Workshop on Universities' engagement in knowledge exchange: International evidence

How do universities manage their technology transfer portfolio? An exploratory study using QCA

Jasmina Berbegal-Mirabent
Dolors Gil-Doménech

London, March 13, 2019

Context

Knowledge-based society

Creativity & Innovation

Speed-up technological innovations

Reduce time lag discovery-application

Professionalization of research activities

Teaching → high quality graduates

Research → top researchers

Technology transfer → solutions to daily problems

Enlarge service portfolio

Change ways of operating

Human resources (time, incentives, skills…)

Financial resources

Infrastructures

Purpose

- Focus on the **technology transfer** (TT) mission
- HEIs have **limited resources** but society expects them to provide **cutting edge solutions** to industries' problems
- **Relax** the traditional constraint that HEIs should conduct **all types of TT** activities → **diversified portfolio** (patents, spin-offs and R&D contracts)
- Our model allows HEIs to **concentrate** in the activity in which each university perform best

Investigate the antecedents of TT outcomes

Examine different patterns

Compare if universities have changed their strategies over time

Method: QCA

Setting: Spanish public HEIs, 2008 & 2015

Literature review. Third mission activities & strategic choices

Third mission activities
(Pausits, 2015)

Economic dimension

Exploitation of research and its **practical application** in the form of innovation

Support **structures** (TTO) to facilitate knowledge flows

Criticisms due to an unequal applicability to all branches of knowledge

Spin-offs (**direct**)

Patents, R&D contracts (**indirect**)

Social dimension

Universities as "**active players**" in social and cultural life

Lack of **data**

Literature review. Antecedents

Individuals' attributes

- **Academic staff** (knowledge, abilities, ideas)
- **Non-academic staff** (coaching, assessment, guidance)

Knowledge stock

Basis for further developments

Financial resources

Sources of fundraising for the daily operations of HEIs and involvement in TT activities

Orientation

- Nature of the research engaged
- Medical & engineering studies
- Specialization and efficiency

Previous experience

- Reduce time span to develop new activities
- Historical records and know-how
- Rigidity vs. flexibility

Data and method

Variables			2008	2015
Outcomes	Patents		5.32 (5.96)	13.19 (11.35)
	Spin-offs		2.30 (3.01)	2.23 (3.74)
	R&D contracts income (th EUR)		10,959.74 (13,860.06)	5,437.89 (5652.19)
Antecedent conditions	Human capital	Academic staff	1,153.98 (810.28)	1,154.09 (740.31)
		Non-academic staff	1,061.66 (760.37)	1,052.81 (685.94)
		Papers	837.83 (715.56)	1,324.00 (1118.63)
	Financial resources	Current expenditures (th EUR)	28,000.00 (16,500.00)	27,100.00 (16,500.00)
	Orientation	Academic diversity	3.17 (0.80)	3.63 (0.91)
	Seniority	HEI	132.43 (220.38)	134.43 (220.38)
		TTO	16.89 (4.43)	23.89 (4.43)

Data

- Spanish public HEIs
- Years 2008 and 2015

Method: QCA

- Which **combinations of factors** are sufficient to explain an outcome?
- **Asymmetrical relationships** between variables
- **Equifinality**: different starting points that lead to a similar outcome
- Perform well with small samples
- **Boolean** algebra and **fuzzy sets** (relative values)

Method. QCA

Step 1: Identify relevant cases and causal conditions

- Identify the outcome, positive and negative cases, major causal conditions, set of relevant cases

Step 2: Calibration

- Crips set: Similar to a dummy variable → 1 (full membership), 0 (full non-membership)
- Fuzzy set: values range from 0 to 1, indicating the degree of membership of the case in each condition → 0.95 (full membership), 0.05 (full non-membership), 0.5 (maximum ambiguity)

Step 3: Analysis of necessity

- A condition is necessary if its consistency is high (>0.9-0.95) and its coverage not too low (>0.5)

Method. QCA

Step 4: Truth table

- A truth table sorts cases by the combinations of causal conditions they exhibit (2^k rows) $\rightarrow$ all logically possible combinations of conditions are considered, even those without empirical instances
- Assess the consistency of the cases in each raw with respect to the outcome
- Identify contradictory rows and compare these cases

Step 5: Analyse the truth table and Boolean minimization

- **Frequency cut-off**: determines how many cases a truth table row has to be populated in order to be included in the analysis
- **Consistency cut-off**: threshold at which a combination of conditions is coded as contributing to the outcome
- **Prime implicants**: the minimization process cannot be further reduced
- **Simplifying assumptions**: how logical remainders are treated in the minimization process
- **Model fit**: consistency and coverage

Method. QCA

Step 6: Evaluation and interpretation of the results

- Select the solutions (complex / intermediate / parsimonious)
- Interpret the results as causal recipes
- Identify the cases that conform to each causal recipe
- Conduct additional case-level analysis

Step 7: Robustness checks

- Vary the frequency threshold
- Vary the consistency threshold
- Change the calibration of the conditions

Results

Year 2008

Conf.	Antecedent conditions							Coverage		Consistency
	Academic staff	Non-academic staff	Publications	Current expenditures	Academic diversity	Age HEI	Age TTO	Raw coverage	Unique coverage	
08_1	●	●	●	●	○			0.419	0.035	0.978
08_2	●	●	●	●		●		0.458	0.103	0.965
08_3	●		●	●	○	○	○	0.219	0.002	0.972
08_4	●	●		○	●	●	○	0.157	0.003	0.915
08_5	○	○	○	○	●	○	○	0.202	0.053	0.833
08_6	○	○	○	●	○	○	○	0.190	0.033	0.877

Solution coverage: 0.664

Solution consistency: 0.895

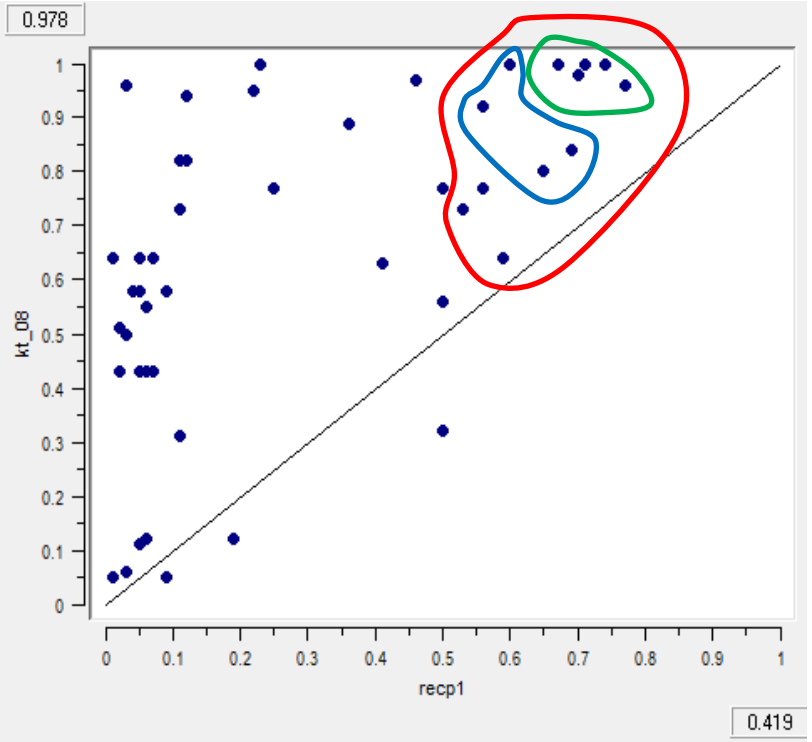
Year 2015

Conf.	Antecedent conditions							Coverage		Consistency
	Academic staff	Non-academic staff	Publications	Current expenditures	Academic diversity	Age HEI	Age TTO	Raw coverage	Unique coverage	
15_1	●	●			●	●	○	0.258	0.013	0.904
15_2	●	●	●	●		●		0.412	0.043	0.949
15_3	●	●	●	●	●			0.427	0.033	0.936
15_4	○	○	○	○	○	○	○	0.207	0.101	0.843
15_5	○	○	●	●	●		○	0.188	0.026	0.851
15_6	●		●	●	●	○	○	0.166	0.003	0.898
15_7	○	●	●	●	○	○	○	0.083	0.004	0.927

Solution coverage: 0.675

Solution consistency: 0.878

Results. 2008



Membership score greater than 0.5

08_01: AS + N_AS + publications + financial resources + specialization

Engineering (UPV, UPC, UPM, EHU) + UGR

Patents + spin-offs + R&D contracts

Large (UB, UV, UAM, UAB)

Ranked in league tables

Regions with a favourable economic environment

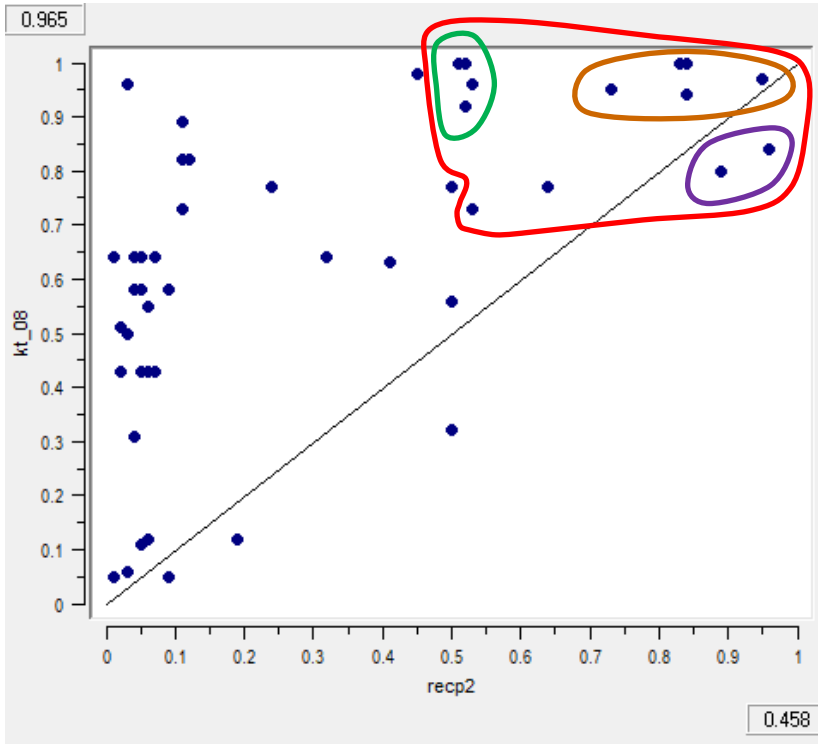
UNIOVI, UCLM, UVA

Human capital stock above the median

Young TTO

Patents

Results. 2008



Membership score greater than 0.5

08_02: AS + N_AS + publications + financial resources + old HEIs

Old HEIs (500 years ago)

Patents + R&D: UCM, USC, UNIZAR

US & UGR similar overall performance but specialization: US (patents), UGR (spin-offs created)

UAM, UPC, UPC, UPV, UAB

Diversified and rich portfolio

Low membership score (0.51-0.53)

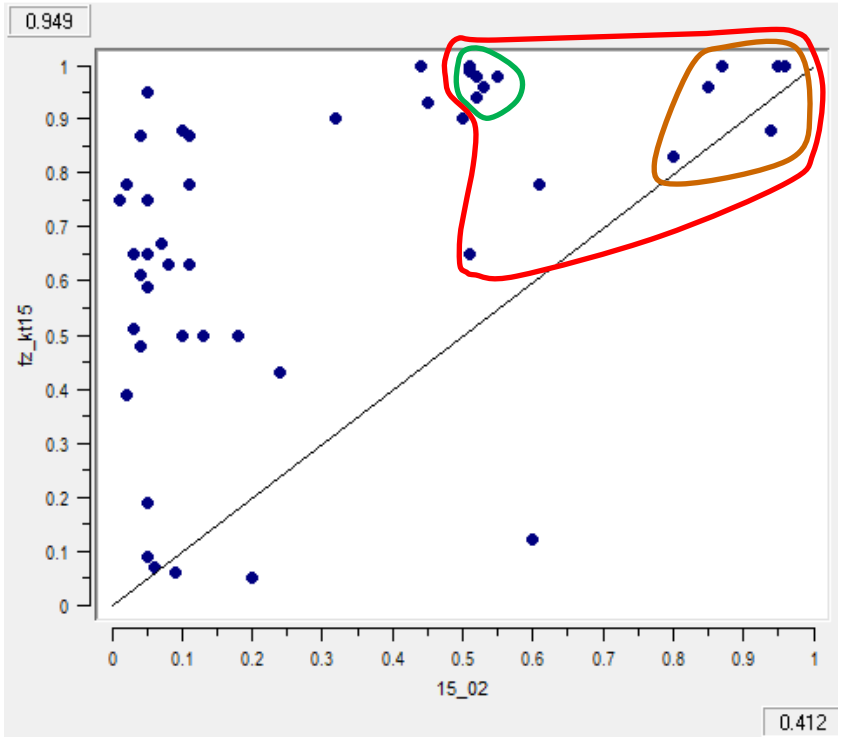
UV and UB

↓ spin-offs, patents + ↑ R&D contracts

USAL, UVA

↓ Performance

Results. 2015



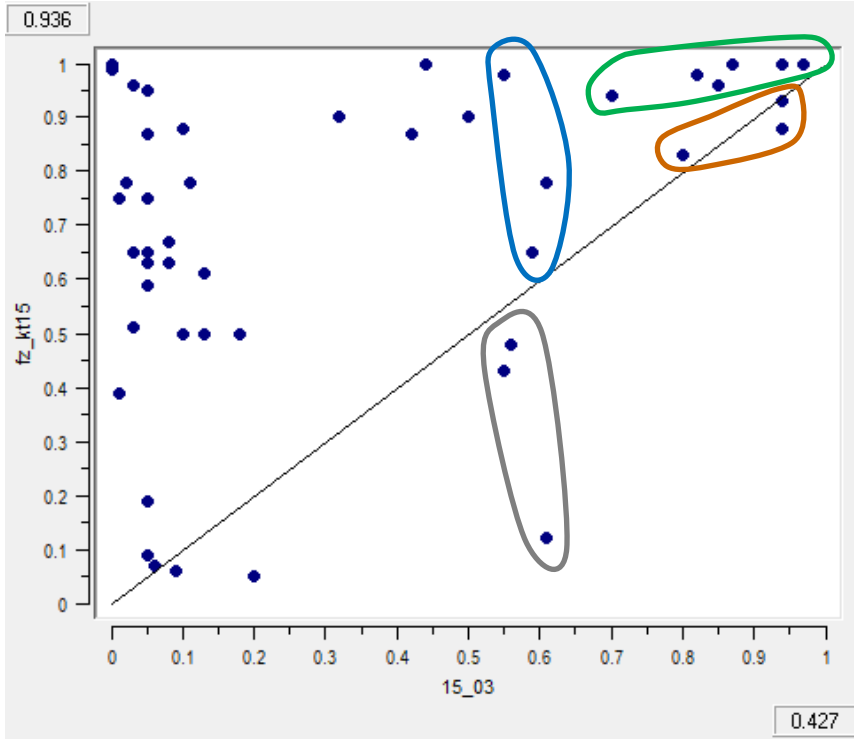
Membership score greater than 0.5

15_02: AS + N_AS + publications + financial resources + old HEIs

(13 out 14 universities in 08_02 are also appearing in 15_02)

- The brown and purple circles seem to have merged
- UB: broader TT portfolio (R&D contracts maintained while in other HEIs diminished)
- USC: movement to the left (green circle)
- UVA disappears: ↑spin-offs + patents, but ↓R&D
- UMA enters: ↓N_AS + current expenditures
- UM (low performing institution): similar resources as USC but focus on teaching

Results. 2015



Membership score greater than 0.5

15_03: AS + N_AS + publications + financial resources + diversification

Large and comprehensive (UCM, UB, US, UGR, UAB, UAM)

UAM: R&D + patents

UGR: patents

Similar resources but very different results

USC leads this group (↑TT), followed by USAL and UMA ↓(TT)

Similar resources as the green ones, but lag behind in TT (although good results, ≥ 0.8)

< 0.5 (UNIOVI, UCLM, UM)

Mission mix does not consider TT as strategic activities

Discussion

- Adopt a new lens (**QCA**) to observe a phenomenon (parametric and non-parametric approaches, composite indexes, other econometric approaches)

- Scarce resources + Different strategy (institutional + regional) → HEIs address their objective function **differently**
  - Different **pathways**
  - HEIs can freely decide the **breadth** (types of outputs) and **length** (volume within each category) of its TT portfolio, allowing for specialization → accomplishment of the third mission
  - Establish more **appropriate benchmarks** (heterogeneity of the Spanish HEI landscape)

- **No** relevant **fluctuations** between 2008 and 2015 → economic downturn, internalization of the third mission

Jasmina Berbegal-Mirabent
jberbegal@uic.es

Dolors Gil-Doménech
mdgil@uic.es