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Country-level investigation of innovation investment in manufacturing: Paired FSQCA of two models

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Abstract

Innovation plays a critical role in economic growth. This study analyses the association between actually implementing innovation and its antecedents, considering a country-level dataset covering innovation-active manufacturing firms in 47 countries. The relationship this article considers is between different drivers of innovation and market preparation for innovation. The study investigates this relationship through fuzzy-set Qualitative Comparative Analysis (fsQCA). The study examines the consideration of different sets of condition variables, identifies the importance of individual variables across causal recipes, and provides understanding of variations in the drivers towards market introduction of innovation between sets of countries. This study also provides an example of the effect on causal recipes in fsQCA when including/excluding a condition variable.

Keywords: FsQCA, innovation; manufacturing; condition variables

1. Introduction

Reducing product life cycles is an ongoing activity (Davis, 1993). Chakravorti (2004) notes that although market innovation is difficult, innovation is beneficial for attaining profitability and growth. Conversely, O'Connor et al. (2013) argue that creating markets for innovation is more problematic than the technological developments themselves.

Furman et al. (2002) suggest that national innovation capacity produces and commercializes technology activity, which infrastructure, industrial clusters environment, and its interconnectivity determines. The United Nations Educational, Scientific and Cultural Organization's (UNESCO) Institute for Statistics (UIS) provides country-level statistics in science, technology, and innovation activities, thus producing indicators on firm innovation types, activities, linkages, and obstacles (UIS, 2015). The Statistical Office of the European Communities define innovation-related activities as "scientific, technological, organizational, financial, and commercial steps which lead to implementation of innovations. Some innovation activities are innovative, others are not novel activities but are necessary for the implementation of innovations" (2005, p. 47).

Innovation levels vary internationally and debate remains regarding its drivers (Reinstaller & Unterlass, 2012). Pickernell et al. (2008) identify that drivers of innovation occur both from single sources and from combinations of them, working collaboratively, or iteratively, to generate innovation between stakeholders. Theoretical controversy and potential still exist in identifying behaviors toward innovation outcomes. This analysis employs fuzzy-set Qualitative Comparative Analysis (fsQCA) (Ragin, 2008). FsQCA derives configurational combinations of attributes that associate with an outcome from a limited number of units of analysis. This study considers necessity and sufficiency using fsQCA (Fiss, 2011).

The study examines the issue of including/excluding a variable from fsQCA with two models: a five-variable model and a four-variable model. The study presents empirical and graphical results, both in terms of applied and technical findings. By identifying novel multiple sets of innovation-related drivers of market introduction of innovation, fsQCA improves the understanding of market innovation introduction.

2. Innovation

Firm ability to sustain innovation and create knowledge leads to improved capabilities and performance (Knight & Cavusgil, 2004). Research and development (R&D) supports the development of new markets and the reinvention of operations to service markets with increased efficiency (Nelson & Winter, 1982). Such innovation derives from internal R&D, drawing on firms' accumulated knowledge and replication of innovations from others (Lewin & Massini, 2003).

Although R&D investment is relevant, investment in physical and human capital through training is also important (Jones et al., 2013) because multiple processes in the innovation pipeline (McCarthy et al., 2014) and requiring resources, knowledge, and skills are what enable market innovation. The innovation pipeline approach identifies that innovation requires R&D and physical or trained human capital to access the market and to enable its successful absorption and utilization (Acs et al., 2012).

This study focuses on firm innovation's market introduction and optimization drivers, thus improving knowledge on innovation-related processes within the innovation pipeline. McCarthy et al. (2014) identify these processes fitting within overlapping categories of knowledge creation, dissemination, utilization, exploitation, and commercialization. This framework highlights five potential drivers towards market introduction of innovation, which this study uses as variables for the analysis.

2.1. Market-introduction of innovation

Bringing innovation to market is a key activity involving marketing and research (Galindo & Mendez, 2014). Improving reputational capital through marketing is relevant to successful innovation-to-market processes (Morris & Paul, 1987). The outcome variable *market-introduction of innovations* describes market preparation and introduction of new/significantly improved goods and services including marketing research and launch advertising (UIS, 2015).

2.2. In-house-R&D

Love and Roper (2015) suggest that in-house-R&D is central to knowledge generation, enabling proprietary intellectual property and innovation development. Raymond and St. Pierre (2010) identify links between in-house-R&D and product innovation. Firm-level R&D is also complementary with external research activity (Veugelers & Cassiman, 1999). The factors affecting relationships between R&D and market introduction of innovation, however, require further research.

2.3. External-R&D

An alternative to internally generated R&D is acquiring R&D from external organizations by using transactional rather than networked approaches (De Lurdes Veludo et al., 2006). Beneito (2006) proposes that combinations of in-house and contracted R&D enhance market innovation outcomes. Issues arising from external R&D include whether internal capacity exists to absorb external R&D and generate successful innovations for market (Pickernell et al., 2008).

2.4. External-Knowledge

Current innovation paradigms emphasize multidisciplinary and interactive knowledge production among governments, universities, and firms: the triple helix model (Etzkowitz & Leydesdorff, 2000). Interactive, iterative, networked learning and innovation approaches, with connectivity between growth, innovation, and external relationships nowadays replace conventional organizational learning and innovation processes (Carroll & Hannan, 2000).

2.5. Training

Frenz and Oughton (2006) suggest that human capital is important to enhance firms' absorptive capacity and to facilitate technology and knowledge transfer, innovation, and growth. Training is essential to have qualified, flexible, prepared, and motivated employees (Raghuram, 1994). Therefore, employee training is a mechanism to enhance firm performance through improved profitability and productivity, organizational performance, and capabilities (Kotey & Folker, 2007).

2.6. Physical-Capital

Investment in physical capital and information communication technology (ICT) is particularly relevant (Diaz-Chao et al., 2015). ICT is crucial to increase productivity and economic growth (Jorgenson et al., 2008; Jorgenson & Vu, 2007). In addition, ICT usage generates complementary innovations, thus improving productivity (Ceccobelli et al., 2012).

Lesjak and Vehovar (2005) recognize that internet use contributes to the creation of current and future economic benefits, creating increased market value, which digital investment occurring alongside investment into human capital or organizational change causes (Brynjolfsson & Hitt, 2003). Lee (2001) describes the processes of transforming to more e-commerce-based approaches as disruptive innovation that radically alters operating procedures.

Innovation drivers occur from single sources, or combination of sources, working collaboratively or iteratively (Pickernell et al., 2008). Research questions therefore focus on whether multiple combinations of variables drive market introduction of innovation, what these combinations are, and how many of these combinations exist. In addition, because of differences across nations (Reinstaller & Unterlass, 2012), the study also identifies combinations by countries.

Because of the debate on including physical capital as a variable (owing to its very loose relation to market introduction of innovation), this study compares five- and four-variable models of innovation to examine how the addition of the physical capital variable affects the results, allowing consideration of the theoretical implications of the physical capital variable. This procedure also allows fsQCA methodological issues relating to the use of a five- versus four-variable model to be explored, adding a “novel feature” of a robustness test as an incremental, though important, practical methodological contribution.

3. UNESCO data set, method, and data pre-processing

3.1. UNESCO Data set

The dataset encompasses innovation-active firms, which implemented product or process innovations, had abandoned or had ongoing innovation activities to develop product or process innovations (UNESCO, 2015). The study focuses on activities of firms active in processes related to innovation, in particular, manufacturing firms.

UIS innovation data collection took place in 2013. Countries had to report data only for manufacturing with the aim of fostering comparability, because innovation surveys customarily fully—or almost fully—cover manufacturing industries (UIS, 2015). One limitation of this dataset is that, for some countries, values do not represent the whole national manufacturing sector but refer to firms that replied to the national innovation survey.

Consideration of this subset enabled comparability across sample countries (UIS, 2015). In national innovation surveys, the questions about innovation activities usually address product or process innovation-active firms. The condition and outcome variable scales that this study considers are for firms engaged in particular forms of innovation activities, as a percentage of innovation-active manufacturing firms (see Appendices in UIS, 2015).

The UNESCO country-innovation dataset reports 59 countries (UIS, 2015). Concerning the condition and outcome variables that Table 1 presents, 47 countries had the complete information necessary for the analysis.

Table 1 here.

3.2. Method

Fuzzy-set Qualitative Comparative Analysis (fsQCA) is a set-theoretic technique for investigating the relationship between potential causal condition variables and an outcome (a development on QCA). FsQCA is a very practical analysis tool in the presence of potential causal complexity (Ragin, 2008). With cases contributing to the prevalence of certain configurations of variables, this level of comparison enables future practical interpretation.

Through comparison, fsQCA identifies causal conditions associated with each outcome, including the minimal causal conditions necessary or sufficient for the outcome to occur. Conditions are necessary when the outcome cannot occur without them, whereas conditions are sufficient when the outcome always occurs when the condition is present, although the outcome could also result from other conditions (Rihoux & Ragin, 2009).

3.3 Data pre-processing

To use the UNESCO data set, the study pre-processes the set, transforming condition and outcome variable values from their respective percentage-based scale values to fuzzy membership scores over 0.0 (full exclusion, "non-membership" from a set) to 1.0 (full inclusion "membership") domain. This study adopts Andrews et al.'s (2015) and Beynon et al. 's (2015) approach to identify three threshold qualitative anchors determining full membership (upper-threshold), full non-membership (lower-threshold), and crossover point within the direct method approach, thus establishing required fuzzy membership scores (Ragin, 2008).

This qualitative anchor evaluation process draws on the identification of the respective 5th percentile (lower-threshold), 95th percentile (upper-threshold) and 50th percentile (crossover point) values by building on a probability-density function (PDF) graph for each variable (see Figure 1).

Figure 1 here.

Within each graph in Figure 1, that is, the respective PDF, points represent individual case (country) values over that variable (note that the study measures each variable over the domain of percentage of firms).

The study undertakes specific consideration of the crossover point ($x^{\times}$) identified in each graph. The examination involved investigating the possible effect of moving a crossover point beyond neighboring case values over their respective domains (to both the left and right of their original crossover point values). FsQCA expert opinion did not consider potential changes in case associations to configurations subject to the possible changes in crossover point values (following the approach in Andrews et al., 2015), were pertinent enough to make such changes to the crossover points found (see also Venn diagrams in Figure 2). The threshold values enable the evaluation of the respective fuzzy membership score values (Ragin, 2008).

4. FSQCA analysis of UNESCO data

This section presents the results of the two fsQCA analyses on the five- and four-variable models (including and excluding the physical-capital condition variable). The study uses fs/QCA Version 2.5 (Ragin & Davey, 2014). Central to these analyses is the truth table (Ragin et al., 2008), which includes all the possible configurations (see Table 2).

Table 2 here.

In Table 2, the results for the five- and four-variable models highlight the possible configurations, raw consistency values to the outcome (i.e., Market-Introduction) and not-outcome (i.e., ~Market-Introduction), and frequency of countries that associate with a configuration based on strong membership (Beynon et al., 2015). In the case of five- and four-variable models, 32 (= 2^5) and 16 (= 2^4) possible configurations exist, respectively. The configurations in bold across the two models, which associate with either Market-Introduction or ~Market-Introduction, depend on the consistency threshold value (see the sufficiency analysis).

The study presents the necessity and sufficiency analysis findings separately for the outcomes, Market-Introduction and ~Market-Introduction (see Fiss, 2011). These analyses examine whether the condition must be present for the outcome to occur (analysis of necessity), or when the outcome occurs when a condition or combination of conditions is present, although the outcome could also result from other conditions (analysis of sufficiency) see Andrews et al. (2015).

For the necessity analysis of individual condition variables for Market-Introduction and ~Market-Introduction, see Table 3.

Table 3 here.

Table 3, shows no condition attributes exist with a consistency value above the threshold value of 0.90, hence no single condition attributes are a necessity in terms of the Market-Introduction or ~Market-Introduction. The results show, within a necessity analysis, that the number of variables does not affect these findings.

In terms of sufficiency analysis (Andrews et al., 2015), the study only considers configurations with at least one country with strong membership. Hence, where a configuration has no countries associated with, either the five- or four-variable model, its consistency and frequency values are struck-through in Table 2.

Across the considered five and four variable- models, the study uses a consistency threshold value of 0.90, enabling distinction of configurations that strongly associate with Market-Introduction and ~Market-Introduction. Choice of this threshold value (working to 2 decimal places of accuracy) was based on the identifying least possible threshold value, while not allowing any configuration to be associated with both Market-Introduction and ~Market-Introduction in the same analysis. In the raw consistency value columns in Table 2, for both five- and four-variable models, the consistency values in bold indicate those configurations that are above the employed threshold value of 0.90).

Employing this consistency threshold value means excluding several groups of countries (configurations) in the five- and four-variable models because of the failure to exceed the 0.90 value for either Market-Introduction or ~Market-Introduction. Schneider and Wagemann (2013) call these configurations remainders. The last row of Table 2 shows the number of non-remainder configurations that associate with Market-Introduction and ~Market-Introduction outcomes across five- and four-variable models.

Tables 4 and 5 present the sufficiency analyses the study uses to interpret complex and parsimonious fsQCA solutions.

Table 4 here.

Table 5 here.

Tables 4 and 5 describe causal recipes- based associations of configurations with Market-Introduction and ~Market-Introduction for the different five- and four-variable models. The notation follows Ragin and Fiss (2008). Black circles (i.e., ●) indicate presence of a condition and cross-out circles (i.e., ⊖) its absence. The size of the circle indicates whether conditions are core or peripheral: large — core conditions, and small — peripheral conditions (blank spaces indicate a "don't care" inference; Fiss, 2011).

Figure 2 presents groupings of the 47 countries in the sample, over five- and four-variable models in a two-tier Venn diagram. Each cell in the Venn diagrams indicates their configuration index and a summary of the representation of the configuration in terms of absence (0) or presence (1) of each condition variable.

Figure 2 here.

Figure 2 presents several results in the two-tier Venn diagram: Each of the two layers offers information on the five (left) and four-variable (right) models. In each tier, a cell denotes a configuration (see Table 2). For each model, the study presents the countries that associate with each configuration. The numbers of countries that associate with a configuration align with the numbers in Table 2.

Cells in the Venn diagrams in dark gray and light gray correspond to the outcome a configuration associates with from the fsQCA analyses, namely Market-Introduction and ~Market-Introduction, respectively (Beynon et al., 2015). The white region signifies no assignment to either Market-Introduction or ~Market-Introduction.

The fsQCA analyses give rise to several contributions. First, in terms of theory, the analyses identify a number of distinct causal recipes. In the complex solutions for Market-Introduction across the five- and four-variable models, the analyses identify the same number (recipes 5CO1, 5CO2, 5CO3, 4CO1, 4CO2, and 4CO3). However, when comparing the two models regarding ~Market-Introduction, the analyses identify four recipes for the four-variable model and two for the five-variable model.

Second, from a methodological robustness standpoint, the five- and four-variable models overlap, with two identical recipes (5CO3 and 4CO2 for the Market-Introduction and 5CN3 and 4CN1 for ~Market-Introduction), and two recipes (5CO1 and 4CO1 for the Market-Introduction and 5CN1 and 4CN2 for ~Market-Introduction) where the only difference was that the five variable model includes the fifth variable (Physical-Capital).

Third, in terms of theory, the analyses show that the condition variable appearing most consistently in the causal recipes is training, which is present in all but one of (– not 5CO1) the recipes for Market-Introduction, and absent from all recipes for ~Market-Introduction. The result suggests that human capital and its development is very important in assisting innovation into market in combination with innovation creation and absorption activities, and that the absence of training prevents innovation into market.

This finding supports prior work of Frenz and Oughton (2006) regarding the importance of human capital towards innovative activity in firms. However, the results also indicate the greater importance of training relative to other condition variables in terms of being the condition variable appearing most often in the causal recipes.

By contrast, although In-house-R&D appears in several recipes, both for Market-Introduction and ~Market-Introduction, the relationship is not consistent. Certain recipes for Market-Introduction show In-house-R&D as present, whilst other recipes show it as absent. Similarly, certain recipes for ~Market-Introduction show In-house-R&D as present, whilst other recipes show it as absent. For Market-Introduction, the presence of External-R&D and External-Knowledge can also make up for the absence of In-house-R&D innovation. Conversely, the presence of In-house-R&D where Training is absent associates with

~Market-Introduction. These results suggest the In-house-R&D is neither necessary or sufficient as a variable in driving market introduction of innovation.

External-Knowledge also appears inconsistently in causal recipes. Presence of External-Knowledge strongly associates with Market-Introduction, appearing in two recipes. However, this variable's absence associates in only of the four recipes describing ~Market-Introduction. Presence of Physical-Capital also associates with Market-Introduction for two of the three recipes, whereas its absence associates with ~Market-Introduction in one of the four recipes. In the 5CN1 recipe, however, presence of Physical-Capital, along with In-house-R&D, and External-R&D associates with ~Market-Introduction when Training is absent. This result reinforces the strength of the role of Training (and its absence) in explaining Market-Introduction and ~Market-Introduction outcomes.

Finally, countries that associate with the same causal recipe are relevant regarding policy benchmarking and development. In terms of policy, for most countries, and country groupings, a single causal recipe is relevant. The exceptions are South Africa (in configuration 24) for Market-Introduction, and Australia, Belarus, Bulgaria, Spain, Mexico, Turkey, India (configuration 1), Latvia (configuration 5), and the Czech Republic (configuration 26) for ~Market-Introduction, where two causal recipes are relevant. Although three of the seven recipes cover mixtures of developed and developing economies, perhaps unsurprisingly, three recipes (5C02, 5CN1 and 5CN2) relate to more developed economies specifically, and only one (5C01) specifically relates to developing economies.

5. Conclusions

This study considers a country-level comparison of innovation marketing and knowledge development strategies within each country. The study offers a novel contribution to knowledge by identifying recipes necessary to bring innovations to market across a diverse range of countries.

An additional methodological feature of this study is the ability to examine uncertainty in the specific model under consideration, specifically the question of whether to include or exclude a fifth variable, by offering technical elucidation of its effect. Even though this analysis is only one example to take evidence from, the study identifies interesting results.

In terms of future directions of research in both applied and technical dimensions, from an applied analysis perspective, researchers should adopt a longitudinal perspective to evaluate country trends regarding relationship between recipes. In terms of technical development, including or excluding a variable is a problem that many researchers face. The issue requires further consideration, with more examples of its occurrence necessary to appreciate the effect.

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Figure 1. PDF graphs of condition (*a* to *e*) and outcome (*f*) variables, with thresholds for full-non-membership ($x^{\perp}$), crossover point ($x^{\times}$) ar

membership (x^{T}).

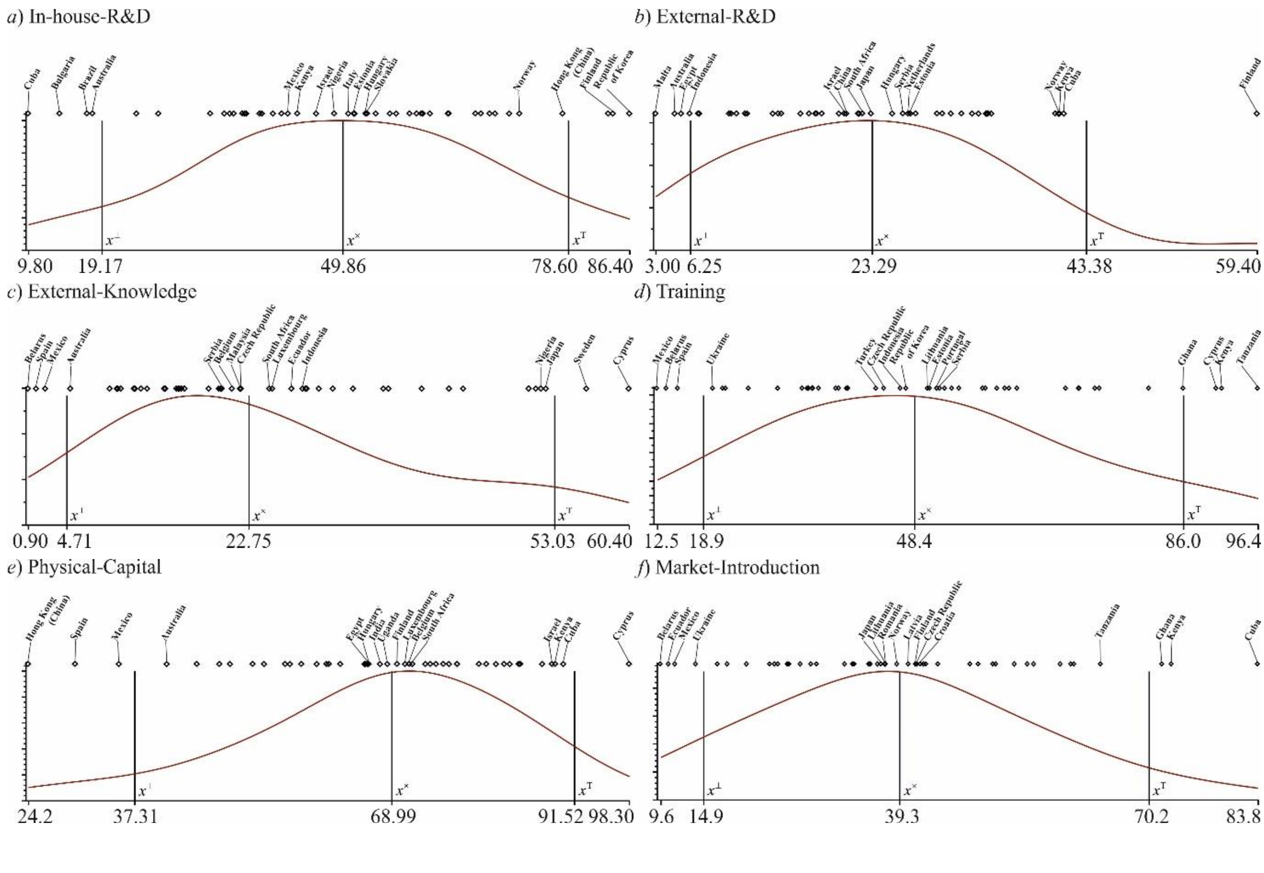

Figure 2. Two-tier Venn diagram showing 47 countries across configurations based on strong membership, for five (left) and four (right) condition variables

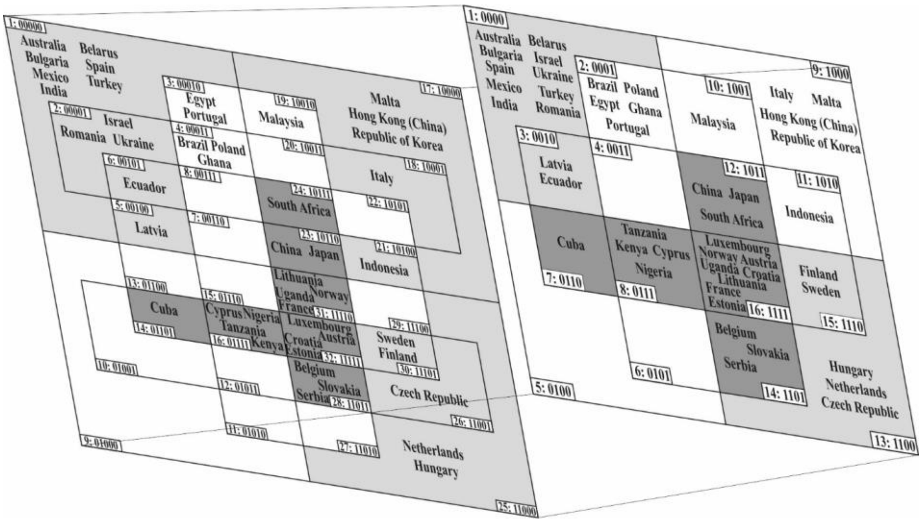

Table 1. Definition of variables

Condition variables	Description
In-house-R&D	Creative work within an enterprise on an occasional or regular basis to increase the stock of knowledge and to devise new and improved goods, services, or processes.
External-R&D	Creative work that an enterprise purchase and other firms, or public or private research organizations perform (including enterprises within the group).
External-Knowledge	Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other firms.
Training	Internal/external training for personnel, specifically for the development and/or introduction of innovations.
Physical-Capital	Acquisition of machinery, equipment, and computer hardware/software to produce new or significantly improved goods, services, production processes, or delivery methods.
Outcome variable	**Description**
Market-Introduction	Activities for market preparation and introduction of new/ significantly improved goods and services, including market research and launch advertising.

Source: D'Este et al. (2012)

Table 2. Truth table showing configuration five (32) and four (16) condition variables, with raw consistency (Raw Cons) values to outcon

(Otcm), not-outcome (~Otcm) and frequency (No) of countries in that configuration (Cnfg)

In-house-R&D	External-R&D	External-knowledge	Training	Physical-Capital	Market-Introduction						
					5 variable model				4 variable model		
					Cnfg	Raw Cons Otcm	Raw Cons ~Otcm	No	Cnfg	Raw Cons Otcm	Raw Cons ~Otcm
0	0	0	0	0	1	0.523	**0.924**	**7**	1	0.496	**0.913**
0	0	0	0	1	2	0.628	**0.945**	**3**			
0	0	0	1	0	3	0.801	0.900	2	2	0.772	0.850
0	0	0	1	1	4	0.791	0.865	3			
0	0	1	0	0	5	0.844	**0.916**	**1**	3	0.817	**0.925**
0	0	1	0	1	6	0.811	**0.964**	**1**			
0	0	1	1	0	7	~~0.929~~	~~0.880~~	~~0~~	4	~~0.932~~	~~0.843~~
0	0	1	1	1	8	~~0.928~~	~~0.857~~	~~0~~			
0	1	0	0	0	9	~~0.769~~	~~0.961~~	~~0~~	5	~~0.787~~	~~0.942~~
0	1	0	0	1	10	~~0.840~~	~~0.937~~	~~0~~			
0	1	0	1	0	11	~~0.933~~	~~0.910~~	~~0~~	6	~~0.938~~	~~0.903~~
0	1	0	1	1	12	~~0.937~~	~~0.902~~	~~0~~			
0	1	1	0	0	13	~~0.923~~	~~0.958~~	~~0~~	7	**0.916**	0.858
0	1	1	0	1	14	**0.911**	0.850	**1**			

0	1	1	1	0	15	~~0.968~~	~~0.881~~	~~0~~	8	**0.960**	0.697
0	1	1	1	1	16	**0.959**	0.688	**4**			
1	0	0	0	0	17	0.699	**0.901**	**3**	9	0.698	0.899
1	0	0	0	1	18	0.793	**0.953**	**1**			
1	0	0	1	0	19	0.850	0.853	**1**	10	0.862	0.828
1	0	0	1	1	20	~~0.890~~	~~0.869~~	~~0~~			
1	0	1	0	0	21	0.892	**0.903**	**1**	11	0.893	0.896
1	0	1	0	1	22	~~0.879~~	~~0.948~~	~~0~~			
1	0	1	1	0	23	**0.928**	0.814	**2**	12	**0.930**	0.777
1	0	1	1	1	24	**0.931**	0.822	**1**			
1	1	0	0	0	25	0.785	**0.970**	**2**	13	0.807	**0.945**
1	1	0	0	1	26	0.885	**0.937**	**1**			
1	1	0	1	0	27	~~0.938~~	~~0.888~~	~~0~~	14	**0.931**	0.843
1	1	0	1	1	28	**0.931**	0.837	**3**			
1	1	1	0	0	29	~~0.927~~	~~0.966~~	~~0~~	15	0.844	**0.905**
1	1	1	0	1	30	0.863	**0.931**	**2**			
1	1	1	1	0	31	**0.908**	0.821	**4**	16	**0.903**	0.720
1	1	1	1	1	32	**0.946**	0.728	**4**			
Number of 'non-remainder' configurations						7	10	20		5	4

Table 3. Analysis of necessity results for Market-Introduction and ~Market-Introduction (Cons - Consistency and Cov - Coverage)

Variable		5 vars model				4 vars model			
		Market-Introduction		~Market-Introduction		Market-Introduction		~Market-Introduction	
		Cons	Cov	Cons	Cov	Cons	Cov	Cons	Cov
In-house-R&D	var	0.713	0.662	0.590	0.613	0.713	0.662	0.590	0.613
	not-var	0.583	0.559	0.675	0.725	0.583	0.559	0.675	0.725
External-R&D	var	0.735	0.740	0.515	0.580	0.735	0.740	0.515	0.580
	not-var	0.583	0.518	0.769	0.765	0.583	0.518	0.769	0.765
External-knowledge	var	0.774	0.786	0.495	0.562	0.774	0.786	0.495	0.562
	not-var	0.569	0.501	0.811	0.801	0.569	0.501	0.811	0.801
Training	var	0.762	0.694	0.596	0.607	0.762	0.694	0.596	0.607
	not-var	0.568	0.557	0.699	0.767	0.568	0.557	0.699	0.767
Physical-Capital	var	0.801	0.789	0.507	0.559	-	-	-	-
	not-var	0.552	0.500	0.808	0.820	-	-	-	-

Table 4. Sufficiency analyses results for Market-Introduction in case of five and four variable models (including complex and parsimonious solutions)

Conditions	Market-Introduction					
	5 variable model			4 variable model		
In-house-R&D	⊖	●	•	⊖	•	•
External-R&D	●			●		●
External-Knowledge	•		●	•	●	
Training		●	●		●	●
Physical-Capital	•	●		-	-	-
Complex Solution	**5CO1**	**5CO2**	**5CO3**	**4CO1**	**4CO2**	**4CO3**
Configurations	14, 16	24, 28, 32	23, 24, 31	7, 8	12, 16	14, 16
Consistency	0.939	0.923	0.890	0.941	0.890	0.870
Raw Coverage	0.407	0.474	0.556	0.424	0.556	0.538
Unique Coverage	0.102	0.027	0.108	0.108	0.053	0.035
Solution Consistency	0.881			0.869		
Solution Coverage	0.684			0.699		
Parsimonious Solution	**5PO1**	**5PO2**	**5PO3**	**4PO1**	**4PO2**	**4PO3**
Configurations	14, 16	24, 28, 32	23, 24	7, 8	12, 16	14, 16
Consistency	0.862	0.900	0.893	0.862	0.893	0.885
Raw Coverage	0.455	0.502	0.683	0.455	0.683	0.634
Unique Coverage	0.064	0.022	0.139	0.064	0.089	0.028
Solution Consistency	0.837			0.832		
Solution Coverage	0.780			0.786		

Table 5. Sufficiency analyses results for ~Market-Introduction in case of five and four variable models (including complex and parsimonious solutions)

Conditions	~Market-Introduction						
	5 variable model					4 variable model	
In-house-R&D	●	●	⊝			⊖	●
External-R&D	•		⊖	⊖		⊖	●
External-Knowledge		⊝					
Training	⊖	⊖	⊖	⊖		⊖	⊖
Physical-Capital	•			⊝		-	-
Complex Solution	**5CN1**	**5CN2**	**5CN3**	**5CN4**		**4CN1**	**4CN2**
Configurations	26, 30	17, 18, 25, 26	1, 2, 5, 6	1, 5, 17, 21		1, 3	13, 15
Consistency	0.918	0.911	0.884	0.903		0.911	0.904
Raw Coverage	0.338	0.563	0.510	0.409		0.563	0.397
Unique Coverage	0.044	0.086	0.014	0.022		0.314	0.148
Solution Consistency	0.880					0.889	
Solution Coverage	0.752					0.711	
Parsimonious Solution	**5PN1**		**5PN2**			**4PN1**	**4PN2**
Configurations	17, 18, 25, 26, 30		1, 2, 5, 6, 17, 21			1, 3	13, 15
Consistency	0.860		0.882			0.911	0.904
Raw Coverage	0.487		0.651			0.563	0.397
Unique Coverage	0.113		0.487			0.314	0.148
Solution Consistency	0.864					0.889	
Solution Coverage	0.765					0.711	