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Modeling entrepreneurial decision-making process using concepts from fuzzy set theory

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Abstract

Entrepreneurship and entrepreneurial culture are receiving an increased amount of attention in both academic research and practice. The different fields of study have focused on the analysis of the characteristics of potential entrepreneurs and the firm-creation process.

In this paper, we develop and test an economic-psychological model of factors that influence individuals' intentions to go into business.

We introduce a new measure of entrepreneurial intention based on the logic fuzzy techniques. From a practical point of view, this theory offers a natural approach to the resolution of multidimensional and complex problems when the available information is sparse and/or of poor quality.

As an illustration, the model is estimated using a data provided by the National Tunisian Global Entrepreneurship Monitor (GEM) 2010 Project, based on the analysis of a sample of 799 cases.

A simulation study of the model suggests that entrepreneurial intention is related to a composite of some demographic, competencies, networks and perception factors. This is an important area of concern in entrepreneurship intention which improves our knowledge about the degree to which the individual holds a positive or negative personal valuation about being an entrepreneur. The modeling insights may also be valuable as input to the design of entrepreneurship curricula.

Keywords: Entrepreneurship; Decision-making process; Entrepreneurial intention; Global entrepreneurship monitor (GEM); Fuzzy set theory

Background

Interest and research in entrepreneurship has captured the attention of both scholars and policy makers during the last decades (Acs & Audretsch, 2003; Gürol & Atsan, 2006; Khefacha, Belkacem & Mansouri, 2014; Laviolette, Radu & Brunel, 2012; Norrman & Bager-Sjögren, 2010).

As for developing countries and developed ones, the importance of entrepreneurship in boosting economic progress and social adjustment is widely encouraged by national economic policies.

The perceived importance of this phenomenon in Tunisia is reflected in government programs designed to spur self-employment, such as the Agency for Promotion of Industry and Innovation (APII), the Company Creators and Business Incubation Centers (BIC), the enterprise incubators and the regional investment and development (RID). These programs constitute a support for any individual to become entrepreneurs

by alleviating credit constraints, building programs, increasing awareness of innovations and business models, identifying and coaching talented people on designing their own business models etc.

In this context, entrepreneurial intentions (defined as a state of an individual mind directing and guiding them to the development and the implementation of new business concept (Bird, 1988)) are seen as the strongest proximal predictor of entrepreneurial activity.

The purpose of the present paper is to develop and test an economic-psychological model of factors that influence individuals' intentions to go into business.

Even though a sizeable literature has arisen about entrepreneurial attitudes, intentions and dispositions (Díaz-García & Jiménez-Moreno, 2010; Fayolle & Gailly, 2015; Shinnar, Giacomini & Janssen, 2012), the purpose of the present paper is to complement, with an empirical investigation, the theoretical discussion about entrepreneurship as a utility-maximizing response. We wish to know whether the attitudes of people towards opportunity entrepreneurial activity, achievement motivation, fear of failure or new venture creation difficulty do indeed affect their choice to create or not a new venture. Why do some people intend to be self-employed while others intend to be employed? Do their intentions differ because their attitudes to opportunity Entrepreneurial Activity or new venture creation difficulty differ?

A substantial entrepreneurship research literature indicates that the socio-demographic traits, human capital resources and attitudes towards entrepreneurship could explain the start-up decision in varying degrees (Wagner & Ziltener, 2008). These variables are necessary but not sufficient (Kolvereid & Isaksen, 2006; Parker, 2004; Shepherd & DeTienne, 2005).

In this framework, our research attempt to evaluate, among the variables included in National Tunisian Global Entrepreneurship Monitor Project (GEM) carried out in 2010, those having an impact on the process to start a new business venture in order to build a mapping of the entrepreneurial intention.

To do so, we develop an approach based on previous theoretical studies to provide an analysis of key determinants of business creation and their impacts. We complete the conceptual framework by introducing one of the most notable of intelligent software techniques: Fuzzy logic, designed to handle imprecise and complex problems (Zalila *et al.*, 2007). Fuzzy set theory is a cognitive framework that aims at formalizing the way human beings cognize the world and think about problems and situations. The integration of fuzzy logic for decision-making purposes represents a reliable methodology that could be appealing for managers, practitioners and analysts (Malagoli, Magni & Mastroleo, 2007).

Our approach represents a first attempt to develop a new methodology for appraising individuals' intentions to go into business. We think that this path is fruitful when dealing with complex situations where a great number of value (both qualitative and quantitative) drivers must be taken into account, and/or where explicit account of their interrelations must be taken for a better description and rationalization of the evaluation process.

The paper is structured as follows: after introduction which is presented in section 1 above, section 2 presents a brief review of the literature of factors having an impact on start-up decision to create new venture. In section 3 the main contribution of this

paper by modeling entrepreneurial decision-making process using concepts from fuzzy set theory is presented. The application of the proposed methodology to a case study in Tunisian context is discussed in Section 4. The last section summarizes the paper and proposes directions for further research.

Methods

New venture decision-making: do we know what it is?

An entrepreneurial culture encouraging innovation has become one of the hallmarks of any society looking to achieve high growth and prosperity for society. Thus, a study of the entrepreneurial decision-making process will enrich the knowledge of mechanisms explaining why some people plan to become entrepreneurs and others do not.

However, discussion of the nature of decision-making in new ventures remains ambiguous and confusing. In fact, entrepreneurial decision-making – as a process that occurs over time (Gartner *et al.*, 1994; Kyrö & Carrier, 2005) - has never been well understood. Different lines of analyses with different assumptions and methods have led to varied empirical results. Since the decision to become an entrepreneur may be plausibly considered as voluntary and conscious (Krueger Reilly & Carsrud, 2000), it seems reasonable to study the reason behind the decision.

Amit and Muller (1994) had shown that the decision to start up a new enterprise is the fruit of two decisions: some new ventures are undertaken out of dissatisfaction with the current situation (Parker, 2004), whereas others are undertaken out of a desire to pursue an opportunity. However, researches on entrepreneurship showed that this decision exceed largely the perimeter of these two reasons. The decision to start a new venture may be influenced by experience and prior knowledge (Shepherd & DeTienne, 2005), social networks and contact with other entrepreneurs (Parker, 2004) and expected profit and success (Knight, 1921; Schumpeter, 1934). Even though many people dream to become entrepreneurs, but seldom who use or know how to access the resources they will need for success.

From an economic perspective, an individual choose to become an entrepreneur when he expect that life-time utility from self-employment is higher than the life-time utility from paid-employment (Knight, 1921). Undoubtedly, the expected life-time utility is based not only on monetary determinants. In this context, researchers have approached the study of entrepreneurship decision-making process through the analysis of non-monetary returns like the individual's age, qualification, work experience, or risk propensity (Cromie & O'Donoghue, 1992). However, the predictive capacity of these strategies was low (Reynolds *et al.*, 2004). In this vein, Ajzen (1991) showed that intention-based models seem to offer a better understanding of the influencing factors and may constitute the best predictors of planned behavior, particularly when behavior is rare or difficult to observe.

There is a variety of empirical studies focusing on the role of the entrepreneur and the factors influencing individuals to participate in entrepreneurship. The objective is to identify the most relevant determinants of entrepreneurial intention as developed in the well-known social psychological theory of planned behavior by Ajzen (1991).

This parsimonious model was first adapted to entrepreneurship by Kolvereid (1996) with the premise to analyze the effort that a person will make to carry out entrepreneurship behavior. It shows that in order to predict whether an individual will engage

in a given behavior, one need to identify whether the latter is influenced by a set of factors which could increase or decrease the likelihood to create new business. In this context, Ajzen's planned behavior model identifies three attitudinal antecedents of intention (Ajzen 1991): the Personal Attitudes; the Subjective Norms and the Perceived Behavioural Control.

The personal attitudes

Previous attempts have showed that a wide range of personality traits abilities with a distinct psychological profile strongly influences the desire to become entrepreneur (Wagner & Ziltener, 2008). This aspect refers to the degree to which the individual holds a positive or negative personal valuation about being an entrepreneur (Ajzen 1991; Kolvereid 1996). It includes not only affective (I like it, it is attractive), but also evaluative considerations (it has advantages).

Among personality traits common in entrepreneurs, we noticed a remarkable need for achievement (McClelland & Winter, 1969), a greater desire for independence (De Jong 2013), the ability to innovate (Schumpeter, 1934) and the locus of internal control (Shapero, 1984). Individuals with a high need for achievement will tend towards independence in their careers, as they prefer to take on responsibility themselves for solving their own problems, and immediately reaping the rewards of their successful efforts; in general contrast to a dependent employee relationship.

Persons with the last trait have the tendency to act autonomously under their own supervision and emphasize their own will, ability and actions in their professional life. This behavior is closely related with the trait of self-efficacy - as the belief in one's own ability to perform a given task (Shane, 2003) - where a high degree conduct peoples to see more opportunities than risks in certain situations. Hence, the fact that individuals see themselves as capable of carrying out the risk is related to the individual's perception of whether they perceive that they possess the necessary skills to initiate any tasks (Ibrahim & Lucky, 2014).

The subjective norms

The second attitudinal antecedents of intention is tied to the perceptions of what important people in the individual's social surroundings would think about the launching a venture. In particular, this indicator is related to the perception that "reference people" would approve or not the decision to become an entrepreneur (Ajzen 1991; Kolvereid 1996).

In the entrepreneurship literature, the role of pressure in decision-making has been studied mainly for persons and groups that the entrepreneur has close, frequent and intimate contacts. These key individuals including friends, family, and close business contacts can actively support or not an entrepreneurial venture.

Moreover, while demographic models have been criticized because they provide little insight on how family background and social forces shape the individual's decision process (Shankar, 2014; Katz, 1992), entrepreneurship literature shows a strong relationship between the presence of role models in the family with new venture creation. Notably, an empirical research realized by Collins, Moore and Unwalla (1964) had shown that the influences over a new venture idea go back to the childhood and the family circumstances of the entrepreneur.

The contribution of the opinion of any given referent is weighted by the motivation that an individual has to comply with the wishes of that referent. Hence, overall subjective norm can be expressed as the sum of the individual perception multiplied by the motivation assessments for all relevant referents (Ajzen & Fishbein, 1980).

The perceived behavioural control

This third dimension of the planned behavior theory accounts for situations where non-motivational factors play a role in attitude turning into action. This construct taps the perceived ease or difficulty of performing the behavior of interest (Ajzen 1991; Kolvereid 1996) and can be associated with the definition proposed by Venkataraman (1997) of entrepreneurship considered as “an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing markets, processes, and raw materials through organizing efforts that previously had not existed” (cited in: Shane, 2003).

It seems hence that the presence of requisite resources and abilities can decrease obstacles or impediments anticipated by peoples and increase consequently the perceived control over the behavior.

Wagner and Ziltener (2008) showed that the situational character of start-up decisions is increasingly being emphasized within some body of theory originally conceived as a sub-discipline of neoclassical economics. In this context, Shapero (1984) emphasized the availability of some resources allowing to potential entrepreneur to create new project such as education, age, gender or current employment status.

For the first factor, there is a great deal of discussion and debate about the impact nature of academic level on the new venture creation. In fact, some researchers have provided contradictory evidence to the extent to which education can affect the step into self-employment. The relationship has been found to be either positive or negative, as well as insignificant (Parker, 2004). Even though empirical studies have not conclusively shown whether having a university degree increases the prospect of success of an entrepreneurial venture (Zhang, Wang, & Owen, 2015; Brüderl & Preisendorfer, 1998), some scholars showed that a high level of education is important to be competitive in today's market and individuals are more likely to exploit opportunities if they are better educated (Casson, 1995). This concern joins the empirical study of Yusuf (1995) while for Lee and Wong (2004) a high level of education has a negative effect.

As for education, the impact of age on the decision to become an entrepreneur is either negative or positive according the studies made in this subject (Kautonen, Luoto & Tornikoski, 2010). In fact, thanks to their number of years accumulated for acquisition money and knowledge, elderly employees should possess relatively more human and physical capital needed for entrepreneurship. Thus, a positive relationship between entrepreneurship and age can be assumed (Parker, 2004). Nevertheless, Van Praag and van Ophem (1995) showed that since the creation of a new venture bears the risk of failure and bankruptcy, persons close to retirement age will not engage in starting a business.

From another optic, several scholars have analyzed the relationship between gender and attitudes with new venture creation (Delmar & Davidsson, 2000; Laviolette et al., 2012), and have found that males have a higher preference for entrepreneurship behavior than females. According to Hindle *et al.* (2009), it has been suggested that female

entrepreneurs are disadvantaged compared to men with respect to most forms of human capital and also because of a lack of suitable and effective social networks.

Finally, as for the academic level and age, there is no consensus on the extent of the influence of work status to the decision to start up a new business.

Some authors (Hatak, Harms, & Fink, 2015; Audrestch *et al.*, 2002; Evans & Leighton, 1990) showed that unemployed individuals are more likely to take entrepreneurial decision than those having a steady job. In this framework, individuals engaged in full-time work are less convinced by the idea of starting up their own business than unemployed ones, part-time workers or students.

Nevertheless, this point of view contradicts what was Reynolds *et al.* (2004) exposed in their study by showing that people in full or part-time work are more likely to set up their own firms than the unemployed or those employed in other categories or work. Although, the relation between work status and the new venture decision were found to be tenuous (Davidsson 1990) Fig. 1.

To sum up, our study try to identify which factors of subjective norms and personality traits impact significantly the decision to create new venture and evaluating these factors using of fuzzy decision-making method as described below.

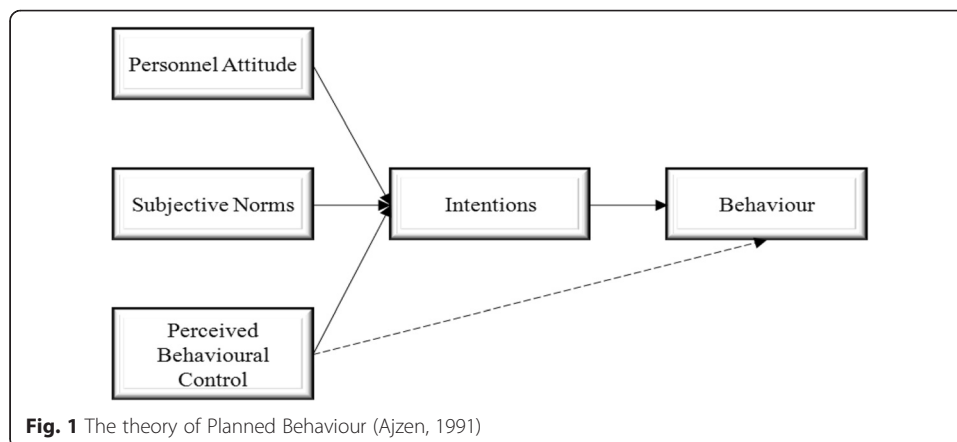
A dynamic model of entrepreneurial intention using fuzzy logic theory

Definition and properties

Fuzzy theory, which was introduced by Zadeh (1975), has been applied in a wide variety of fields such as Engineering, Management Sciences and Social Sciences (Chaudhuri, De & Chatterjee, 2009).

Formally, fuzzy theory can mimic the inherent flexibility in human information processing because they are designed to solve some decision making problems which involve impreciseness, uncertainty and vagueness linguistic concepts such as tall, short, fast, or slow (Zadeh, 1984). It defines an interface between qualitative/symbolic and quantitative/numeric concepts (Zalila *et al.*, 2007).

Fuzzy logic is based on the theory of fuzzy sets; a generalization of conventional (or «crisp») sets. In classic set theory, things have clear boundaries where two possible states of membership are defined: an element x is either "in" or "out" of a set. This binarity of states can take several forms: a proposal can be either true or false; in probability theory, an event occurs or does not occur (Zalila *et al.*, 2007). Even though



the binary approach is necessary in formal mathematical demonstrations, it becomes restrictive when resolving problems of the real world.

Fuzzy set boundaries, by contrast, are vague, and the transition from member to non-member is gradual rather than abrupt (Klir & Folger, 1988). The grade of membership takes values within the interval [0;1] and represents the degree to which an element is similar or compatible to the concept represented by the fuzzy set.

A membership function is an arbitrary curve whose shape is defined by convenience. A fuzzy set A defined on a universe of discourse X can be represented by a set of ordered pairs as:

$$A = \{(x, \mu_X^A(x)) \mid x \in X\}$$

where μ_X^A denotes the membership of element x to the fuzzy set A.

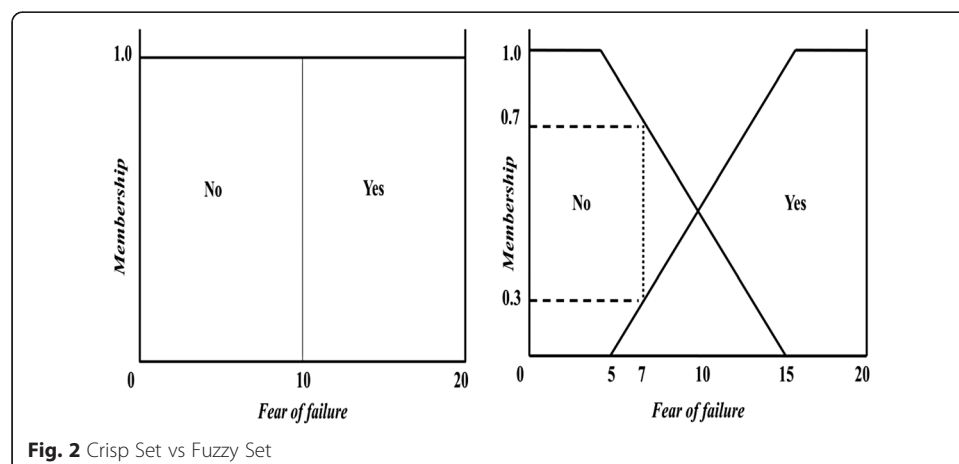
For example, in our entrepreneurial research, if we classify the dimension “*Fear of failure*” into two distinct sets *yes* and *no* (see Fig. 2), there is an abrupt change from *no* to *yes* when the score is 10. A score of 9.9 is considered *no* whilst 10.1 is considered *yes*, despite only a 0.2 point difference between the two scores. Such crisp distinctions do not appeal to our ordinary sense of what we consider to be *yes* or *no*. If we consider 9.9 to be *no*, then 10.1 will also be *no* but with a lesser degree of ‘false’.

Fuzzy sets give a more realistic representation of this trait: there is a gradual decline in the strength of the *no* set and a gradual increase in the *yes* set as the score increases. This is called a fuzzy membership diagram (Fig. 2). The range of a given variable’s values (the scores on traits in our example) is shown along the horizontal axis, called the universe of discourse. The fuzzy membership value is represented on the vertical axis.

Fuzzy inference systems (FIS)

A fuzzy inference system is a framework, formulated or designed, to manage information from inputs to produce desired outputs (Mathworks, 2007). The framework gives a basis to take decisions.

FIS have been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision (Sumathi & Surekha, 2010).



Because of its multi-disciplinary nature, the fuzzy inference system is known by a number of names, such as fuzzy-rule-based system, fuzzy expert system, fuzzy model, fuzzy associative memory, fuzzy logic controller, and simply (and ambiguously) fuzzy system (Mathworks, 2007).

More precisely, the system is based on three steps: fuzzyfication, fuzzy inference and defuzzyfication. Although these are briefly described below, a wide description can be found in Ross (2004).

The fuzzyfication means that the real variables are transferred on linguistic variables. The definition of linguistic variable goes out from basic linguistic variables. For example, at the variable “*High growth expectation*” derived from the question “*Compared to one year ago, your expectations for growth is*”, it is set up the following attributes: lower, somewhat lower, about the same, somewhat higher or higher. Usually there are used from two to seven attributes of variable.

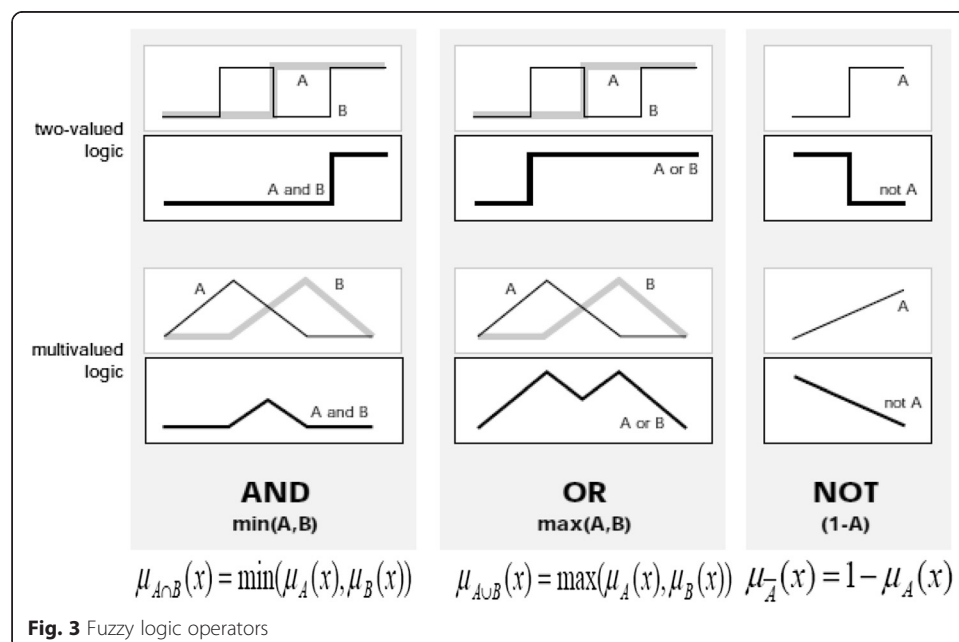
Once fuzzy membership functions are defined (both for input and output variables), new data items can be ‘fuzzified.’ For example, as in Fig. 2, a score of 7 will have a membership of 0.7 in the fuzzy set *no* and a membership of 0.3 in the fuzzy set *yes*.

When the fuzzyfication step is completed, the fuzzy inference defines the behavior of system by means of rules based on the three main standard fuzzy set operations: AND (conjunction, intersection), OR (disjunction, union) and NOT (negation, complementation) Fig. 3.

Fuzzy sets and fuzzy operators are the subjects and verbs of fuzzy logic. But in order to say anything useful we need to make complete sentences. Conditional statements IF...THEN rules (implication, deduction) are the things that make fuzzy logic useful. The conditional clauses are in the form:

<When> *Input a* <And> *Input b* *Input x* <Or> *Input y* <Then> *Output1*,

It means, when (the state occurs) *Input a* and *Input b*,, *Input x* or *Input y*,, then (the situation) is *Output1*. The if-part of the rule “*x* is *A*” is called the *antecedent* or *premise*, while the then-part of the rule “*y* is *B*” is called the *consequent* or *conclusion*.



In contrast to conventional rule-based systems where only one rule is activated in response to its conditions being true, all rules in a fuzzy rule-base whose conditions match or partially match will contribute to the final result. By means of an inference engine implementing approximate reasoning schemas derived from the Generalized Modus Ponens (Zadeh, 1975; Zalila, 1993), appropriate fuzzy rules can be fired to calculate the final decision of the fuzzy system. This technique is a major contributor to flexibility when dealing with incomplete and inconsistent data Fig. 4.

Finally, given a fuzzy set that encompasses a range of output values, we need to return one number, thereby moving from a fuzzy set to a crisp output. To do so, the system will defuzzify, i.e., resolve all the assessments into a single crisp command.

Hence, the defuzzification step transfers the results of fuzzy inference on the output variables, that describes the results verbally (for example, whether the fearlessness exists or not).

In general, there are five built-in defuzzification methods supported (Ross, 2004): centroid, bisector, middle of maximum (the average of the maximum value of the output set), largest of maximum, and smallest of maximum.

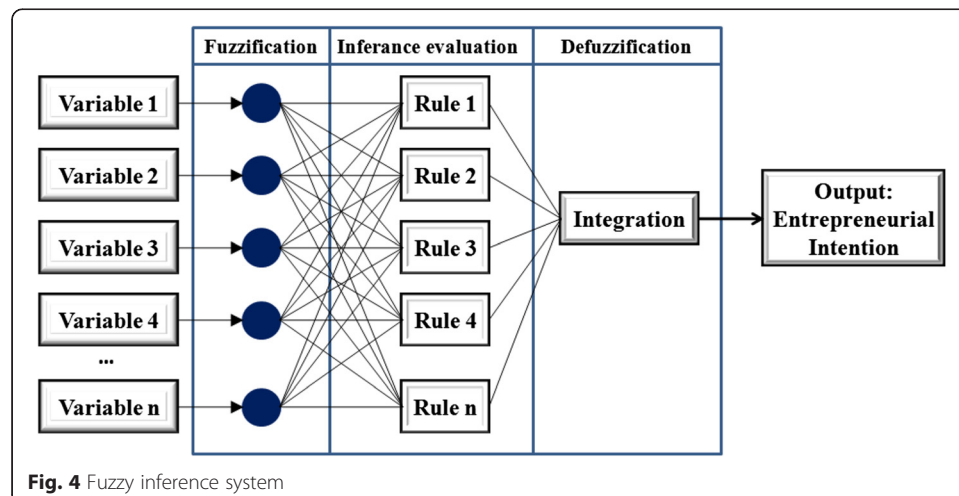
The most popular method is the centroid method, where the system looks for the center of gravity of the geometric shape as shown in Fig. 5. It finds the point where a vertical line would slice it into two equal masses. This leads to a final reading for the output that is numerical and crisp. The result of applying defuzzification centroid method to a fuzzy conclusion can be expressed as follows (Polo, 2001):

$$y = \frac{\sum_i \mu_y^A(y_i) * y_i}{\sum_i \mu_y^A(y_i)}$$

if y is discrete, and by the formula

$$y = \frac{\int \mu_y^A(y_i) * y_i dy}{\int \mu_y^A(y_i) dy}$$

if y is continuous.



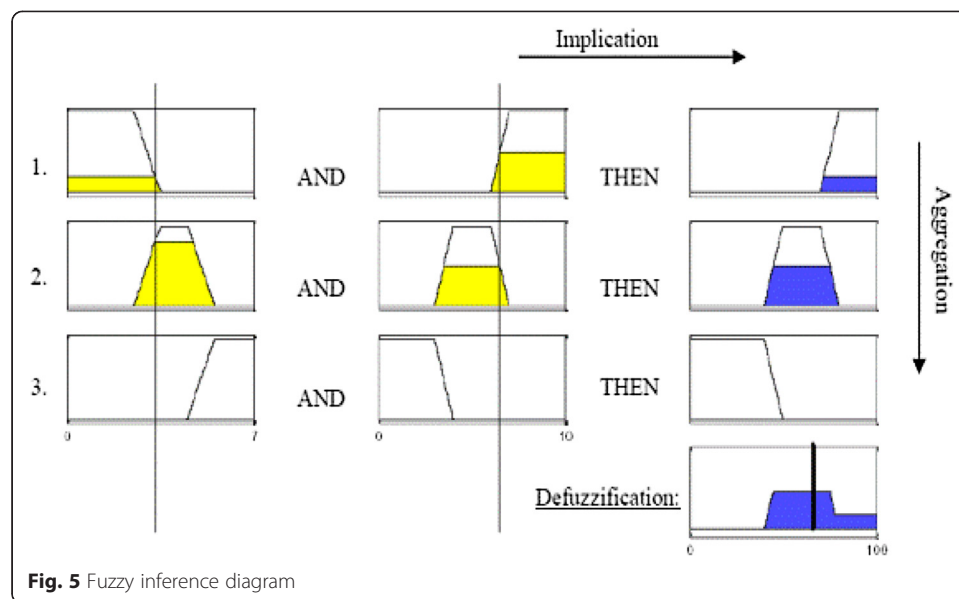


Fig. 5 Fuzzy inference diagram

Fuzzy inference diagram

The fuzzy inference diagram involves all of the pieces that are described in the previous sections: membership functions, fuzzy logic operators, and if-then rules. The diagram provides a basis from which decisions can be made, or patterns discerned. Information flows through the fuzzy inference diagram as shown below. Notice how the flow proceeds up from the inputs in the lower left, then across each row, or rule, and then down the rule outputs to finish in the lower right.

There are two types of fuzzy inference systems that can be implemented in the Fuzzy Logic Toolbox: Mamdani-type and Sugeno-type (Roger & Gulley, 1995). This is a very compact way of showing everything at once, from linguistic variable fuzzification all the way through defuzzification of the aggregate output (Mathworks, 2007).

Results and discussion

Data set and variables

Data for this study are taken from the National Tunisian Global Entrepreneurship Monitor¹ Survey, 2010, based on the analysis of a sample of 799 cases. This follows the standard GEM survey methodology, i.e. a telephone survey of the adult population of Tunisia. The GEM survey provides detailed data on individuals' involvement in different aspects of enterprise activity as well as their background characteristics, location and experience. In addition, and of central interest here, the GEM survey also provides information on individuals' perceptions regarding their intention to create new venture.

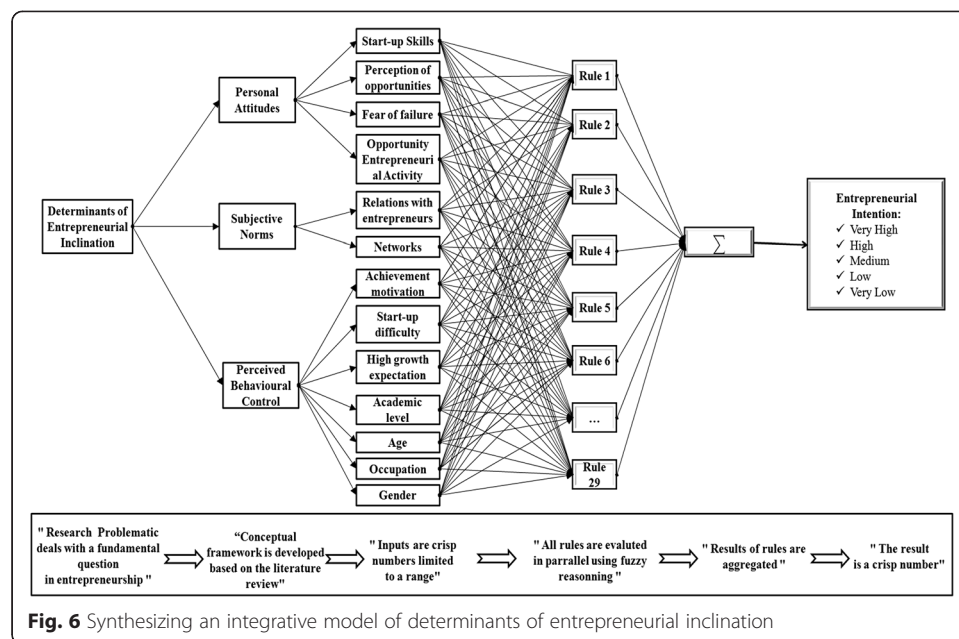
The focus of our empirical work here is on 13 variables collected as part of the 2010 GEM survey and identified as the most determinants of entrepreneurial intention as described by Ajzen (1991) and Kolvereid (1996):

- *Perception of skills, knowledge and experience* "Start-up Skills": This variable indicate whether the individual sees themselves as having the ability to create a new

business or not. This perception was gauged in the questionnaire by asking: “Do you have the knowledge, skill and experience required to start a new business?”

- *Relations with entrepreneurs* “Relations with entrepreneurs”: This variable is measured using the question “Do you know someone personally who started a business in the past 2 years?”, and indicates whether an individual is acquainted with an entrepreneur or not. This variable is related to the perception of the viability of creating a business.
- *Perception of opportunities* “Perception of opportunities”: This variable, which is also dichotomy, tells us directly whether the individual does or doesn’t perceive the existence of business opportunities in the local area through the question “In the next six months there will be good opportunities for starting a business in the area where you live?”
- *Fear of failure* “Fear of failure”: This variable shows whether an individual is afraid of failing in the creation of a new business. It can be considered as an approximate measurement of the aversion to risk. The question related to this item is “Fear of failure would prevent you from starting a business?” It is important to point out that overconfidence can reduce the fear of failure to a certain extent.
- *Opportunity Entrepreneurial Activity* “Opportunity Entrepreneurial Activity”: this dimension reflect the reasons to create a new venture i.e. to take advantage of a business opportunity or because the person has no better choices for work.
- *Achievement motivation* “Achievement motivation”: this dimension permit to distinguish individual who (i) claim to be driven by opportunity as opposed to finding no other option for work; and (ii) who indicate the main driver for being involved in this opportunity is being independent or increasing their income, rather than just maintaining their income.
- *New venture creation difficulty* “Start-up difficulty”: interviews are asked also for their perception about the degree of difficulty of starting a business now compared to one year ago: More difficult, Somewhat more difficult, About the same, Somewhat less difficult or Less difficult.
- *Advice* “Networks”: This variable is measured using the question “During the last year, have you received advice from family or relatives?”, and indicates the influence of the family members on the decision to start-up.
- *High growth expectation* “High growth expectation”: this variable indicates the individual’s perception about their expectations for growth now compared to one year ago: Lower, Somewhat lower, About the same, Somewhat higher or Higher.
- *Occupation* “Occupation”: this variable has the following categories: full or part-time; only part-time; retired/ disabled; homemaker; student, not working, other and self-employed.
- *Academic level* “Academic Level”: This variable presents the following categories: pre-primary education, primary education, lower secondary, upper secondary, post-secondary, first stage of tertiary and second stage of tertiary.
- *Age* “Age”: 7 modalities characterize this indicator: [0–17]; [18–24]; [25–34]; [35–44]; [45–54]; [55–64] and [65–120].
- *Gender* “Gender”: is a categorical variable having two categories (male and female)

Fig. 6.



Description of the model: fuzzy rules and membership functions

The fuzzy values of each variable are defined; it's time to define the fuzzy rules which will characterize the fuzzy system. Considering the qualitative nature of the variables of our study, the Factor Analysis of Multiple Correspondences (FAMC) was adopted. The FACM, as intermediate stage of calculation, served us to build all the rules needed to model the entrepreneurial intention using a fuzzy set theory. This analysis is based on the coordinates of variables in the factorial axis which can be either negative or positive (Lebart, Morineau & Piron 1995). And so, two types of variables were distinguished: active variables which contribute to create factorial axes, and illustrative variables which permit to improve the analysis by calculating the Pearson's chi-square (χ^2). In our research, we consider the dimensions: Perception of skills, knowledge and experience, Relations with entrepreneurs, Perception of opportunities, Fear of failure, Opportunity Entrepreneurial Activity, Achievement motivation, New venture creation difficulty, Advice, High growth expectation and Entrepreneurial Intention as the active variables and Occupation, Academic level, Age and Gender as the illustrative variables.

In our case 29 decision rules are constructed, which combine all the different variables allowing the system to take care of all the different possibilities that could happen. The list of some of them is shown in the following table. All the implementations and testing was carried out using the Matlab 7.0.1 programming.

Rules should cover every possible combination of variables. A rule from Table 1 above can be extracted as:

If (Start-up skills = Yes) **and** (Fearlessness = Yes) **and** (Start-up Difficulty = Less Difficult) **and** (High growth expectation = Higher)... **and** (Gender = Female) **and** (Occupation = not working)

then (Entrepreneurial Intention = High)

Once the rules have been defined, all the variables, including the output variable, must be scaled. To do this, we have used the Matlab Fuzzy Logic Toolbox to define the membership functions which suit us best. It's in this moment when we have to decide

Table 1 Formation of entrepreneurial intention rules

Rule no.	Start-up skills	Fearlessness	Start-up Difficulty	High growth expectation	...	Gender	Occupation	Age	Entrepreneurial Intention
1	Yes	Yes	Less Difficult	Higher	...	Female	not working		High
2	No		Somewhat Less difficult	Somewhat Higher	...	Male	Self-Employed	35-44	Very High
3		Yes	More Difficult	Somewhat lower	...	Female	Currently Employed	25-34	Modest
...
...
...
27	Yes	Yes	Somewhat Less Difficult	Somewhat Higher	...	Female	not working		High
28			Somewhat Less Difficult	Higher	...	Male	Self-Employed	55-64	Very High
29	No	No	More difficult	Lower	...	Male	Currently Employed		Low

between all the different types of membership functions we can choose (Roger & Gulley, 1995): triangular, trapezoidal, gaussians, sigmoidals, etc.

In this case, we've chosen the most common parametrizable membership functions used in practice that is triangular and trapezoidal form. They are very simple and this is their main benefit in a very broad field of applications (Bojadziev, 1995).

For example, we already know the names of the five entrepreneurial intention attributes: *very low*, *low*, *modest*, *high* and *very high*. We use triangular membership function types for the output (also for some indicators with more than 3 attributes). To display the output variable membership functions, the input range was a rating scale of 0 to 20, but the output scale is going to be a tip between -5 and 25 : the *very low* membership function will have the parameters $[-5 \ 0 \ 5]$, the *low* membership function will be $[0 \ 5 \ 10]$, the *modest* membership function will be $[5 \ 10 \ 15]$, the *high* membership function will be $[10 \ 15 \ 20]$ and the *very high* membership function will be $[15 \ 20 \ 25]$. So each of these is a fuzzy set centered on the typical number Fig. 7.

To clarify, consider only the three indicators: “*Fearlessness*”, “*Start-up difficulty*” and “*Occupation*” as inputs. In this setting, six decision rules are elaborated. Assume that the score on “*Fearlessness*” for an individual under consideration is 13 points, on “*Start-up difficulty*” is 18 points and 4 points for “*Occupation*”. Referring to membership function defined for “*Fearlessness*”, notice that the score of 13 will have a membership of 0.2 in the fuzzy set *no* and a membership of 0.8 in the fuzzy set *yes*. The value of 18 on “*Start-up difficulty*” corresponds to a membership of 0.7 in the fuzzy set *more difficult* and a membership of 0.3 in the fuzzy set *somewhat more difficult*. Finally, the score of 4 on “*Occupation*” has as membership value 0.2 for *fulltime homemaker* and 0.8 for *seeking employment* on the corresponding scales.

Figure 8 shows how the Entrepreneurial Intention determinations arise from the first two rules. The three vertical lines that cut through all six rules are the scores for

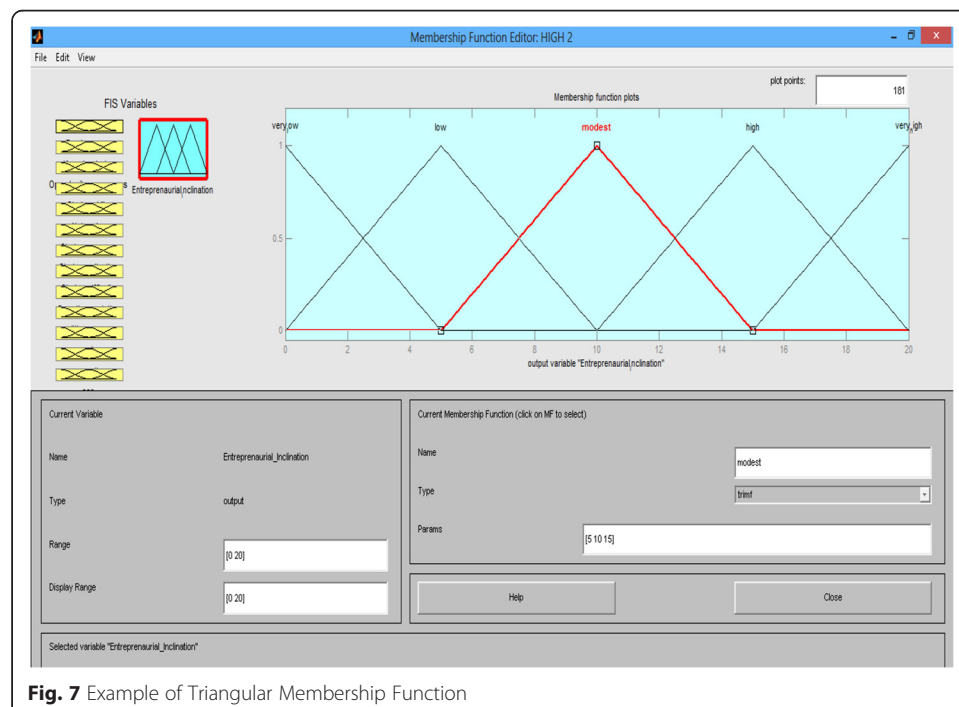


Fig. 7 Example of Triangular Membership Function

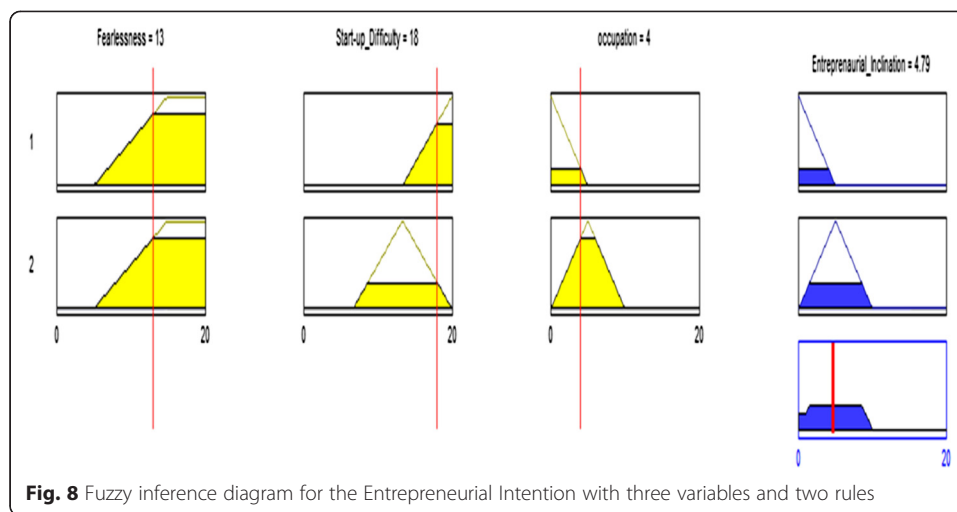


Fig. 8 Fuzzy inference diagram for the Entrepreneurial Intention with three variables and two rules

“Fearlessness”, “Start-up difficulty” and “Occupation”. All six rules fire at once. In the first, the vertical lines yield a “Fearlessness” membership of 0.8 in *yes* and 0.2 in *no*. The rule then takes the lesser value of 0.2 – the correct way to evaluate the AND operator – and applies it to the *low* Entrepreneurial Intention reading. In other words, the system determines *low* Entrepreneurial Intention to 0.2 degrees.

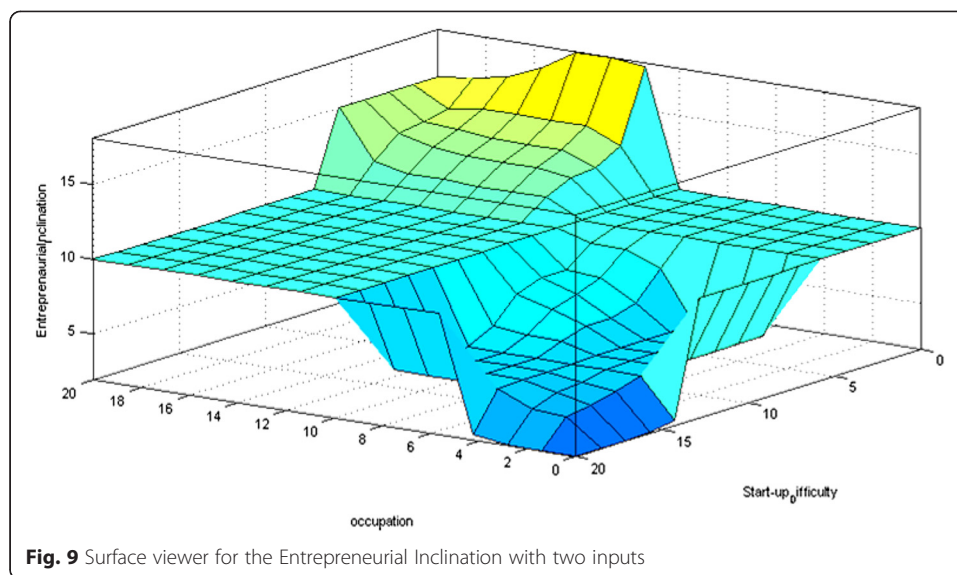
At this stage, the system has an assortment of degrees to which Entrepreneurial Intention has been assessed. Next, it must total up the recommendations. In order to aggregate all the decision rules, the system lops off the top of the triangles at the indicated membership levels, and superimposes the resulting trapezoids atop one another to create a new geometric shape. This shape is the sum of the assessment leading to a final reading for Entrepreneurial Intention that is numerical and crisp (defuzzification). In our simplistic case of three inputs, the score on Entrepreneurial Intention is 4.79 points corresponding to a membership of 0.15 in the fuzzy set *very low* and a membership of 0.85 in the fuzzy set *low*.

Finally, we can see the output surfaces in terms of the inputs covering both the whole input space and the whole output space, in order to show the interaction between inputs and outputs.

In the following figure, we can observe how a determinate value of two input values affects the one output; it’s very useful because just with one view we can see the interaction.

Since this is a two-input one-output case, we can see the entire mapping as three-dimensional plots and it helps us to improve the fuzzy rules if some characteristic of performance isn’t right. An example of this shape is shown below by considering start-up difficulty and occupation as inputs and Entrepreneurial Intention as output Fig. 9.

As a general illustration, we provide below the fuzzy inference diagram including all the 29 decision rules and the membership functions of 13 determinants of entrepreneurial intentions. By keeping the centroid method as method of defuzzification, a simulation of the model shows that the score on Entrepreneurial Intention is 9.01 points corresponding to a membership of 0.25 in the fuzzy set *low* and a membership of 0.75 in the fuzzy set *modest*.



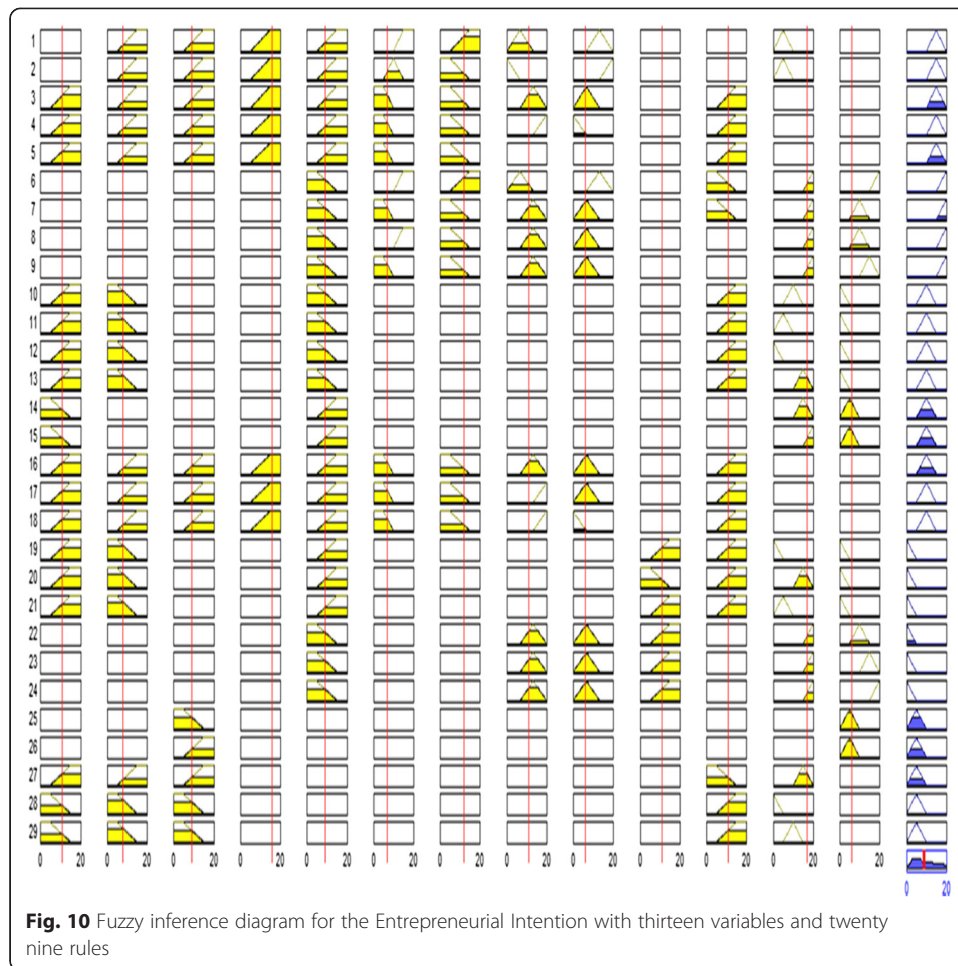
We can assume any score for the all 13 inputs of our model and we have hence the corresponding score of the output Fig. 10.

Discussion

In the current study, analysis of the results demonstrates a significant relationship between some dimensions of attitudinal antecedents of intention described by Ajzen (1991) and entrepreneurial intention in the Tunisian context. More precisely, our model suggests that individuals possess some key personality characteristics and motivational factors, and that these in turn push them to create new venture. Start-up skills, opportunity entrepreneurial activity, achievement motivation and start-up difficulty were analyzed with respect to personnel characteristics and were identified as correlates of being or desiring to be an entrepreneur.

More precisely, the study reveals that the intention to become entrepreneur is either “very high” or “high” when the attributes of the following factors are present:

- *Achievement motivation*: the decision to create new business is sensibly related to the opportunity of being independent or increasing the income, rather than just maintaining the income.
- *New venture creation difficulty*: our simulation shows that if the degree of difficulty of starting a business now compared to one year ago is “Somewhat less difficult”, the intention to launch a new project is very high.
- *Opportunity Entrepreneurial Activity*: to take advantage of a business opportunity is also one of the main attributes that push an individual to start-up a business.
- *High growth expectation*: more the individual's perception about their expectations for growth now compared to one year ago is “somewhat higher” more their intention is also higher.
- *Gender* provides also significant differences when explaining entrepreneurial intention. Notably, male exhibit higher influence compared to female.



- *Groups of Age* provide differences when explaining entrepreneurial intention. In particular, the relationship between perceived behavioral control and entrepreneurial intention varies depending on the age; elder subgroups increase highly the decision to create new firm rather than younger subgroups. This may be due to the fact that perceived behavioural control is related to experience; and students or early age stages do not have the experience to judge how good they can perform (McGee et al. 2009).
- *Current employment status* of potential entrepreneurs provides significant differences when explaining entrepreneurial intention. In fact, our model show that “seeking employment” is one of the reasons to think seriously to create new business.
- Finally, when explaining entrepreneurial intention, *perception of skills, knowledge and experience* which indicate whether the individual sees themselves as having the ability to create a new business or not exhibit differences towards those who haven't.

By contrast, our model shows that the presence of the following attributes decrease sensibly the intention to create a new venture (“very low” and “low”). *Fear of failure* which is considered as an approximate measurement of the aversion to risk. More an individual is afraid of failing in the creation of a new business more the entrepreneurial

intention is “very low”. Moreover, the absence of *Relations with entrepreneurs* related to the perception of the viability of creating a business and a negative influence of the family members on the decision to start-up (*Advice*) lead individuals to not engage in new business creation. Finally, young people and especially female are the two main personality characteristics which represents an obstacle for launch of a new entrepreneurial project.

To summarize, the influence of subjective norms, personal attitudes and perceived behavioral control encourage or restrict, in various degrees, the intention to create a new business. Some factors influenced significantly higher towards entrepreneurial intention.

Conclusion

Entrepreneurship and entrepreneurial culture are receiving an increased amount of attention in both academic research and practice. The different fields of study have focused on the analysis of the characteristics of potential entrepreneurs and the firm-creation process (Krueger, Reilly & Carsrud, 2000; Khefacha, Belkacem & Mansouri, 2013; Reynolds *et al.*, 2004).

This research focuses explicitly on various determinants influencing the entrepreneurial decision in Tunisia. For this, the accent is put on the well-known theory of planned behavior developed by Ajzen (1991) and improved by Krueger and Brazeal (1994). It is quite possible that a better understanding of the factors that influence attitudes towards entrepreneurship and entrepreneurial intent could facilitate the successful development of these initiatives. Understanding factors related to entrepreneurial intentions is important since intentions are reliable predictors of entrepreneurial action (Krueger *et al.*, 2000).

To this end, we introduce a new approach to study entrepreneurial intention using concepts from fuzzy logic theory. From a theoretical point of view, this theory offers a natural approach to the resolution of multidimensional and complex problems when the available information is sparse and/or of poor quality. As well, fuzzy logic is nuanced and gradual which enables it to be more close to human logic approaches and allow it to become an accurate replacement for the probability theory (Zalila *et al.*, 2007).

In this paper, we also present a practical experiment including fuzzy data to illustrate the economic-psychological model of factors that influence individuals' intentions to go into business and to valid its applicability in Tunisian context. A simulation study of the model suggests that entrepreneurial intention is related to a composite of some demographic, competencies, networks and perception factors. It assumes that individuals make their choices based on simple rules relating perceptions (of the attributes of the available alternatives) to preferences (towards them) both of which are modeled using fuzzy sets.

Among the most relevant aspects shaping the entrepreneurial decision, we analyze the role of subjective norms and personal attitudes like the perception of having the necessary skills, knowledge and experience, fear of failure or advice. Conversely, perceived behavioral control is represented by perceived control to exploit identified opportunities, occupation, age, gender or current employment status.

Our findings confirm that the decision to create new venture is not just a matter of either “like” or “ability”. Results suggest the decision to become an entrepreneur is best

explained by a composite of some factors, notably knowing someone personally who started a business in the past 2 years, presence of good opportunities for starting a business or the advice of some family members about the consequences of the decision. Start-up is much more likely when some factors are satisfied simultaneously.

This is an important area of concern in entrepreneurship intention which improves our knowledge about the degree to which the individual holds a positive or negative personal valuation about being an entrepreneur (Kolvereid, 1996). The modeling insights may also be valuable as input to the design of entrepreneurship curricula.

Although the results are promising and the approximate reasoning framework has shown great flexibility in explaining the decision-making process, application of this approach in our study suffer from some limitations. Among them, the formulation of decision fuzzy rules must be improved by using other techniques as developed by Zalila et al. (2007) in their automatic knowledge extraction Xtractis® which best translate the modeled process into linguistic decision rules. In addition, the constructed of the Fuzzy Inference Systems on rule connected with AND operations can be replaced by OR operations which could also be deployed.

Finally, the behavioral interpretation of fuzzy method for selecting the appropriate form of membership functions and structure of rules are areas of further research using notably neuro-fuzzy framework (Linkens & Chen, 1999).

Endnotes

¹Global Entrepreneurship Monitor (GEM), initiated in 1999, conducts systematic research into diverse characteristics of entrepreneurship, such as motivation, innovativeness, competitiveness, and growth expectation. GEM is widely acknowledged to be the best source of comparative entrepreneurship data in the world (Shorrock, 2008) and has been utilized in studies published in leading journals (e.g., Bowen & De Clercq, 2007).

Competing interests

The authors declare that they have no competing interests.

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