Determinants of entrepreneurship using fuzzy-set methods: Europe *vs* non-Europe

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Abstract

This paper uses fuzzy set qualitative methods, with GEM2014 data, to show differences in the entrepreneurial determinants between European developed countries and non-European developing countries. We first estimate baseline regression models and then develop fuzzy set Qualitative Comparative Analysis to study the necessary and sufficient conditions of entrepreneurial activity. Results indicate that, while in Europe the key determinants are education and technological equity, individuals in developing and non-developed countries tend to be, or become, entrepreneurs independently of the macroeconomic background.

Keywords: Entrepreneurship, fuzzy set methods, fsQCA, GEM data
JEL codes: M13, C65

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I. Introduction

Entrepreneurship, nascent firms, and starts-up are engines of development and it is important to analyze how to promote them (Brown and Ulijn, 2004; Acs et al., 2005; Thurik, 2009; Stuetzer et al., 2012; Grimm and Paffhausen, 2015). For instance, entrepreneurship has been thoroughly analyzed in a range of scenarios and from different specifications in the recent years. Governments usually offer a wide range of help for entrepreneurs, such as financial subsidies, credits, and/or specific programs, and also ask the self-employed and entrepreneurs to pay taxes. These may strongly determine whether an individual who intends to found a new business finally does so, or not. But not only government affects the entrepreneurial decision - private investors, institutions, the degree of development, and/or the individual financial situation, all play their roles. However, given the lack of consensus on the effectiveness of such programs and situations, and the complexity of the entrepreneurial phenomenon, new methods have recently been used to provide new evidence that complements classical quantitative regression analyses. For example, Coduras et al. (2015) applies fuzzy set Qualitative Comparative Analysis (fsQCA) with Global Entrepreneurship Monitor (GEM) data to show that fsQCA extends the possibilities of GEM indicators. Other authors have applied fuzzy set logic to entrepreneurship, although none have analyzed the determinants of entrepreneurship using GEM data. Beynon et al. (2016) analyze entrepreneurial attitudes and activities; Jenson et al. (2016) study technological innovation system failure models; Kuckertz et al. (2016) study entrepreneurship in different type of economies; Lisboa et al. (2016) study orientation and firm performance; and Muñoz and Kibler (2016) link local institutions to social entrepreneurship. A recent review of the use of fuzzy sets in business and management can be found in Roig-Tierno et al. (2016).

We now use fsQCA with the latest available GEM 2014 NES database to show new differences in the entrepreneurial determinants between European developed countries and non-European developing countries. We measure entrepreneurial activity by the Total (early stage) Entrepreneurial Activity indicator (TEA), whereas the determinants have been previously selected as the better predictors for the TEA by applying a new algorithmic approach that avoids significance biases: entrepreneurial education at universities, creativity and self-sufficiency at school, government subsidies, and technological equity (Giménez-Nadal et al., 2016). This algorithm assures us that the effect of these variables on the dependent one is the strongest among the rest of potential regressors. Our results show the global importance of entrepreneurial education at University, together with equity of access to

technology in European countries, but we find that government subsidies have a mixed effect. For developing and non-developed countries, we find that, for some reason, individuals tend to be, or become, entrepreneurs independently of the country attributes.

Our contribution is twofold. We first make use of the latest available micro GEM data on entrepreneurship to develop an fsQCA analysis of the necessary and sufficient conditions of entrepreneurial activity, with our study being the first to analyze the determinants of entrepreneurship using this qualitative method which complement the usual quantitative results. Second, we use an original algorithm approach in selecting variables as the most important in terms of their predictive power, avoiding test-significance and selection biases. Moreover, this resampling technique allows us to avoid multicollinearity and noisy variables, and assures the best models in terms of predictions, and thus the most accurate conclusions.

II. Data and Variables

II.1. Data

We use the GEM NES data for year 2014 to analyze the relationship between the TEA and a series of macroeconomic variables, related to entrepreneurial finances, government policies, government entrepreneurship programs, entrepreneurship education, R&D transfers, commercial and legal infrastructures, entry regulation, physical infrastructures, and cultural and social norms. Each variable is first measured between 0 (absolutely disagree/non-fulfilment) and 5 (absolutely agree/fulfilment) by 36 GEMs experts per country, and then takes the mean value of these for each country. More information about the data can be found in http://gemconsortium.org/wiki/1154. The main advantage of GEM databases is that GEM is the leading global entity researching entrepreneurship, and the data collected is processed by experts in the field. We take the TEA values from GEM NES Global Key Indicators, a free GEM database (http://www.gemconsortium.org/data/sets).

With confidence in GEM's database, we make no restriction in our data. This leaves us with observations for 69 countries, of which 29 belong to the OECD.[1] In order to select the

[1] We have information of the following OECD countries: Germany, Australia, Austria, Belgium, Canada, Chile, Denmark, United States, Salvador, Slovakia, Slovenia, Spain, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Mexico, Norway, Netherlands, Poland, Sweden, Switzerland and United Kingdom; and of the following non-OECD countries: Angola, Argentina, Belize, Bolivia, Bosnia, Botswana, Brazil, Burkina-Faso, Cameroon, China, Colombia, Costa Rica, Croatia, Ecuador, Filipinas, Georgia,

independent variables, we follow Giménez-Nadal et al. (2016), who develop an algorithm for the selection of the variables with the highest relevance using a bootstrapped process of resampling, random selection of regressors and predictive power over *test sets*, in this way avoiding certain biases from the absence of normality and overfitted models. Specifically, this technique is based on bootstrapped iterations. In each iteration, using resampling, we fit a model of the TEA against randomly chosen regressors using a subset of individuals, and then estimate the goodness of fit of the model with another subset of observations. The quality of those models is estimated using their predictive power over individuals not used to estimations of the parameters, avoiding important problems arising from overfitting, not usually taken into account, and allowing us to determine 'the best' variables. The gains with respect to R-squared and similar measures come from the overperformance of the latter. Further, this resampling technique allows us to avoid multicollinearity and noisy variables, and assures the best models in terms of predictions, and thus the most accurate conclusions. As a result of this process, the variables included are found to be the best determinants of entrepreneurial activity: availability of government subsidies (GOV); level of self-sufficiency and creativity at school (SELF); level of entrepreneurial education at University (GROW), and equity in access to technologies and research (TECH), all of which assure the 'best' model and the absence of multicollinearity. Descriptions are shown in Table 1. There is a clear intuition underlying these variables: government subsidies and access to resources are directly related to institutional theory (North, 1990), and entrepreneurship training at schools and universities has also been the focus of several studies, giving support to these features from entrepreneurship theories.

II.2. Fuzzy Sets

A fuzzy set measures the degree of belonging to a group, or fulfilment of a characteristic. It can be said that a fuzzy set is, in some way, a relaxation of a categorical variable, since we allow more than two values (e.g., 0 absolutely disagree (non-fulfillment); 0.25 disagree (non-fulfillment), but not absolutely; 0.5 neither disagree (non-fulfillment), nor agree (fulfillment); 0.75 not totally agree (fulfillment); 1 total agree (fulfillment)). It is important to set the middle point as the inflexion point in the decision/fulfillment/belonging that defines the variable. Fuzzy logic can be a better tool to analyze economic issues with respect to the traditional

Guatemala, India, Indonesia, Iran, Jamaica, Kazajistan, Kosovo, Lithuania, Malaysia, Panama, Peru, Puerto Rico, Qatar, Romania, Russia, Singapore, South Africa, Suriname, Thailand, Trinidad and Tobago, Uganda, Uruguay, and Vietnam.

approaches given its greater precision in modelling (Zadeh, 1965; Lin, 1996; Armstrong, 2012). More information about fuzzy sets theory can be found in http://www.u.arizona.edu/~cragin/fsQCA/.

We follow Ragin's (2007) direct method for the calibration of fuzzy sets. We have selected the mean and the two quartiles, Q1 and Q3, of each variable as reference points for the transformations. A summary table of our fuzzy set redefinitions is shown in Table 1.

(Table 1 about here)

III. Results and Discussion

III.1. Baseline results

We first estimate a linear regression model on the TEA index as a function of the selected variables (measured as indicators taking values between 0 and 5). Estimates are shown in Table 2. Column 1 shows results when all countries have been included in the model, while Columns 2 and 3 are limited to EU and non-EU countries, respectively. In Column 4 we repeat the analysis of Column 3 without the US, China, and India, to avoid biases. We find that, on average, the only positive relationship is found to be between the TEA index and the degree of entrepreneurial education at University. The rest of the variables appear to be negatively related to entrepreneurial activity.

When we focus on Column 2, we find that, for the EU countries, the effect of entrepreneurial education at University is smaller but still positive, the coefficients for government subsidies and self-sufficiency and creative education at primary and secondary levels are again negative but closer to zero and, finally, the effect of equality of access to technology is small but positive. Results in Columns 3 and 4 for the non-EU countries barely differ from those in Column 1.

(Table 2 about here)

III.2. FSQCA results

In order to check and compare the previous results, we develop a fsQCA by using the fs/QCA 2.5 free software (Ragin and Stean, 2014). The use of fsQCA is motivated from different

perspectives. From a methodological point of view, certain authors point to a paradigm shift in approximating to economic issues, and fsQCA represents a promising new direction of research (Woodside et al., 2012). In this way, fsQCA complements traditional quantitative analyses from a qualitative scenario, leading to a different, and more accurate, set of results and conclusions. From the point of view of inference and economic policy, fsQCA allows us to study causal relationships, which represent a major advantage relative to regression techniques, in this way allowing us to develop suitable economic policies. This is particularly important in the labour markets, where entrepreneurship appears to be one option to reduce the unemployment arising from the economic crisis.

Table 3 shows the results of the sufficient analysis for both EU and non-EU countries. For the former group, we find the following sufficient conditions for being an entrepreneurial country, among the rest of the EU countries: 1) high levels of entrepreneurial education at University, and creativity at school; 2) subsidies, creativity at school, and equality of access to technology; 3) entrepreneurial University education and equality of access to technology, with government subsidies being a characteristic that may, or may not appear (with greater consistency when it is absent); and 4) the negation of all characteristics but equality of access to technology. For the non-EU countries, we find that the sufficient conditions are only the individual negation of each of the independent characteristics.

(Table 3 about here)

Table 4 shows the results of the necessity conditions analysis, i.e., groups of characteristics that the entrepreneurial countries possess. When we take 0.75 as the consistency lower bound to select a condition as necessary (i.e., conditions with consistency values greater than 0.75 are considered necessary), we find that, for the EU countries, entrepreneurial education at University (and thus all possible combinations that include it) and the combination of the three remaining attributes (government subsidies, self-sufficiency and creativity at primary school, and technological equity) are necessary conditions. For the non-EU countries, we find that each triple combination, and the combination of all of the four characteristics, are necessary conditions, together with the combinations of two variables (except for subsidies plus technological equity, and creativity at school plus technological equity, with values closer to the critical threshold of 0.75).

(Table 4 about here)

III.3. Discussion

Results for the EU countries that are less entrepreneurial (Wennekers et al., 2005), are clear: countries that encourage the spread of technologies and research the incentives of individuals to become entrepreneurs, are allowed to use the same technologies as the established and large firms. Furthermore, insofar as University rates and levels of human capital are high in these countries (Hanushek, 2013), and highly-skilled individuals emerge from universities and colleges, the greater the extent of entrepreneurial encouragement, the larger the entrepreneurial population (Gnyawali and Fogel, 1994; Glaeser et al., 2004). However, government subsidies and creativity at school, or their negations, appear to contribute depending on the rest of the characteristics and, thus, the overall effect is not clear, as is posed in Martin et al. (2013). The R^2's and the consistency of fsQCA solutions show that this model is relatively accurate for the EU countries.

On the other hand, we find in the regressions that, for non-EU countries, only entrepreneurial education at University is positively (and quite strongly) related to entrepreneurial activity (in line with Cho, 2014). However, our fsQCA results show that the only sufficient conditions are the individual negation of the attributes. R^2's and solution consistencies demonstrate that the model is less accurate for non-EU countries.

When we take into account that developing and non-developed countries (most of them non-EU countries) are the most entrepreneurial (perhaps because of their own lack of development), are also the ones with the weaker institutions (Chang, 2006; Rodrik et al., 2004; Acemoglu et al., 2005; Acemoglu and Robinson, 2008), including education, this may partly explain these results. We can also argue that in these countries individuals tend to be, or to become, entrepreneurs no matter the macroeconomic conditions, since becoming a businessman is a desirable labor condition, in contrast with being a paid worker (Mondragón-Vélez and Peña, 2010; Naudé, 2013). It is possible that paid workers in these countries – excluding the US, China, India, and perhaps others - are the worst paid (because of lower levels of human capital), or have worse working conditions (Ashenfelter and Jurajda, 2001), which may lead individuals to increase their welfare by becoming entrepreneurs, and also that individuals become entrepreneurs from necessity, without focusing on aspects that individuals in the EU and developed countries would usually take into account (Mondragón-Vélez and Peña, 2010).

IV. Conclusions

Making use of the GEM 2014 NES National Level database this paper sets out a qualitative analysis to find that European and non-European countries may have structural differences that condition different motivations for entrepreneurship. For the EU countries, the level of entrepreneurial education and formation at universities and colleges appears to be the key indicator, together with equality of access to new technologies and research, in contrast to government subsidies, and creativity and self-sufficiency attributes taught at schools. On the other hand, non-European countries, which may include developing and non-developed nations, appear to produce entrepreneurs no matter what.

Thus, policymakers should take these results into account in order to promote entrepreneurship - and, thus, development and economic growth - in a more effective way. Promoting entrepreneurial courses and formation at University should help individuals to develop their new ideas and, together with good programs that allow access to the same resources as large, established firms, could lead to an improvement in the entrepreneurial rates of the developed countries. On the other hand, although developing and non-developed countries are the most entrepreneurial, if they improved the quality and efficacy of their programs and institutions, individuals would be more likely to become entrepreneurs, with a subsequent effect on rates of economic growth and levels of development.

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Table 1. Summary statistics

Variables	Description	EU			No-EU		
		Mean	S.D.	Score	Mean	S.D.	Score
TEA	Total entrepreneurial activity (at early stage)	7.820	2.222	0.475	15.716	8.768	0.463
GOV	There are sufficient government subsidies available for new and growing firms	3.072	0.451	0.527	2.536	0.570	0.465
SELF	Teaching in primary and secondary education encourages self-sufficiency, creativity and personal initiative	2.313	5.333	0.423	2.249	0.466	0.498
GROW	Colleges and universities provide good and adequate preparation for starting-up and growing new firms	2.618	0.354	0.534	2.732	0.334	0.494
TECH	New and growing firms have just as much access to new research and technology as large, established ones	2.281	0.394	0.465	2.304	0.356	0.464
N. Obs.			23			46	

Note: The TEA index is measured in %, and the rest of the variables take values between 0 (absolutely disagree) and 1 (absolutely agree). Variables have been transformed into fuzzy sets following the metjodology of Ragin (2007) separately for EU and non-EU countries, with the mean value for each variable selected as the 'cross-over', and Q3 and Q1 chosen as 'upper bound' and 'lower bound', respectively. Scores represent the degree of membership or the degree to which countries belong to the corresponding variable, with 1 being the absolute fulfillment and 0 being the absolute non-fulfillment.

Table 2. Regression analysis for E.U. and non-E.U. countries

	(1)	(2)	(3)	(4)
Variables	All countries	E.U. countries	Non-E.U. countries	Non-EU, USA, China and India
GOV	-4.906***	-1.351	-3.714	-3.687
	(1.704)	(1.506)	(2.241)	(2.284)
SELF	-4-416**	-1.391	-4.423*	-4.414
	(1.730)	(1.131)	(2.336)	(3.120)
GROW	11.983***	4.764**	12.331***	12.322***
	(2.840)	(1.693)	(3.624)	(4.189)
TECH	-2.138	0.212	-4-483**	-4.395
	(5.573)	(1.488)	(2.195)	(3.832)
Constant	9.056	2.234	11.722	11.444
	(5.573)	(4.618)	(7.612)	(11.896)
N. Obs	69	23	46	43
R2	0.287	0.402	0.275	0.178
Wald's Chi2	(<0.001)	(0.003)	(0.002)	(0.021)
Root MSE	6.802	1.899	7.820	8.121

Note: Dependent variable is the TEA index. Independent variables take values between 0 (absolutely disagree) and 1 (absolutely agree).

Table 3. Sufficient conditions analysis for E.U. and non-E.U. countries

Model 2. TEA=f(GOV,SELF,GROW,TECH). Complex solution. EU Countries			
Frequency cut-off: 1.0	Consistency cut-off: 0.702	Solution coverage: 0.781	Solution consistency: 0.695
	Raw coverage	Consistency	
GOV + SELF	0.576	0.736	
GROW + TECH	0.415	0.849 (highest)	
GOV + SELF + TECH	0.386	0.723	
GOV + GROW + TECH	0.460	0.713	
TECH	0.243	0.764	

Model 2. TEA=f(GOV,SELF,GROW,TECH). Complex solution. Non-EU Countries			
Frequency cut-off: 1.0	Consistency cut-off: 0.762	Solution coverage: 0.933	Solution consistency: 0.558
	Raw coverage	Consistency	
Non-GOV	0.744	0.643	
Non-SELF	0.606	0.555	
Non-GROW	0.706	0.651	
Non-TECH	0.782	0.677	

Note: Non-GOV means the non-fulfillment of the GOV attribute (independently of the rest of the features), and similarly with respect to the other variables.

Table 4. Necessary conditions analysis for E.U. and non-E.U. countries

Condition	EU Countries		Non-EU Countries	
	Consistency	Coverage	Consistency	Coverage
GOV	0.585	0.527	0.583	0.580
SELF	0.583	0.655	0.591	0.549
GROW	0.810	0.720	0.724	0.678
TECH	0.605	0.619	0.587	0.586
GOV + SELF	0.714	0.536	0.765	0.559
GOV + GROW	0.860	0.596	0.834	0.600
GOV + TECH	0.694	0.541	0.728	0.561
SELF + GROW	0.817	0.662	0.780	0.575
SELF + TECH	0.746	0.591	0.738	0.545
GROW + TECH	0.858	0.643	0.810	0.596
GOV + SELF + GROW	0.860	0.576	0.856	0.556
GOV + SELF + TECH	0.767	0.535	0.822	0.547
GOV + GROW + TECH	0.874	0.584	0.861	0.566
SELF +GROW + TECH	0.858	0.609	0.836	0.551
GOV + SELF + GROW + TECH	0.874	0.565	0.874	0.540