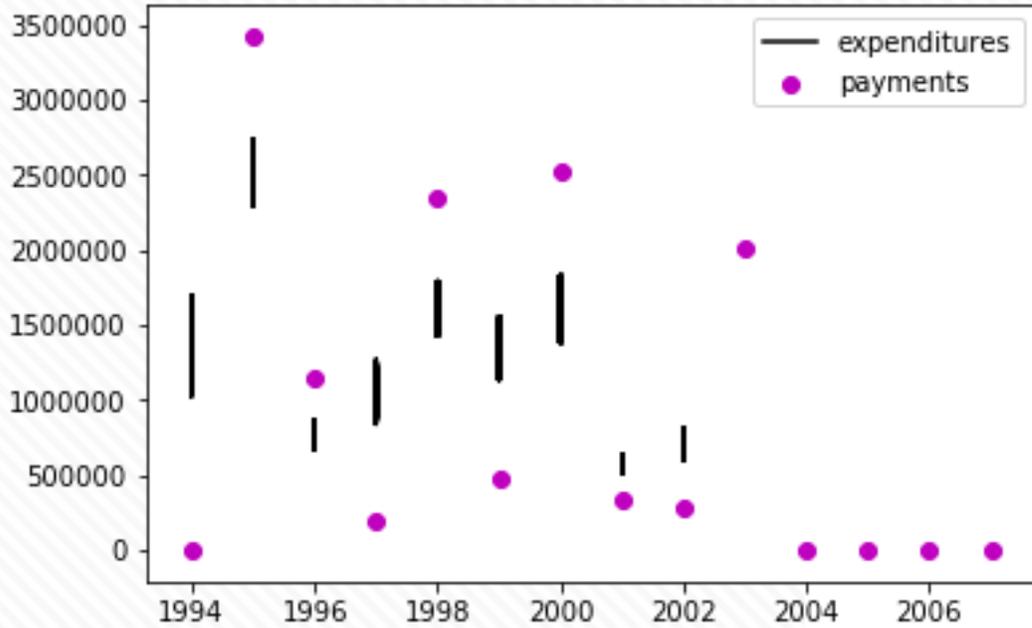
ERDF_TOTAL_SD	ERDF_TOTAL_SErr	ERDF_TOTAL_mean	NUTS2Code	Programming Period	year
152529.7434	4825.827517	3880882.311	AT11	2007-2013	2007
177739.0781	5623.41557	4517412.672	AT12	2007-2013	2007
30616.38018	968.6594015	785762.5207	AT13	2007-2013	2007
83975.10894	2656.85487	2298365.777	AT21	2007-2013	2007
191152.5093	6047.797753	5214993.739	AT22	2007-2013	2007
115900.1114	3666.917247	3082107.223	AT31	2007-2013	2007
16772.13938	530.6470066	436007.4317	AT32	2007-2013	2007
44325.12628	1402.384934	1212780.039	AT33	2007-2013	2007
21463.70543	679.0815876	575953.3104	AT34	2007-2013	2007
70295.44419	2224.049431	1902230.548	BE10	2007-2013	2007
76842.7855	2431.198143	1474788.258	BE21	2007-2013	2007



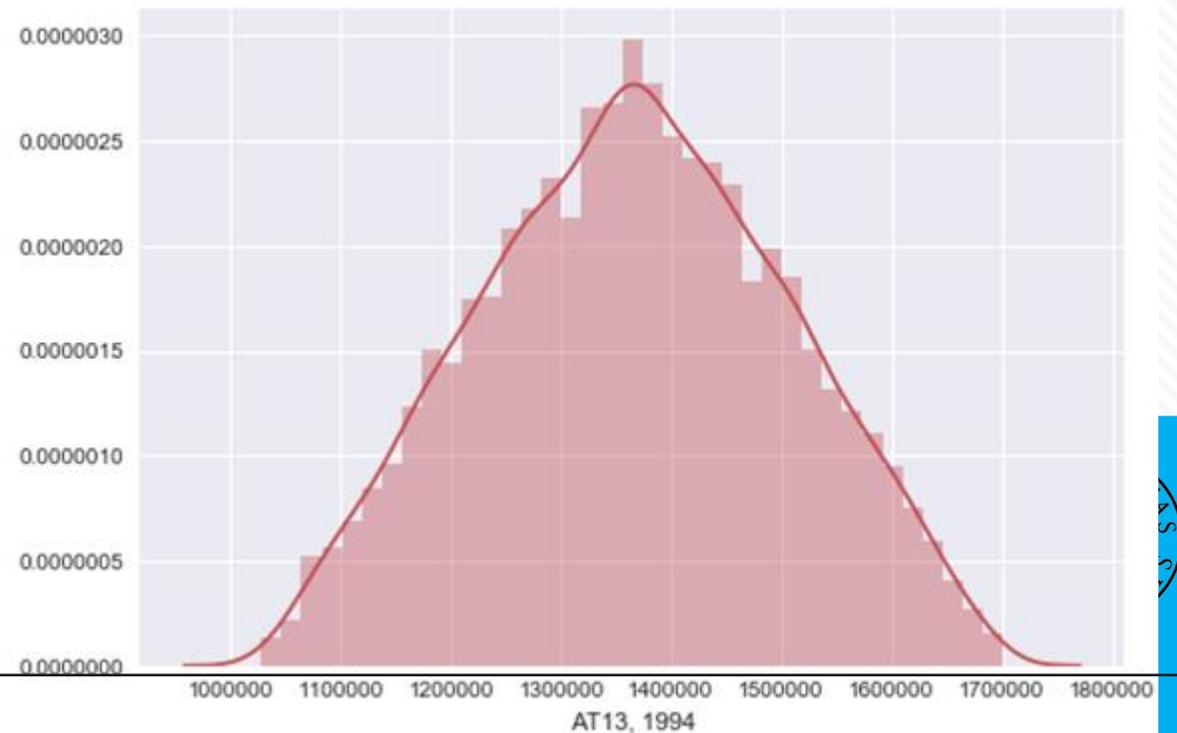
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# Conclusion

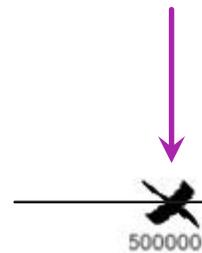
ERDF 1994 – 1999 (AT13, Wien)  $\mu_{AT13} = 0.42$



## Expenditure distribution



Payment



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# Further work

Validation of the consistency of the algorithm developed by comparison with national payment databases such as e.g. the Italian *Opencoesione*.



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# End



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# What are the $l_s$ for the various $p+q-k$ years?

$$m = \text{int}(\mu_z * (q - 1)) + 1$$

$$l_{p+q} = \text{random}(1, m)$$

$$l_{p+q-1} = l_{p+q} - 1 \quad \text{or} \quad l_{p+q-1} = 1 \quad \text{if} \quad l_{p+q} = 1$$

$$l_{p+q-2} = l_{p+q} - 2 \quad \text{or} \quad l_{p+q-2} = 1 \quad \text{if} \quad l_{p+q} < 2$$

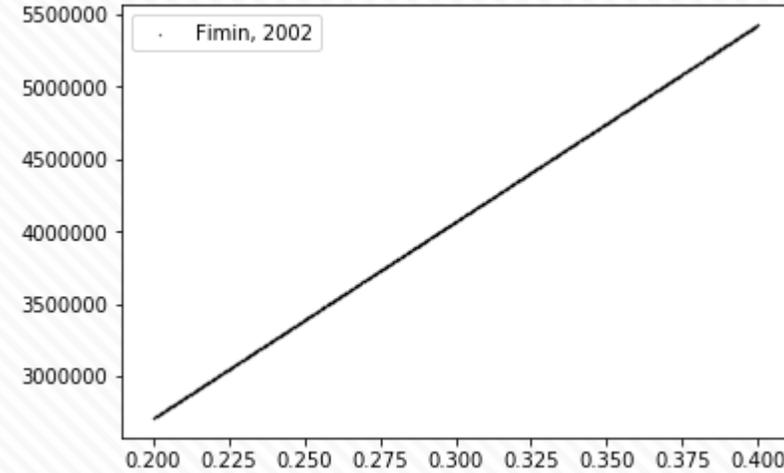
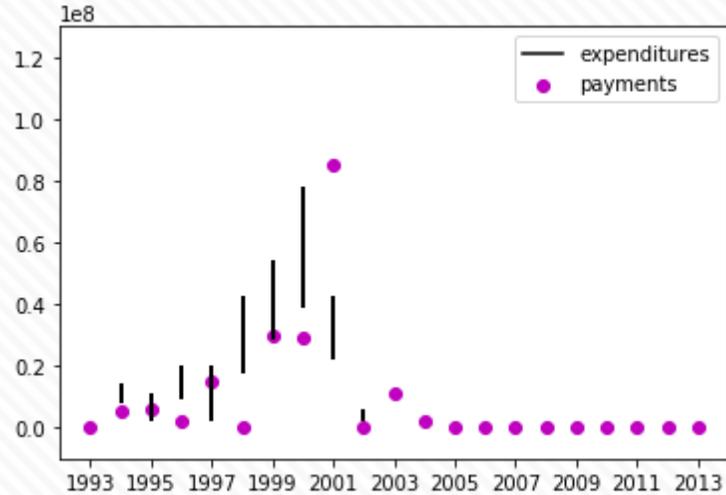
$$l_{p+q-(m-1)} = l_{p+q} - (m-1) \quad \text{or} \quad l_{p+q-(m-1)} = 1 \quad \text{if} \quad l_{p+q} < m$$



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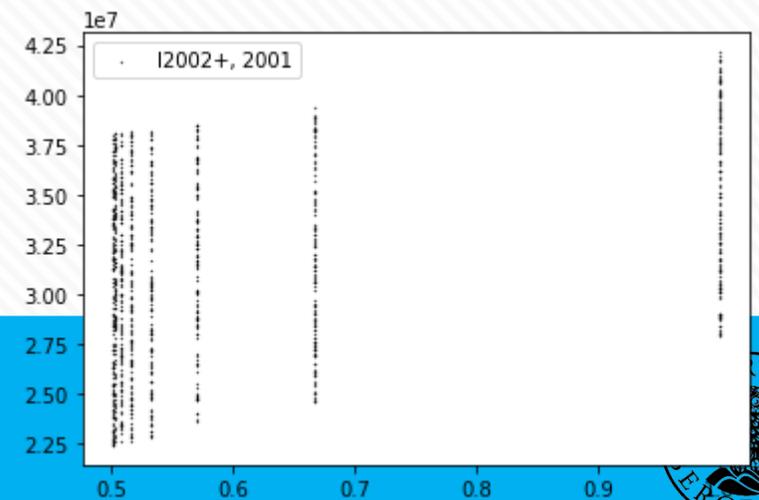
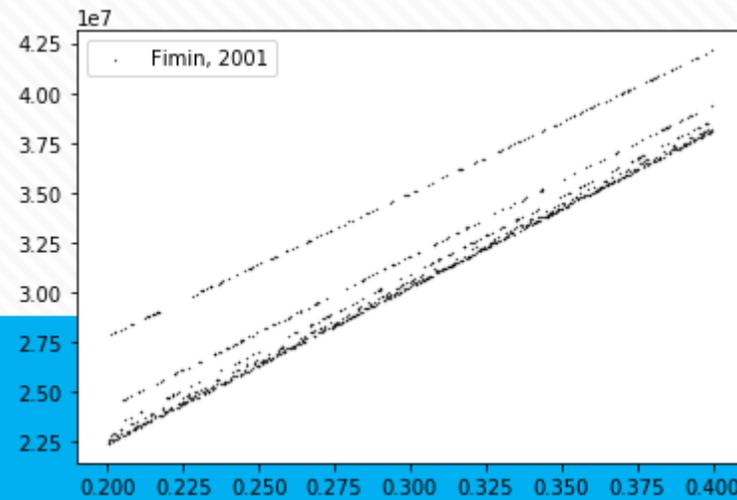


# UA: Martinique (FR92), ERDF1994-1999

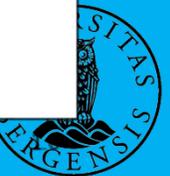


$$m = \text{int}(1 * (8 - 1)) + 1$$

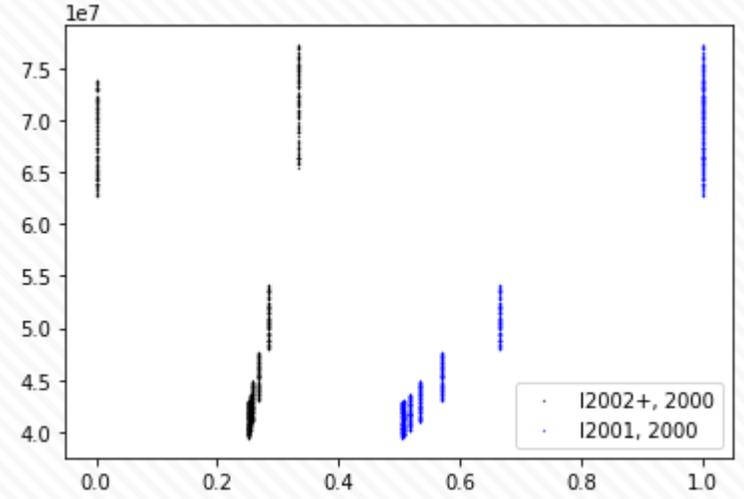
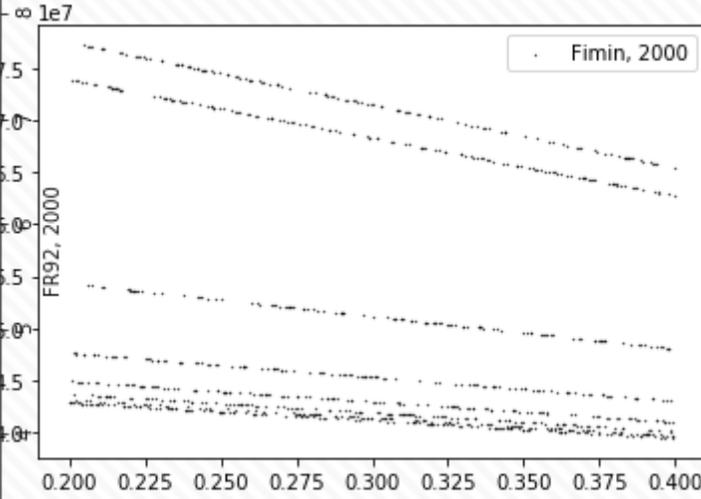
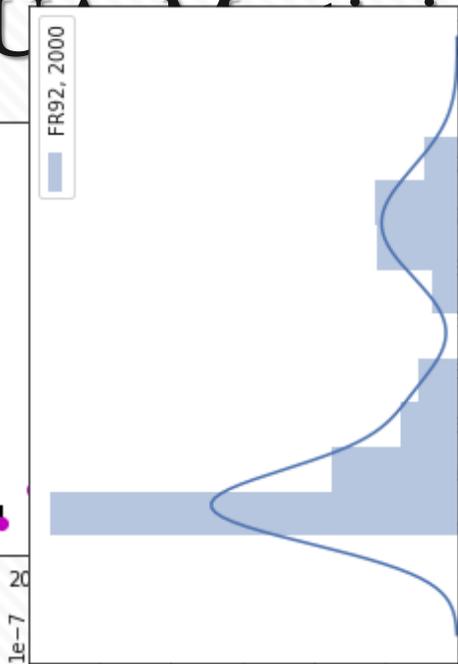
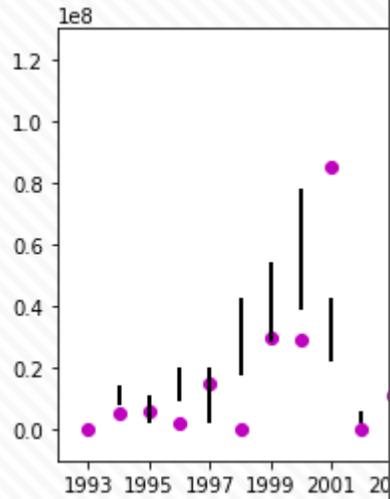
$$l = \text{random}(1,8)$$



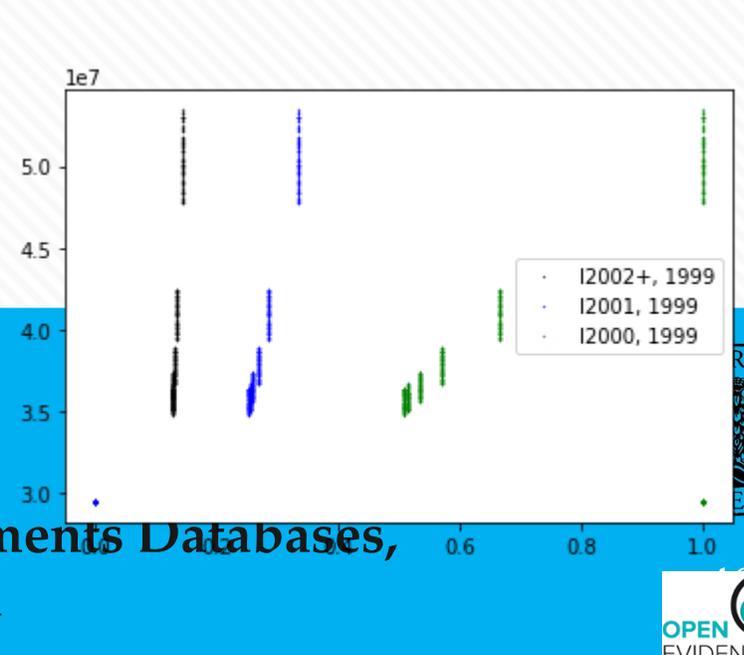
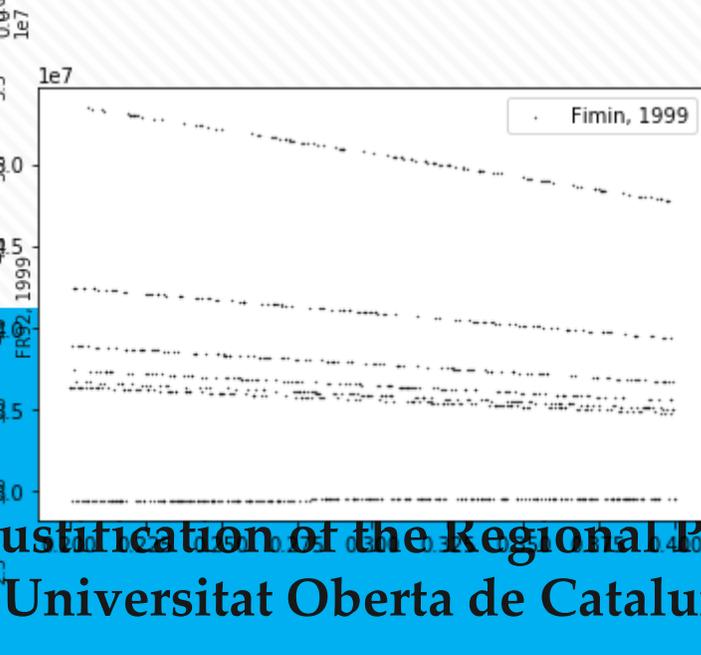
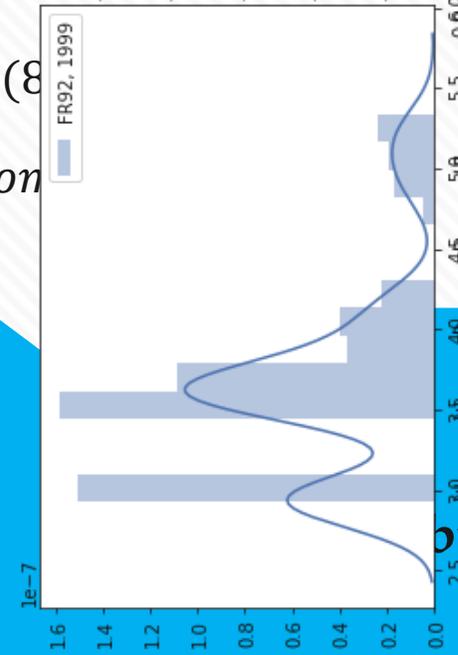
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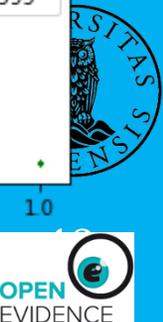
# Urbain, Miquel (FR92), ERDF1994-1999



$m = \text{int}(1 * (8$   
 $l = \text{random}$



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# Sensitivity analysis – a screening test

For a given year, programming period and funding scheme:

count NUTS2 having

- Total indexes  $> 0.1$
- First order indexes  $> 0.1$
- Larger 'order' indexes  $> 0.1$



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# Sensitivity analysis – what is the most important parameter?

Programming Period	Scheme	Index	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
8	2007-2013	ERDF	SHI	0	1	3	9	26	40	59	50	24	0
0	2007-2013	ESF	STMax	253	253	229	208	137	97	98	115	172	170
1	2007-2013	ESF	STmin	259	250	229	193	133	108	67	116	185	187
2	2007-2013	ESF	STI	2	11	10	61	127	193	184	213	121	0
3	2007-2013	ESF	SFMax	260	254	229	217	151	131	123	134	191	177
4	2007-2013	ESF	SFmin	262	255	254	212	150	134	113	136	194	187
5	2007-2013	ESF	SFI	2	23	13	65	136	227	230	235	127	0
6	2007-2013	ESF	SHMax	0	0	25	8	38	55	68	46	19	0
7	2007-2013	ESF	SHmin	0	0	25	9	35	62	68	48	19	0
8	2007-2013	ESF	SHI	0	0	25	9	36	61	69	47	20	0
0	2007-2013	EAGGF	STMax	257	255	256	157	122	91	93	219	258	0
1	2007-2013	EAGGF	STmin	209	186	235	112	70	27	9	173	213	0
2	2007-2013	EAGGF	STI	3	4	10	77	90	128	165	174	0	0
3	2007-2013	EAGGF	SFMax	257	255	257	180	145	148	140	226	258	0
4	2007-2013	EAGGF	SFmin	209	191	235	179	99	86	69	175	213	0
5	2007-2013	EAGGF	SFI	3	15	12	94	123	178	212	189	0	0
6	2007-2013	EAGGF	SHMax	0	0	2	39	33	54	53	30	0	0
7	2007-2013	EAGGF	SHmin	0	0	2	43	32	56	53	29	0	0
8	2007-2013	EAGGF	SHI	0	0	2	43	33	56	55	32	0	0