"Connecting Smart and Sustainable Growth through Smart Specialisation": regional green branching and KETS in a European patent based analysis.

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Agenda

1. Inspiring motive.

2. Aim of the paper and research questions.

3. Background literature.

4. Empirical application.

5. Results.

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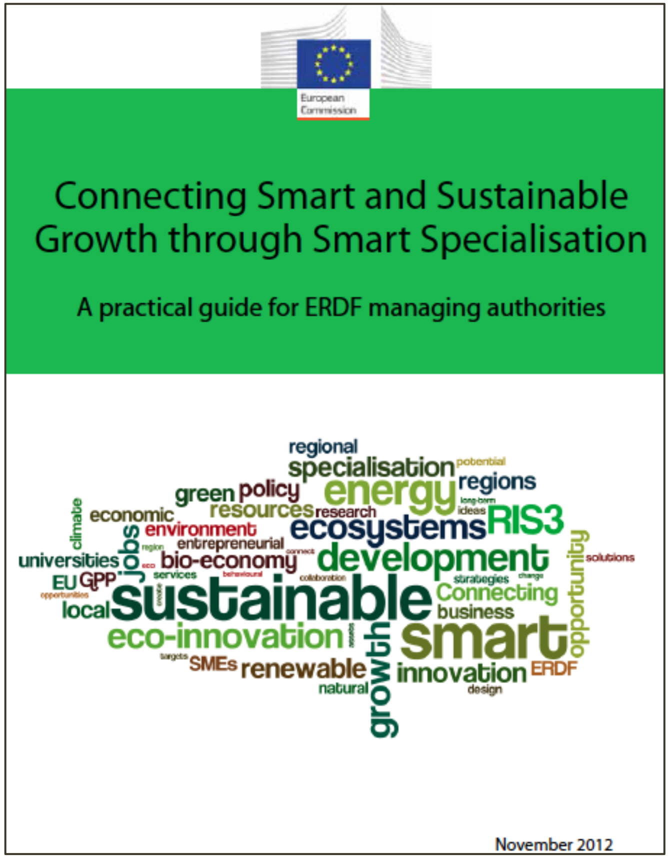
1. Inspiring motive (1/3)



- **Connecting smartness and sustainability**: a new course of policy action supporting *complementarity* between EU2020 objectives.
- Research on "**policy leverages**" to bridge objectives:
- ***Macro and industry level***: the bridging role of **eco-innovations (EIs)** (Fussler and James, 1996; Rennings, 2000; Kemp and Pontoglio, 2007); ...
- ***Regional/urban level***: from **EIs in local contexts** (*Cainelli-Mazzanti-Montresor, 2012; Ghisetti and Quatraro, 2013; Leoncini-Montresor-Rentocchini, 2016*) …
- to the bridging role of **smart specialisation strategies for research and innovation** (**RIS3**) ...

1. Inspiring motive (2/3)

- **Why and how should RIS3 connect regional smartness and sustainability?**

- **The "simple" policy claim**:
- ***Why***: regional authorities with greater "proximity" to environmental and growth problems, and higher control of policy instruments for their combined solution (e.g. urban planning, local public procurement, energy programmes) (EC, 2012).
- ***How***: "… place sustainable growth at the core of RIS3"; "consider [it] at each step in the design of the RIS3"; "develop multi-level governance for integrated innovation policies, where sustainable growth takes predominance" (ibidem, p. 18)   (EC, 2012, p. 18-25).

- **The need of a more research-grounded policy claim**:
- Extending the RIS3 logic of "regional branching" to the green realm.
- Considering the role of Key-Enabling-Technologies (KETS) for regional "green branching".

1. Inspiring motive (3/3)

- **i) Regional branching (in a nutshell) and RIS3** (Boschma and Giannelle, 2014): regions specialise smartly by diversifying into new sectors and/or technologies, but ***related*** to their pre-existing knowledge base.

- → **Regional "green branching"**: regions connect smart and sustainable growth by mastering new environmental technologies through the recombination of their existing knowledge base.

- **ii) KETS and regional branching (Montresor and Quatraro, 2016):** given their ***GPT nature***, KETS (also) attenuate the role of technological relatedness for regional branching and help the regional exploration/discovery of new technologies.

- → **KETS and regional green branching**: KETS could make pre-existing regional competencies less binding for the acquisition of new green ones, and help it also in otherwise locked-in "poor-green" regions.

2. Aim of the paper and research questions

- **Aim:**
- Investigate the interplay of regional branching and KETS in helping regions connect smart and sustainable growth strategies, that is, …
- the determinants of new and cognitively related regional specialisations in green technologies.

- **Research questions**:
- Do technological relatedness #and# KETS affect the region’s capacity of acquiring new green technological specialisations?
- Do KETS moderate the impact of technological relatedness on such a regional capacity?

3. Background literature (1/4)

- **The "standard" regional branching hypothesis:** cumulative regional learning affects industry and *technology* diversification, in terms of their *entry*, exit, and cohesion in regions (Tanner, 2014; Neffke et al., 2011).

- **Theoretical foundations** (Castaldi et al., 2014; Colombelli et al., 2014): local "*variety*" of industries and/or technologies spurs Jacobsian knowledge spillovers, turning into "*recombinant innovations*" by relying on their "*technological relatedness*".

- **Empirical evidence**: several confirmations at the technology level, using bibliometric and patent data (e.g. Koegler et al., 2013; Rigby, 2013; Boschma et al., 2014; Tanner, 2014; Colombelli et al., 2014; Boschma et al., 2015; Castaldi et al., 2015; Montresor-Quatraro, 2016).

3. Background literature (2/4)

- **Towards "green" regional branching:** regional diversification into new, related and sustainable industries and technologies.
- **Theoretical foundations (our own view!):** the special nature of "green technologies" - early-stage, (Consoli et al., 2016), complex (Braungart et al., 2007), multi-mode (Marzucchi-Montresor, 2016) - makes "incremental" approaches (CII-ITC, 2010; EC, 2012) to regional sustainability less risky and costly than "radical" ones (Simmie, 2012; Antonioli et al., 2016).
- **Empirical evidence:** number of supportive case-studies (Cooke, 2008; 2012; EC, 2012), but still few systematic empirical evidences (patent data for European regions) (Tanner, 2014; van den Berge and Weterings, 2013).

3. Background literature (3/4)

- **KETS and regional branching (Montresor and Quatraro, 2016)**: GPT like KETS (EC, 2009) - *industrial biotechnology, nanotechnology, micro- and nanoelectronics, photonics, advanced materials, and advanced manufacturing technologies* - can favour regional branching and make technological relatedness less binding for it to happen.

- **Theoretical background**: KETS/GPT attenuate the recombination limits posed by the ruling technological paradigm (Olson and Frey, 2002), and yield "newer" re-combinations beyond simple branching (Frenken et al, 2012).

- **Empirical evidence**: 26 EU countries, 1998-2010; KETS patent-knowledge accounts for new regional technological specialisations and negatively moderates – that is, attenuates – the impact exerted by their related variety to pre-existing technologies.

3. Background literature (4/4)

- **Towards KETS and "green" regional branching**.
- **Theoretical foundations (our own view!):** the combined action of GPT/KETS and regional branching is reinforced with respect to eco-innovations, given the pervasive role of recombinatory processes in economies' green-transitions (Zeppini and van den Bergh, 2011).
- **Empirical evidence (suggestive):** regional green-branching compatible with different regional knowledge-bases (contra-theory) (Fornahl et al., 2012), providing some other horizontal-locational conditions are present, like access to infrastructure, positive market developments,
- …. and KETS?

4. Empirical application (1/6)

- **Dataset and variables**: combination of 3 data sources for EU regions:
- **(1) OECD Reg Pat dataset**: georeferenced filled patent micro-data:
- New technological specialisation of region *i* in green technology (GT) *s*, at time *t*: $\boldsymbol{NewGT\_RTA_{ist}}$ controlling for GT being in KETS ($\boldsymbol{Dummy\_KETS_{ist}}$);
- Technological relatedness between a newly acquired (by specialisation) GT, *s*, and the pre-existing technologies of region *i*: $\boldsymbol{Dens_{ist}}$;
- Pre-existing specialisations (knowledge) of region *i* in GT: $\boldsymbol{GT\_RTA_{it\text{-}k}}$;
- Pre-existing specialisations (knowledge) of region *i* in KETS technologies: $\boldsymbol{KETS\_RTA_{it\text{-}k}}$;
- GT and KETS identified by clustering IPCs and CPC according to the WIPO Green Inventory (2012) and the EC-Feasibilty-Study (EC, 2012).

4. Empirical application (2/6)

- **Dataset and variables**: combination of 3 data sources:
- **(2) European Regional Database** (Cambridge Econometrics): other determinants of regional branching and controls:
- Region *i* valued added at time *t - k*: $\boldsymbol{GVA_{it-k}}$;
- Region *i* employment at time *t - k*: $\boldsymbol{Employment_{it-k}}$;
- **(3) Eurostat regional statistics:**
- Region *i* R&D intensity at time *t - k*: $\boldsymbol{R\&D_{it-k}}$
- **Final sample**: 235 NUTS2 regions for 26 EU countries (excluding only Greece and Croatia from the 28 of the EU due to data constraints) over the period 1981-2010.

4. Empirical application (3/6)

- **Variables construction:**

- **Technology-related variables:** built up by working out the Revealed Technological Advantage (RTA) of region *i* in the focal technology *s*:

$$RTA_{ist} = \frac{PAT_{ist} \Big/ \sum_{i=1}^{n} PAT_{ist}}{\sum_{s=1}^{m} PAT_{ist} \Big/ \sum_{i=1}^{n}\sum_{s=1}^{m} PAT_{ist}}$$

- Region *i* technological specialisation in *s* if $RTA_{ist} > 1$;
- erratic trends in patents smoothed with 5-year MA;
- regressors lagged by 5 years ($k = 5$) (robust choice).

4. Empirical application (4/6)

- **Variables construction:**

$$NewGT\_RTA_{ist} = 1, \text{ if } GT\_RTA_{ist} > 1 \text{ and } 0 < GT\_RTA_{ist-k} < 1$$
$$NewGT\_RTA_{ist} = 0, \text{ otherwise}$$

$$GT\_RTA_{it-k} = \sum_{s=1}^{n} DGT\_RTA_{ist-k}$$
$$\text{with } DGT\_RTA_{ist-k} = 1 \text{ if } GT\_RTA_{ist-k} > 1; \text{ 0 otherwise}$$

$$KETS\_RTA_{it-k} = \sum_{s=1}^{n} DKETS\_RTA_{ist-k}$$
$$\text{with } DKETS\_RTA_{ist-k} = 1 \text{ if KETS}\_RTA_{ist-k} > 1; \text{ 0 otherwise}$$

4. Empirical application (5/6)

Variables construction:

Following and extending Hidalgo et al. (2007),

$$Dens_{ist} = \frac{\sum_{s \neq z} \varphi_{szt-1} NewGT\_RTA_{ist}}{\sum_{s \neq z} \varphi_{szt-1}}$$

where :

$$\varphi_{szt} = \min\left\{P(RTA_{st} \middle| RTA_{zt}), P(RTA_{z} \middle| RTA_{s})\right\}$$

$$P(RTA_{st} | RTA_{zt}) = \frac{P(RTA_{st} \cap RTA_{zt})}{P(RTA_{zt})}$$

4. Empirical application (6/6)

- **Econometric strategy:**

$$NewGT\_RTA_{ist} = f(Dens_{ist}; GT\_RTA_{it-k}; Dens_{ist} * GT\_RTA_{it-k};$$
$$KETS\_RTA_{it-k}; Dens_{ist} * KETS\_RTA_{it-k};$$
$$Dummy\_KETS_{ist}; z_{it-1}; dtime; dregion; \varepsilon_{it})$$

- Dichotomous-dependent variable:
- Linear Probability Model as benchmark: binomial regression making use of OLS;
- Generalized Linear Model (McCullaghand Nelder, 1989): reference model to deal with possibly inefficiency (Cox, 1970).

5. Results (preliminary) (1/6)

Table 1 – Green regional branching and KETS

	(1) Full Sample	(2) Full Sample	(3) Full Sample	(4) No KETs GTs
$Dens_{ist}$	0.8299***	1.2247***	0.9436***	0.9242***
	(0.0220)	(0.0200)	(0.0266)	(0.0287)
GT_RTA_{it-5}	0.0046***	0.0184***	0.0046***	0.0043***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)
$Dens_{ist}$ * GT_RTA_{it-5}		-0.0454***		
		(0.0011)		
$KETS\_RTA_{it-5}$			0.0001***	0.0002***
			(0.0000)	(0.0000)
$Dens_{ist}$ * $KETS\_RTA_{t-5}$			-0.0006***	-0.0005***
			(0.0001)	(0.0001)
Dummy_KETS			0.0055***	
			(0.0011)	
…				
…				
Constant	-0.0015	-0.1480***	-0.0161***	-0.2136***
	(0.0042)	(0.0050)	(0.0052)	(0.0485)
N	977184	977184	977184	674365
R^2	0.099	0.119	0.100	0.096
adj. R^2	0.0984	0.1185	0.1001	0.0958

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The cognitive/technological proximity to the pre-existing knowledge base makes the acquisition of a green specialisation more probable.

→ Regional branching apparently at work also in the green realm.

5. Results (preliminary) (2/6)

Table 1 – Green regional branching and KETS

	(1) Full Sample	(2) Full Sample	(3) Full Sample	(4) No KETs GTs
$Dens_{ist}$	0.8299***	1.2247***	0.9436***	0.9242***
	(0.0220)	(0.0200)	(0.0266)	(0.0287)
GT_RTA_{it-5}	0.0046***	0.0184***	0.0046***	0.0043***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)
$Dens_{ist}$ * GT_RTA_{tt-5}		-0.0454***		
		(0.0011)		
$KETS\_RTA_{it-5}$			0.0001***	0.0002***
			(0.0000)	(0.0000)
$Dens_{ist}$ * $KETS\_RTA_{t-5}$			-0.0006***	-0.0005***
			(0.0001)	(0.0001)
Dummy_KETS			0.0055***	
			(0.0011)	
...				
...				
Constant	-0.0015	-0.1480***	-0.0161***	-0.2136***
	(0.0042)	(0.0050)	(0.0052)	(0.0485)
N	977184	977184	977184	674365
R^2	0.099	0.119	0.100	0.096
adj. R^2	0.0984	0.1185	0.1001	0.0958

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Pre-existing green knowledge does also make the acquisition of new green technologies more probable.

→ The regional approach to environmental sustainability actually looks "incremental" and path-dependent.

5. Results (preliminary) (3/6)

Table 1 – Green regional branching and KETS

	(1) Full Sample	(2) Full Sample	(3) Full Sample	(4) No KETs GTs
***Dens**$_{ist}$*	0.8299***	1.2247***	0.9436***	0.9242***
	(0.0220)	(0.0200)	(0.0266)	(0.0287)
***GT_RTA**$_{it-5}$*	0.0046***	0.0184***	0.0046***	0.0043***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)
***Dens**$_{ist}$ * **GT_RTA**$_{tt-5}$*		-0.0454***		
		(0.0011)		
***KETS_RTA**$_{it-5}$*			0.0001***	0.0002***
			(0.0000)	(0.0000)
***Dens**$_{ist}$ * **KETS_RTA**$_{t-5}$*			-0.0006***	-0.0005***
			(0.0001)	(0.0001)
Dummy_KETS			0.0055***	
			(0.0011)	
…				
…				
Constant	-0.0015	-0.1480***	-0.0161***	-0.2136***
	(0.0042)	(0.0050)	(0.0052)	(0.0485)
N	977184	977184	977184	674365
R^2	0.099	0.119	0.100	0.096
adj. R^2	0.0984	0.1185	0.1001	0.0958

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

An history of green knowledge could even make technological relatedness less binding for its renewal.

→ Green regions could have more scope for exploring and diversifying in a sustainable manner.

5. Results (preliminary) (4/6)

Table 1 – Green regional branching and KETS

	(1) Full Sample	(2) Full Sample	(3) Full Sample	(4) No KETs GTs
$Dens_{ist}$	0.8299***	1.2247***	0.9436***	0.9242***
	(0.0220)	(0.0200)	(0.0266)	(0.0287)
GT_RTA_{it-5}	0.0046***	0.0184***	0.0046***	0.0043***
	(0.0003)	(0.0004)	(0.0003)	(0.0003)
$Dens_{ist}$ * GT_RTA_{tt-5}		-0.0454***		
		(0.0011)		
$KETS\_RTA_{it-5}$			0.0001***	0.0002***
			(0.0000)	(0.0000)
$Dens_{ist}$ * $KETS\_RTA_{t-5}$			-0.0006***	-0.0005***
			(0.0001)	(0.0001)
Dummy_KETS			0.0055***	
			(0.0011)	
…				
…				
Constant	-0.0015	-0.1480***	-0.0161***	-0.2136***
	(0.0042)	(0.0050)	(0.0052)	(0.0485)
N	977184	977184	977184	674365
R^2	0.099	0.119	0.100	0.096
adj. R^2	0.0984	0.1185	0.1001	0.0958

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

KETS do actually help green regional branching, and attenuate the role of technological relatedness for it to happen.

→ KETS could help (in particular less and/or no green) regions attenuate the binding role of the proximity to their knowledge base for diversifying in a sustainable manner.

5. Results (preliminary) (5/6)

Table 2 – Green regional branching and KETS by typology

	(1)	(2)	(3)	(4)	(5)	(6)
Dens $_{ist}$	0.9536***	0.8594***	0.8862***	0.9089***	0.9119***	0.9376***
	(0.0258)	(0.0235)	(0.0270)	(0.0268)	(0.0287)	(0.0281)
KETS_1_RTA $_{it-5}$	0.0014***					
	(0.0001)					
Dens $_{ist}$**** KETS_1_RTA*** $_{it-5}$	-0.0044***					
	(0.0004)					
KETS_2_RTA $_{it-5}$		0.0245***				
		(0.0034)				
Dens $_{ist}$**** KETS_2_RTA*** $_{it-5}$		-0.0727***				
		(0.0109)				
KETS_3_RTA $_{it-5}$			0.0009***			
			(0.0002)			
Dens $_{ist}$**** KETS_3_RTA*** $_{it-5}$			-0.0026***			
			(0.0004)			
KETS_4_RTA $_{it-5}$				0.0014***		
				(0.0002)		
Dens $_{ist}$**** KETS_4_RTA*** $_{it-5}$				-0.0043***		
				(0.0006)		
KETS_5_RTA $_{it-5}$					0.0005***	
					(0.0001)	
Dens* KETS_5_RTA $_{it-5}$					-0.0014***	
					(0.0002)	
KETS_6_RTA $_{it-5}$						0.0005***
						(0.0001)
Dens $_{ist}$**** KETS_6_RTA*** $_{it-5}$						-0.0014***
						(0.0002)

KETS role invariant with respect to their specific typology:

An apparently homogeneous group also in terms of regional green branching.

5. Results (preliminary) (6/6)

Table 2 – Green regional branching and KETS by typology

	(1)	(2)	(3)	(4)	(5)	(6)
Dummy_KET	0.0036***	0.0038***	0.0040***	0.0040***	0.0039***	0.0041***
	(0.0013)	(0.0014)	(0.0014)	(0.0013)	(0.0014)	(0.0013)
GT_RTA$_{it-5}$	0.0042***	0.0042***	0.0042***	0.0042***	0.0042***	0.0042***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
…						
Constant	-0.1365***	0.0972***	0.0433***	0.0424***	0.0413***	0.0443***
	(0.0402)	(0.0339)	(0.0144)	(0.0144)	(0.0144)	(0.0149)
N	784341	784341	784341	784341	784341	784341
R^2	0.092	0.090	0.091	0.091	0.091	0.091
adj. R^2	0.0913	0.0902	0.0905	0.0909	0.0907	0.0912

6. Conclusions and future research (1/2)

- **Main conclusions**

- Regions do show an incremental (path-dependent) approach to environmental sustainability and reveal traces of green branching.
- **Policy implication**: sustainability does actually seem to connect with smartness in the acception of RIS3 → RIS3 appears a research grounded connecting policy.

- KETS play a similar role to previous experience of green knowledge in attenuating the impact of technological relatedness on green regional branching.
- **Policy implication**: integrating KETS in the RIS3 tool-box could help inexpert green regions to enter in the environmental realm.

6. Conclusions and future research (2/2)

- **Future research:**
- Insert other forms of proximity for regional green branching to occur (e.g. spatial one with regional spillovers).
- Address the net role of KETS for regional green branching and eventually their role in allowing regions to shift from non-green to green technologies.
- Compare the net effect of the 6 different KETS.
- Combine the Green Inventory (WIPO, 2012) with the OECD "Environmental Technologies" indicators ENV-TECH (Haščič and Migotto, 2015) to refine the identification of green technologies.
- Refine the econometric strategy and insert a more consistent set of controls (e.g. environmental regulations), also for regions with different degrees of development.

Thanks for your attention