

Economic dynamics, Emission trends and Delinking

**Evidence using NAMEA
and provincial panel data for Italy**

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Background and research directions (1)

- Environmental Kuznets Curves (EKC) studies have been judged not so satisfactory since they are mostly based on cross country evidence that provides as result average effects on environment-economic links
- Cross country homogeneity may be a problem
 - EKC evidence may differ not only by externality but also by country/region and by sector
 - More heterogenous based evidence, disaggregated at both geographic and (or) sector level is more relevant in policy terms

Background and research directions (2)

- EKC developments over recent years to address the issue:
 - Using heterogenous panel estimators relaxing the homogenous slope assumption
 - Focusing on within region/country heterogeneity by analysing disaggregated datasets (more likely to be available, if they are, at national level)

Background and research directions (3)

- **Our current research effort** is based on such premises
 - **CO2:** Bayesian approach to CO₂ estimation (worldwide evidence, FEEM paper 2006, www.feem.it)
 - **WASTE:**
 - Regional and provincial analysis on waste generation and waste landfilling using italian environmental agency data 1995-2005 for 20 regions and 103 provinces (FEEM paper 2006)
 - Complement to a EU25 analysis on waste trends using EUROSTAT data
 - **NAMEA Analyses**

NAMEA ANALYSES

(National Accounting matrix including Environmental Accounts)

- GHG and air emissions EKC analysis
- EKC study on emission and value added (PAPER presented today)
 - Correlation analysis of environmental efficiency and labour productivity trends
 - Shift share analysis using NAMEA data for 2000 regarding Region of Rome and Italy

Policy issue

- Provided EU environmental policies (ETS, CAFE) are based on general Directives implemented at National level and that countries differ regarding the intrinsic structure of emissions-economy relationships, country based evidence is necessary to provide insights at a decentralised level
- Evidence is rooted on geographical/sector heterogeneity, that is additionally useful to shape a policy within a country

The paper: main aims

- Assessing EKC shapes for 9 emissions (3 GHG and 6 air pollutants) using NAMEA sector data and provincial data for Italy
- Value added per capita/employee is the main driver
- Assessing EKC shapes for manufacturing, industry and services taken separately
- Including/testing in NAMEA the stock of capital as alternative driver
- Testing and controlling for trade openness (that theoretically is linked to possible, even conflicting, effects on emissions)

The Datasets

Two panel datasets:

- sectoral (two digit) disaggregated NAMEA 1990-2001 emissions per employee (full time equivalent jobs) → **productive sector emissions**
- geographically disaggregated emissions per capita at provincial level (1990, 1995, 2000) → **total emissions**

The Datasets

- we consider 9 emissions
- 3 GHGs (CO_2 , N_2O , CH_4) and
- 6 other emissions (NO_x , SO_x , NH_3 , NMVOC, CO , PM_{10})
- The two evidences may be useful to assess the role of productive sectors in affecting delinking trends, given total emissions include household effects, though a strict comparison is not possible between the two

NAMEA data: some comments

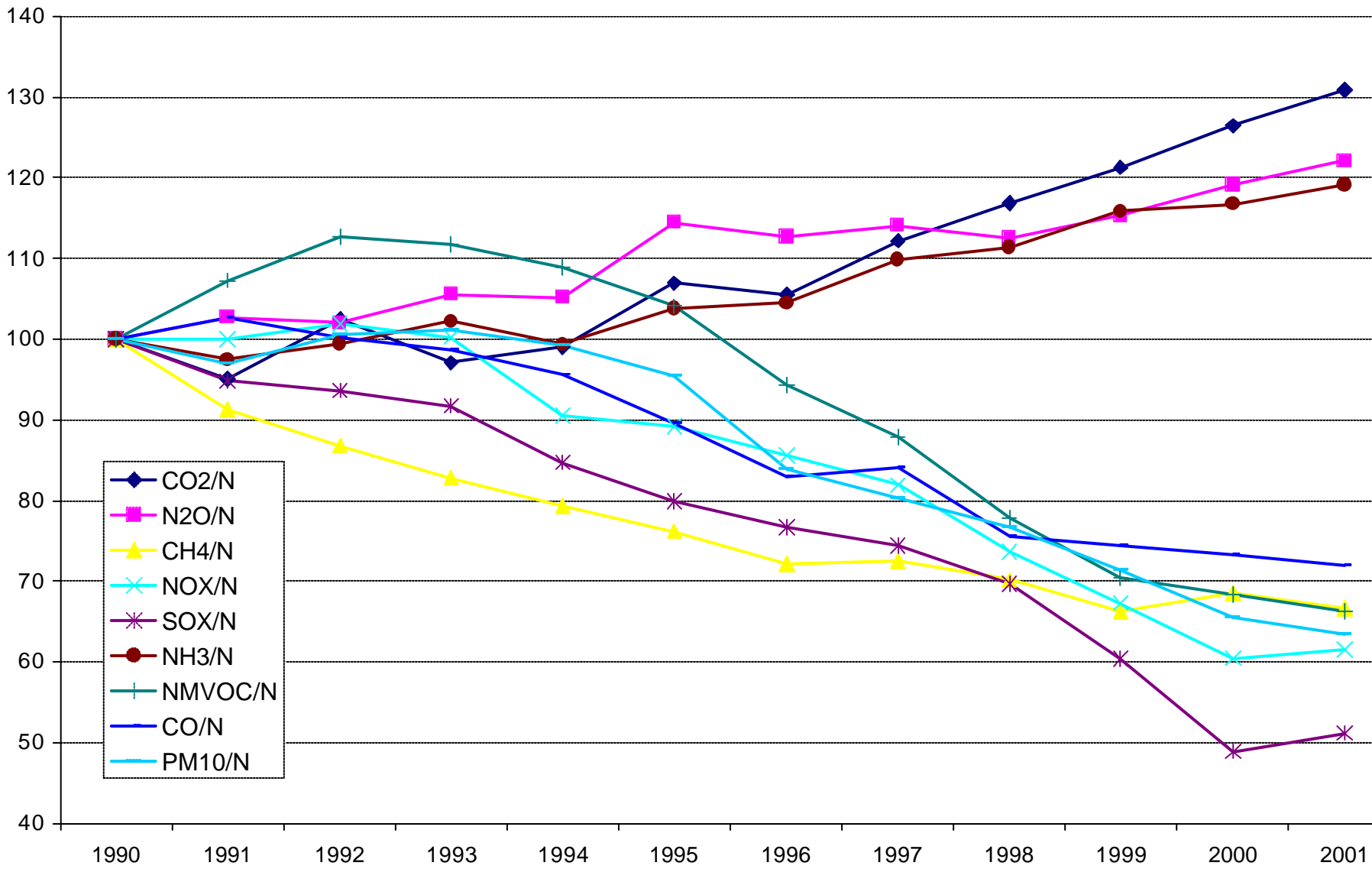
- Italian NAMEA data are of high quality. The statistical agency (ISTAT) produces a panel matrix constantly updated
- To our knowledge NAMEA for other countries are not in panel settings (UK has two years 1995, 2002, some EU projects are setting up very detailed NAMEA but it remains cross section evidence)
- A balanced panel offers the chance to test EKC by econometric tools, exploiting a rich source of data

Descriptive statistics

Variable	Mean	Min	Max	% Variation 1990-2001
VA/N	53,10	10,77 (B, 1992)	286,70 (CA, 1997)	15.2%
K [§] /N	148,26	22,89 (F, 1992)	852,66 (E, 2001)	28.8% [§]
TO [§]	1,07	0 (F, & most services)	8,01 (CA, 2001)	69.7% [§]
CO ₂ /N	65176,48	460,1751 (M, 1990)	1402528, 39 (E, 2002)	30.9%
N ₂ O/N	8,78358	0,033108 (M, 1990)	121,7485 (DG, 2001)	22.1%
CH ₄ /N	150,9765	0,057327 (M, 2002)	2532,667 (CA, 1990)	-33.4%
NO _x /N	148,5734	1,256879 (M, 2002)	3051,222 (E, 1991)	-38.5%
SO _x /N	308,1429	0,16914 (M, 2002)	6406,314 (E, 1990)	-48.8%
NH ₃ /N	11,29025	0,001477 (M, 1990)	325,1738 (A, 2002)	19.2%
NMVOC/N	155,3243	0,280438 (M, 2002)	2893,252 (DF, 1992)	-33.7%
CO/N	118,7348	1,445866 (M, 2002)	796,8578 (E, 1990)	-28.0%
PM ₁₀ /N	19,88375	0,09783 (M, 2002)	290,3656 (E, 1990)	-36.6%

A, K= value added, total capital stock (millions of euro liras 1995); N= employees in terms of equivalent full time jobs (thousands); TO= Trade openness (import + export /VA); Emissions (tonnes of CO₂, N₂O, CH₄, NO_x, SO_x, NH₃, NMVOC, CO, PM₁₀) (thousands of tonnes); [§]K and TO refer to years 1991-2001 instead of 1990-2001

Emissions per employee (trend)



Empirical Model

- We estimate usual log specifications for EKC, both quadratic and cubic
- We compare LSDV (testing time fixed effects, testing AR1) and REM panel outcomes
- EKC shape → absolute delinking
- Positive but <1 elasticity → relative delinking
- N shape as eventual additional evidence

Evidence NAMEA GHG (aggregate)

- CO₂ and CH₄ present EKC shapes
- Turning points are within the value added per employee ranges
- N₂O shows instead a linear positive correlation with VA (relative delinking)

Evidence NAMEA air pollutants (aggregate)

- Absolute delinking (EKC) for CO and NH₃
- SO_x, NO_x, PM₁₀, NMVOC present EKC evidence. Nevertheless, signals of N shape are also present with significant cubic specifications that may lead to future new upturn
- This is to be verified by eventual additional data after 2001

Evidence NAMEEA (sector analyses)

- **CO₂** and **CO** delinking driven by industry/manufacturing not services
- **CH₄** **Pm₁₀** driven by by all sectors
- **NH₃** mainly manufacturing
- **SO_x** **NO_x** show services (-) and industry (+) with conflicting paths
- Worth keeping in mind for commenting on results that using NAMEEA we correlate emissions/employees to value added/employees (Full timeJobs).
- This differs from having GDP and population

Additional Evidence

- Stock of gross total capital as driver (obviously correlated to VA)
 - Regressions are generally robust
 - Evidence may differ (CO₂ showing no EKC, NO_x EKC) at aggregate and sector level
- Trade openness
 - EKC shapes do not change
 - **positive sign for GHG (is prevailing a capital stock Heck-Ohlin effect on pollution haven hp?)**
 - negative sign in trade open service sectors
 - Other emissions present a prevailing negative sign also on aggregate level

Evidence on Province data (total emissions)

- **GHGs:**
 - Only CH₄ confirms EKC, CO₂ shows a monotonic relationship
- **Air pollutants:**
 - NMVOC, PM_x, CO, SO_x, NO_x show negative relationships that highlight delinking
- Those outcomes confirm EEA assessment on 1990-2000 trends in the EU

Main conclusions (*GHG*)

- **Some absolute delinking evidence arises for GHG** and other pollutants, confirming recent empirical works
- The role of productive sectors may largely explain delinking. Total trends including Household related emissions seem less EKC oriented
- This may be an (indirect) evaluation of policy relevancy in influencing EKC
- It is highlighted that sector trends might be heterogeneous
- More research needed on sector evidence, especially on industry vs services

Main conclusions (air emissions)

- CO shows robust EKC in all analyses
- PM and NMVOC shows EKC in total figures, not NAMEA. This is consistent
- SO_x and NO_x generally present absolute delinking, with some signals of reversal driven by industry (further check needed)
- sector trends might be heterogeneous as well

Final suggestions

- Increasing need to complement analyses that use WB, OECD, EUROSTAT data with country-based analyses (geographic areas, sector, etc..).
- Crucial role of environmental agencies and public local institutions in providing such data over time (panel), with frequent update (yearly, etc..)
- This country/regional based research direction also generates more integration at applied level between economics, policy studies, env. Sciences, geography, regional sciences

Empirical results

(by macro sector)

Sector	Variables	CO ₂ /N	N ₂ O/N	CH ₄ /N	NO _x /N	SO _x /N	NH ₃ /N	NMVOC/N	CO/N	PM ₁₀ /N
N=216 (12 years*15 sectors)	VA/N	12.96***	12.81***	6.86***	27.38***	-18.06***	115.61***	-17.99***	17.24***	19.64**
	(VA/N)2	-2.86***	-2.506***	-0.696**	-6.197***	1.75***	-23.68***	4.27***	-3.65***	-4.44**
	(VA/N)3	0.207***	0.168*		0.457***		1.61***	-0.324***	2.56**	0.328**
	VA/N turning points	137.07 (quadratic)	281.57 (quadratic)	138.12	119.56 (quadratic)		156.15 (quadratic)		150.36 (quadratic)	136.07 (quadratic)
Manufacturing N=168 (12*14)	VA/N	20.32***	15.23**	6.104***	32.75***	46.71**	39.08***	12.38**	4.428***	28.23**
	(VA/N)2	-4.41***	-3.07**	-0.587***	-7.72***	-14.52***	-4.10***	-3.36***	-0.467***	-6.75**
	(VA/N)3	0.311***	0.210*		0.599***	3.22***		0.293***		0.531**
	VA/N turning points	86.09 (quadratic)	201.23 (quadratic)	181.14	397.20 (quadratic)		116.29		113.56	
Services N=108 (12*9)	VA/N	-73.00***		-1.82***	-138.27***	-503.73***	324.35**	-276.4**	-313.16**	-9.68**
	(VA/N)2	18.21***			33.91***	123.77***	-79.84**	67.65**	75.94**	1.11**
	(VA/N)3	-1.50***			-2.76***	-10.11***	6.54**	-5.53*	-6.16**	
	VA/N turning points	A negative relationship is generally observed over the period								

Empirical results

(GHGs, all provinces)

Variables	CO ₂ /Pop		N ₂ O/Pop		CH ₄ /Pop	
VA/Pop	0.372**	0.342*	0.201*	0.271**	13.989***	11.331***
(VA/Pop) ²	-	-	-	-	-0.744***	-0.607***
(VA/Pop) ³	-	-	-	-	-	-
Pop density	-	0.223**	-	-0.490***	-	-1.142***
FEM/REM	REM	REM	REM	REM	FEM	FEM ^o
Turning point (VA/Pop) [§]	-	-	-	-	9.401	9.334
F test and Chi squared prob.	0.047	0.011	0.085	0	0.001	0
N	285	285	285	285	285	285

