Learning A Bayesian Structure to Model Entrepreneurial Intentions and Attitudes Toward Business Creation among Emirati Students

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LEARNING A BAYESIAN STRUCTURE
TO MODEL ENTREPRENEURIAL INTENTIONS
AND ATTITUDES TOWARD BUSINESS CREATION
AMONG EMIRATI STUDENTS[1]

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Abstract

Economic growth in most advanced countries is driven by small and medium-sized enterprises (SMEs), and most countries prioritize entrepreneurship for economic growth and innovation. This is very apparent in the United Arab Emirates (UAE), where an average of around 39 percent of adults want to start a business in the next three years. As such, entrepreneurial intentions have been a major area of focus in research, but they have always been studied using generic models. We use Bayesian networks as a relatively new technique to model entrepreneurial intentions as it provides an advantage over classical methods. Using the theory of planned behavior as a foundation, we conduct a cross-sectional study among a random sample of 324 Emirati university students in the UAE. We implement unsupervised structural learning within BayesiaLab using the SopEQ unsupervised algorithm to minimize the "minimum description length" score. Our model provides confirmation of and more robust statistical support for existing theoretical frameworks. It helps us find relationships among the different entrepreneurial factors and assess the effects of changes in these variables on intentions. One of the strengths of our study is the inclusion of attitudes toward entrepreneurship and self-efficacy variables. Accordingly, the main conclusion that can be drawn from our model is that entrepreneurial intentions are highly affected by attitude, self-efficacy, subjective norms, and opportunity feasibility. The results can be used by professionals for proposing new policies for university opportunities and government support.

ملخص

الغرض. تدفع الشركات الصغيرة والمتوسطة بالنمو الاقتصادي في معظم البلدان المتقدمة، كما تعطي معظم البلدان الأولوية لريادة الأعمال من أجل نمو الاقتصاد والابتكار. وهو ما يتجلى بشدة في دولة الإمارات العربية المتحدة حيث يرغب حوالي 39٪ من البالغين في المتوسط في بدء عمل تجاري في السنوات الثلاث المقبلة. على هذا النحو، كانت نوايا ريادة الأعمال محورا رئيسيا للبحث ولكن دائماً ما كان يتم دراستها باستخدام نماذج عامة. لذا فنحن نستخدم شبكات بايزية (Bayesian) كأسلوب جديد نسبيا لنمذجة نوايا ريادة الأعمال لأنها توفر ميزة على الأساليب الكلاسيكية. المنهج المستخدم: باستخدام نظرية السلوك المخطط كأساس، أجريت دراسة مقطعية على عينة عشوائية من 324 طالبا جامعيا إماراتيا في دولة الإمارات العربية المتحدة. قمنا بتنفيذ التعلم الهيكلي غير الخاضع للإشراف داخل BayesiaLab باستخدام خوارزمية SopEQ غير الخاضعة للإشراف لتقليل درجة "الحد الأدنى لطول الوصف". نتائج الدراسة: يوفر نموذجنا تأكيدا ودعما إحصائيا أكثر قوة للأطر النظرية الحالية. ولم يساعد ذلك في إيجاد علاقات بين مختلف عوامل ريادة الأعمال فحسب، بل ساعد أيضا في تقييم آثار التغيرات في هذه المتغيرات على نوايا رواد الأعمال. الإبداع. هنا هو أن إحدى نقاط القوة في دراستنا هي إدراج المواقف تجاه ريادة الأعمال ومتغيرات الكفاءة الذاتية. وفقا لذلك، فإن الاستنتاجات الرئيسية التي يمكن استخلاصها من نموذجنا هي أن نوايا ريادة الأعمال تتأثر بشدة بالموقف والكفاءة الذاتية والمعايير الذاتية وجدوى الفرصة. يمكن استخدام النتائج من قبل المحترفين لاقتراح سياسات جديدة للفرص الجامعية والدعم الحكومي.

Introduction

Economic growth in most advanced countries is driven by large numbers of small and medium-sized enterprises (SMEs) across all sectors, and most countries prioritize the importance of entrepreneurship for economic growth and innovation. Therefore, it is vital for a country's advancement to stimulate a culture of entrepreneurship at an early age through education systems. For this purpose, higher education institutions should commit to helping students achieve their full potential through personal and entrepreneurial development as well as opening new opportunities for future growth through a multidiscipline lens. In addition to economic growth, entrepreneurial activity is a key driver of employment, innovation, and productivity. Furthermore, it is generally assumed to be a vital driver of economic development and transformation through the prevalence of an innovative environment. Indeed, entrepreneurship doesn't just benefit entrepreneurs; it also benefits the overall economy through job creation in the market at all levels (Al Saiqal, 2017). This starts with universities, the role of which is to provide students with entrepreneurial skills and supply the country with qualified entrepreneurs who are able to create new innovative businesses and contribute to the country's economic growth (Chrisman et al., 2012; Henderson, 2000).

Despite the fact that most universities are criticized for not being able to deliver qualified graduates with practical skills (Del Arco and Enciso, 2011), and while most studies agree on the significance of entrepreneurship education in starting a business, others find that even though entrepreneurship education does not have a significant impact on business performances, it has a large impact on graduates' motivation to start a business (Henderson, 2000).

The Global Entrepreneurship Monitor Report 2019/2020 (GEM, 2020) states that firms are increasingly valuing entrepreneurship skills among employees. In the United Arab Emirates (UAE), the United Kingdom, and Australia, more than eight percent of employed adults are involved in entrepreneurial activities (such as developing new goods or services) as part of their employment, compared to less than one percent in 16 of the 50 economies. Moreover, in 13 economies, five percent or more of adults are starting or running a new business and expecting to employ an additional six or more people within the next five years, including two countries with more than 10 percent in this position (Chile with 13 percent and the UAE with 11 percent). Furthermore, the intention to start a business is relatively high in innovation-driven economies, where, on average, around 39 percent of adults want to start a business in the next three years in the UAE. The GEM report also indicates that while 71 percent of adults consider it easy to start a business in the UAE, only 13.7 percent have entrepreneurial intentions, and 35.1 percent declared facing the fear of failure if presented with the opportunity to start a business.

The National Agenda of the UAE aims for the country to be among the best in the world in entrepreneurship as it plays a key role in unlocking the potential of nationals and enables them to become a driving force of the country's economic development through private sector SMEs. Furthermore, the National Agenda strives to instill an entrepreneurial culture in schools and

universities to foster generations endowed with leadership, creativity, responsibility, and ambition. This will allow the UAE to be among the best in the world in terms of ease of doing business, innovation, entrepreneurship, and research and development indicators. Thus, entrepreneurship is now regarded as an important element to be integrated into the curricula of higher education institutions in the UAE, making it an ideal context for studying entrepreneurial attitudes.

Entrepreneurial attitudes refer to the extent to which students think there are good opportunities for starting a business, or the degree to which they attach high status to entrepreneurs. Measuring entrepreneurial attitudes is important because they express the general feelings toward entrepreneurs and entrepreneurship. Other relevant attitudes may include the level of risk that individuals might be willing to bear and individuals' perceptions of their own skills, knowledge, and experience in business creation. Entrepreneurial attitudes can influence entrepreneurial activity and vice versa.

Although entrepreneurial attitudes and intentions are not new phenomena, they have always been studied using the generic entrepreneurial intention models (Aljuwaiber, 2020). In this paper, we propose using Bayesian Networks (BNs) as a relatively new technique that can model entrepreneurial intentions and attitudes while providing some advantages compared to classical methods.

BNs are a set of statistical methods used to model problems, extract information, and make decisions. A formalism of probabilistic reasoning, BNs are increasingly used in several fields such as industry, health, finance, and image processing. We will use BNs to model relationships among the different factors involved in this study.

Literature review

Attitudes toward entrepreneurship have become an important factor in describing and explaining entrepreneurial behavior in recent entrepreneurship research. Several models have been developed to study entrepreneurial attitudes. One of the first models that take desirability and feasibility into consideration was introduced by Shapero and Sokol (1982). This model argues that the entrepreneurial intentions variable depends on perceptions of desirability, feasibility, and propensity to act. It was later updated in McMullen and Shepherd (2006) to point out the role of societies where entrepreneurs reside. Perceived desirability is defined as a subjective norm regarding the perceived social support and personal interest to perform entrepreneurial activities, while perceived feasibility is defined as the perceived ease or difficulty of performing entrepreneurial activities and the perceived self-competence in the context of entrepreneurship.

In Krueger et al. (2000), the subjective norms variable is defined as a person's perception of a specified behavior such as starting a business, which may be influenced by family, friends, society, educators…etc. Furthermore, role models, usually associated with parents and friends, have been

established as a factor that positively affects entrepreneurial behavior. Other models suggest adding additional factors considered important in entrepreneurial intentions and attitudes. Obstacles or barriers to business creation as well as the support available to entrepreneurs are examples of such factors. Regardless of the model used to study entrepreneurial intentions among students, we believe that there is a need to promote entrepreneurship and understand the role of universities in fostering entrepreneurship among students.

Several studies have analyzed the entrepreneurial attitudes of university students (Ruiz-Ruano and Puga, 2019; Moriano et al., 2012; Luiz and Mariotti, 2011; de la Cruz Sánchez-Escobedo, 2011; Harris and Gibson, 2008).

Our literature review identified a lack of studies on entrepreneurial intentions and attitudes in the Arab world; only a few studies have been conducted on the topic in the Middle East region (Saleh and Salhieh, 2014; Sayed and Ben Slimane, 2014), in Saudi Arabia (Wassim, 2016), in Kuwait (Wajeeh and Al-Yacoub, 2016), in Bahrain (Al-Shammari and Waleed, 2018), in Jordan (Abualbasal and Badran, 2019; Al-Mohammad, 2010), in Lebanon (Hendieh et al., 2019), in Oman (Bakheet and Varghese, 2013; Bakheet, 2018), and in Egypt (Sharaf et al., 2018).

Saleh and Salhieh (2014) suggest that entrepreneurial activity in the selected MENA and GCC countries is determined by the stage of economic development and population growth, as well as employment, level of education, financial development, macroeconomic stability, and technological development.

Sayed and Ben Slimane (2014) explore the factors that influence the entrepreneurial intention of university students in four Arab countries (Jordan, Lebanon, Egypt, and Oman) and find that the study participants had moderate intentions and were motivated to study entrepreneurship, but their perceptions of market conditions, governmental regulations and policies, and their university education were moderately low, even though financial sources and society encouragement were moderate.

In the UAE, we were able to identify a limited number of research studies directed toward entrepreneurship attitudes in general and for students in particular. The first study to examine entrepreneurial intentions among 544 UAE senior business and engineering undergraduate students inside and outside the country was done by Saiqal and Yousif (2017). In their study, the collected data are analyzed using structural equation modeling (SEM) and reveal that gender, age, entrepreneurship experience, and family role model have direct and indirect effects on entrepreneurship. The study also reveals that Emirati males have stronger intentions than females.

Jabeen and Faisal (2018) study the enablers of 224 UAE female entrepreneurs and their behavior using interpretive structural modeling. The results show that the most important enablers are

spotting market trends and consumer needs, management skill development, and sustainable competitive advantage. According to this study, women in the UAE do not consider entrepreneurship as an option because of the lack of education in business skills.

In addition, Vracheva et al. (2019) examine the factors affecting the entrepreneurial intent of a group of 151 UAE female students and find that family business exposure doesn't affect entrepreneurial intent. They also find that university-based subjective norms and exposure to business classes are not significantly associated with entrepreneurial intent. Pauceanu et al. (2018) study the factors that influence students to start a business. Using the same dataset from Vracheva et al. (2019), the study focuses on gender, age, and parents' self-employment status, as well as 23 entrepreneurial and cultural support features to explain students' intentions to start a business. They find that entrepreneurial confidence is the only significant factor that directly influences students' intentions to start a business. Finally, Mohammed (2019) investigates the factors that influence entrepreneurial intentions to start a business using linear regression. The study finds that perceived educational support has a significant strong relationship with entrepreneurial intentions. However, the study was done on a small sample of only 53 students, the majority of whom were females.

All of the above studies in the UAE were conducted using generic models. To our knowledge, no study in the UAE has ever used the BNs framework to model entrepreneurial intentions. A close exception is one study by Sohn and Lee (2013), where the authors examine the dynamic relationship among early-stage entrepreneurial attitudes, activities, and aspirations using BNs. They examine how attitudes affect the entrepreneurial activities and aspirations of the current year. Therefore, we will be the first to use BNs as a tool to study students' entrepreneurial intentions and attitudes toward starting a business in the UAE.

On the global level, we were able to find a limited number of studies that investigate entrepreneurial attitudes using BNs (Ruiz-Ruano and Puga, 2019; García et al., 2014; López et al., 2012). In Ruiz-Ruano and Puga (2019), the authors use BNs to explain the variables involved in and directly affecting entrepreneurial intention, such as self-efficacy, desirability, attitude, and social norm, among a sample of 1,068 university faculty members from Spanish public universities. The structure of the BN in this study is automatically learned from the dataset and compared to the basic postulates of the generic model (Shapero and Sokol, 1982).

Another example is García et al. (2014), where the authors combine both theory and statistical evidence to create a BN model. The study starts from a plausible theoretical model and then tests it using automatic learning algorithms to build BNs using the BNlearn algorithm implemented within R (Nagarajan et al., 2013). The obtained BN shows that entrepreneurial behavior depends on perceived desirability and feasibility. Moreover, it indicates that desirability and feasibility

relate to normative beliefs, attitudes, and obstacles, which is substantially different from the theories and results of other studies.

Finally, López et al. (2012) use the same data from García et al. (2014) and examine entrepreneurial attitudes among Spanish women entrepreneurs using BNs, but this time they model feasibility using two different dimensions: opportunity feasibility and resource availability. The results show that the BN predicted better entrepreneurial intentions with both added dimensions of feasibility.

In our study, we will be examining entrepreneurship intentions and attitudes among students who are not yet entrepreneurs and see how this can affect their intentions to start a business. Conclusions stem from the existing Emirati social construct (people-centric society of the Arab world, rather than the system-centric society of the Western world). This has created a value-adding contribution to the research questions. Furthermore, BNs have been used in many domains such as industry, marketing, health, computer sciences, economics, and management. However, their use in psychology and behavioral studies is still limited (Sohn and Lee, 2013). This study will contribute to this area.

Methodology and data analysis

Bayesian networks

Also known as probabilistic graphical models, BNs are statistical tools to represent and handle uncertainty in different domains (Pearl, 1988). BNs represent the joint probability distribution (JPD) of a set of selected random variables of an area of knowledge and can handle the qualitative and quantitative dimensions of any domain. The qualitative part consists of the structure of the BNs comprising a set of random variables (nodes) and directed edges connecting the nodes to form a directed acyclic graph. The quantitative part of the BNs consists of the conditional probability tables associated with each node. Each edge between the two nodes (A and B) in the BN structure indicates a statistical dependence between the two variables, i.e., a correlation between A and B (Pearl, 1988). The direction of the edge does not necessarily mean cause and effect. If the edge is directed from A to B, we dispose of the probability distribution of A conditioned by B (P(A|B)). Therefore, every variable in the BN is associated with a probability distribution conditioned by the set of its parents (direct ancestors in the graph). This conditional probability distribution is represented as a probability distribution table (PDT) as all variables in the BN will be discretized.

BN can be built using experts' knowledge or learned from data. Learning a BN from data means finding the BN structure that best represents the JPD that is sampled by the data. There are two families of methods for learning BNs: the constraint-based methods and the score-based methods. In the second family of methods, a score that measures the BN structure with respect to the data is defined. The minimum description length (MDL) score, the shortest description of the data as the best model, is a well-known and commonly used score in BNs learning. The learning algorithms

will then find the BN structure that minimizes the defined score while taking into account the structural capacity to encode the data as well as the BN complexity.

We use entropy and logarithmic loss to evaluate the goodness of the fit of the BN model and carry out a sensitivity analysis to evaluate the impact of each variable in the model on the intention variable. Entropy reduction (or mutual information) refers to the expected reduction in the query variable (intentions, in our case) due to a finding in any other variable of the model (Bayesia, 2021).

One of the main challenges of adopting BNs is learning their structure from data. This task is complicated by the huge search space of possible solutions and due to the fact that the problem is *NP*-hard. Most of the time, this necessitates approximations. However, as our sample is limited in terms of number of variables and size of the data, it is considered a small BN compared to BNs using hundreds of variables and millions of rows of data. The software used in this study, BayesiaLab (Bayesia, 2021), is a powerful software that can handle large BNs, so no approximation is needed in our example.

Materials and methods
We conducted a cross-sectional study among a random sample of 324 Emirati students attending university in the UAE. Out of 324 students, 87 percent were females and 13 percent were males aged between 17 and 35 years old. The average age of participants was 22.7 years with a standard deviation of 3.1 years. The majority of the participants were from the Emirate of Dubai (52.2 percent), followed by Abu Dhabi (28.4 percent).

Students were recruited by choosing classes randomly through Excel from the list of 2020 Summer and Fall semesters, contacted by emails, briefed about the study, and asked to fill out the survey instrument that was developed for the study. The online survey consisted of three main parts. The first part included socio-economic and demographic questions about gender, city of residence, age, field of study, high school, language of instruction at their high school, year of study at the university, GPA, campus (Dubai or Abu Dhabi), employment status, parents' level of education, parents' employment status, and their job sectors.

The second part collected general background information on entrepreneurship, such as how they learned about entrepreneurship, earlier activities of starting a business and their attitudes toward it, whether they had taken a specialized course in entrepreneurship, read about it, or took part in workshops and conferences, and their plans after graduation. The last part of the survey measured students' perceptions of entrepreneurship and entrepreneurs, the effect of entrepreneurship on the individual and the society, students' attitudes toward entrepreneurship, entrepreneurial opportunities, the entrepreneurial environment within the university, the UAE entrepreneurial environment, the limitations of starting a new business, entrepreneurial characteristics and

behavior, interest in one's own enterprise, and entrepreneurial motives. In each question, students were able to choose their answers on a Likert scale of 1 to 5, with 1 being "strongly disagree" and 5 being "strongly agree."

The different statements to measure students' intentions, attitudes, opportunity feasibility, self-efficacy, subjective norms, perceived risk, country opportunity feasibility, university opportunity feasibility, and obstacles were taken from Ruiz-Ruano and Puga (2019), Moriano et al. (2012), Luiz and Mariotti (2011), Abualbasal and Badran (2019), Al-Mohammad (2010), and Moriano et al. (2008). We reformulated, added, and/or deleted some of the items to suit our population.

Validity and reliability of the questionnaire
A professional translator translated the English version of the questionnaire into Arabic. A second bilingual speaker cross-checked the Arabic version word for word with the English version. The content validity of the Arabic version of the questionnaire was assessed by a panel of experts in the field to evaluate the items' readability, language simplicity, and suitability, and to evaluate the relationship of each item to the whole scale. The panel was composed of a professor of economics and a professor of entrepreneurship. We made changes based on their comments. The internal consistency reliability of the Arabic version of the questionnaire was assessed using Cronbach's α, which was 0.976 based on a pilot study of 10 students. Students in the pilot study were not included in the main study.

Ethical consideration
Ethical clearance was obtained from the university's Research and Ethics Committee. Students were invited to participate in the study on a voluntary basis. The confidentiality and anonymity of the participants were assured by not asking for their names and only identifying them by codes. All data were kept undisclosed, and participants were informed about the type of data to be collected and that it would be used for scientific purposes only. The published results of the study contain only statistical or group data from which no individual participant can be identified.

Method
The scales generated from the different statements included in the survey are entrepreneurial intentions (INT), entrepreneurial attitudes (ATT), entrepreneurship self-efficacy (SE), subjective norms (SN), opportunity feasibility (OF), university opportunity feasibility (UOF), country opportunity feasibility (COF), perceived risk (PR), obstacles (OBS), and family and friends' support (FFS). The INT scale was created using seven statements from the questionnaire. The value of intention reported here is the average agreement of the statements. Higher scores on the intention scales indicate a higher intention toward starting a new business with a Cronbach's α of 0.79.

To measure ATT, we used a scale of 10 items, with high scores on the attitude scale indicating a more positive attitude toward business creation, with a Cronbach's α of 0.89. The SN was computed based on a set of 14 items and showed a reliability of 0.92. The highest scores on the subjective norm scales indicate stronger support for business creation within the potential entrepreneur's social milieu. The results of all variables are summarized in Table 1.

Table 1: Descriptive statistics and internal consistency coefficients

Variables	Number of statements	Cronbach's α	Mean	Standard Deviation
Intention	7	0.79	3.34	0.54
Attitudes	10	0.89	3.83	0.69
Opportunity feasibility	5	0.79	3.40	0.59
Self-efficacy	11	0.79	3.07	0.61
Subjective norms	14	0.92	3.83	0.64
Perceived risk	5	0.74	3.00	0.69
Country opportunity feasibility	5	0.89	3.86	0.84
University opportunity feasibility	15	0.94	3.52	0.74
Obstacles	10	0.86	3.26	0.72
Family and friends' support	1	-	3.99	1.03

Table 1 shows that the least mean score is perceived risk, and the highest mean score is family and friends' support. This can be explained by the fact that family and friends support was measured directly by one statement, but since entrepreneurship and risk are two sides of the same coin, perceived risk was measured by five statements.

Data analysis
Several BN learning algorithms exist. In this paper, we use Unsupervised Structural learning implemented within BayesiaLab (Bayesia, 2021) which is a BN software available in the market. We tried some unsupervised algorithms and selected the one that minimized the "Minimum Description Length" (MDL) score defined on BNs. We considered Maximum Weigh Spanning Tree, Taboo, and SopEQ algorithms and found SopEQ to provide us with the lowest MDL score.

SopEQ algorithm is a search algorithm based on heuristics. It first identifies the set of potential parents of each node, then, for the addition of edges, it explores the equivalence class space where both edges' orientations are equivalent with respect to the encoded joint probability. The edges' directions are then added after all conditional dependencies have been identified. The scores of the different scales are discretized into three bins using R2-GenOpt for discretizing continuous variables available within BayesiaLab (Bayesia, 2021). The BN output is based solely on the collected data and no expert knowledge is used to determine any type of association between the variables.

Results

The fitted BN is shown in Figure 1. According to the obtained BN model, entrepreneurial attitude, self-efficacy, and opportunity feasibility play an important role in shaping entrepreneurial intentions. Additionally, attitude is directly affected by subjective norms; therefore, the subjective norms variable has an influence on intention, which is mediated by attitude.

Figure 1. The learned BN structure
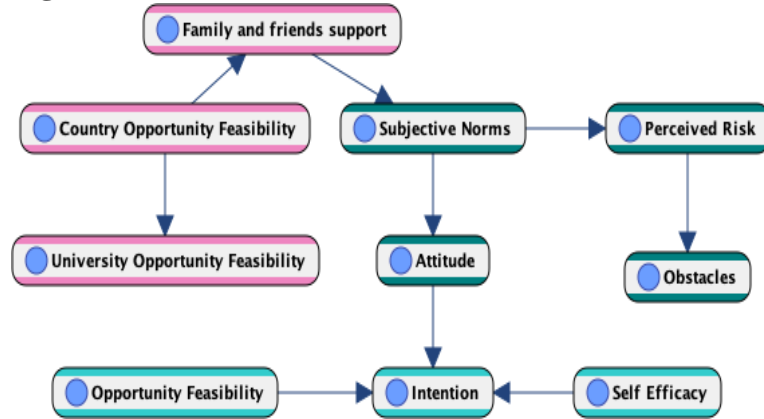
On the other hand, the subjective norms variable is a direct parent of the perceived risk variable and a direct descendant of the family and friends' support variable, which is an indication that the latter variable has an impact on intention, which is mediated by attitude. The same applies to the country opportunity feasibility variable as a direct parent to the family and friends' support variable.

Furthermore, country opportunity feasibility influences both family and friends' support and university opportunity feasibility.

While there is a positive correlation between country opportunity and university opportunity, the correlation between country opportunity and family and friends' support is negative. The negative correlation points to the possibility that whenever family and friends' support is strong, reliance on country support is weak, and if family and friends' support is weak, reliance on country support is stronger.
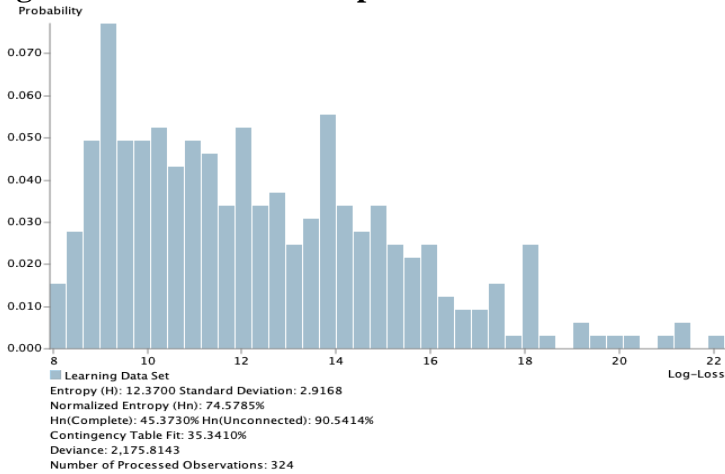
The strength of the relationships represented by the arcs of the BN is given in Table 2.

Table 2. Relationships analysis

Parent	Child	KL Divergence	Relative Weight	Overall Contribution	Mutual Information	Symmetric Normalized Mutual Information	G_{KL}-test	p-value	Pearson Correlation
Subjective norms	Attitude	0.62	1.00	0.23	0.62	0.39	276.97	<0.0001	0.78
Country opportunity feasibility	Family and friends support	0.45	0.74	0.17	0.45	0.23	203.67	<0.0001	-0.21
Family and friends' support	Subjective norms	0.39	0.64	0.14	0.39	0.20	176.11	<0.0001	-0.21
Perceived risk	Obstacles	0.37	0.61	0.14	0.37	0.24	168.03	<0.0001	0.62
Attitude	Intention	0.23	0.37	0.08	0.12	0.07	103.66	<0.0001	0.30
Country opportunity feasibility	University opportunity feasibility	0.23	0.37	0.08	0.23	0.14	103.17	<0.0001	0.50
Opportunity feasibility	Intention	0.17	0.28	0.06	0.08	0.05	76.74	<0.0001	0.30
Self-efficacy	Intention	0.16	0.26	0.06	0.05	0.03	88.44	<0.0001	0.22
Subjective norms	Perceived risk	0.10	0.16	0.04	0.10	0.06	44.08	<0.0001	0.12

* GKL-test: The independence test G is computed from the Kullback-Leibler divergence of the relationship

The BN model is the best compact representation of the JDP. To evaluate the performance of the model, we evaluate the joint probabilities of all the observations described in the data (Figure 2), where the probability of each instance of the dataset is computed using the BN structure. The lower the probability, the higher the cost to encode the information in the dataset.

Figure 2: The BN network performance

Learning Data Set
Entropy (H): 12.3700 Standard Deviation: 2.9168
Normalized Entropy (Hn): 74.5785%
Hn(Complete): 45.3730% Hn(Unconnected): 90.5414%
Contingency Table Fit: 35.3410%
Deviance: 2,175.8143
Number of Processed Observations: 324

The density graph in Figure 2 summarizes the distribution of the log-loss values corresponding to the multidimensional observations described in the dataset. The global performance index of the network over our data consists of the entropy obtained with the fully connected BN when we assume all variables are dependent. The normalized entropy is obtained with the fully unconnected BN when we assume all variables are independent (straw model). The contingency table represents the degree of fit between the BN JDP and the data, and the deviance that measures the difference between the average log-likelihood of the BN and the data.

The probability distribution of intention conditional to attitudes, self-efficacy, and opportunity feasibility is given in Table 3. As an example, we can read from this table that there is a 60.87 percent chance of an intention average higher than 3.57 (high intention), given that attitude is higher than four, self-efficacy is between 2.64 and 3.36 (moderate), and opportunity feasibility is higher than 3.5 (high).

Table 3: Conditional probability table of intention given attitudes, self-efficacy, and opportunity feasibility

Attitude	Self Efficacy	Opportunity Feasibility	Intention		
			≤ 2.86	≤ 3.57	>3.57
≤ 3.2	≤ 2.64	≤ 2.67	64.71	35.29	0.00
		≤ 3.5	33.33	66.67	0.00
		>3.5	33.33	33.33	33.33
	≤ 3.36	≤ 2.67	40.00	60.00	0.00
		≤ 3.5	31.82	68.18	0.00
		>3.5	0.00	100.00	0.00
	>3.36	≤ 2.67	33.33	33.33	33.33
		≤ 3.5	33.33	66.67	0.00
		>3.5	33.33	33.33	33.33
≤ 4	≤ 2.64 (1/3)	≤ 2.67	33.33	66.67	0.00
		≤ 3.5	23.08	73.08	3.85
		>3.5	0.00	100.00	0.00
	≤ 3.36 (2/3)	≤ 2.67	100.00	0.00	0.00
		≤ 3.5	18.60	74.42	6.98
		>3.5	13.04	82.61	4.35
	>3.36 (3/3)	≤ 2.67	33.33	33.33	33.33
		≤ 3.5	7.69	76.92	15.38
		>3.5	5.88	58.82	35.29
>4	≤ 2.64	≤ 2.67	83.33	16.67	0.00
		≤ 3.5	26.67	66.67	6.67
		>3.5	0.00	66.67	33.33
	≤ 3.36	≤ 2.67	33.33	33.33	33.33
		≤ 3.5	9.09	54.55	36.36
		>3.5	8.70	30.43	60.87
	>3.36	≤ 2.67	33.33	33.33	33.33
		≤ 3.5	6.25	37.50	56.25
		>3.5	0.00	15.22	84.78

To explore the impact of each variable in the BN model on entrepreneurial intentions, we run a sensitivity analysis as shown in Table 4.

Table 4: Overall analysis with intention

Node	Mutual Information	Relative Significance	Prior Mean Value	X^2-test	P-value
Attitude	0.118	1.000	3.832	53.178	0.000%
Opportunity feasibility	0.085	0.718	3.401	38.155	0.000%
Subjective norms	0.056	0.470	3.835	24.982	0.005%
Self-efficacy	0.054	0.455	3.066	24.187	0.0073%
Family and friends' support	0.021	0.178	1.772	9.438	30.674%
Country opportunity feasibility	0.009	0.077	3.864	4.082	39.504%
Perceived risk	0.003	0.028	2.970	1.492	82.812%
University opportunity feasibility	0.002	0.018	3.526	0.936	91.930%
Obstacles	0.001	0.006	3.256	0.323	98.826%

Table 4 shows the nodes in descending order according to the information they bring to the knowledge of the target node's intention. Mutual information represents the amount of information brought by each node to intentions, while relative significance represents the ratio between the mutual information and the maximum mutual information value (0.118). The prior mean value is the variables' mean values. The independence X^2-test is computed from the BN structure for each of its variables' target intention, while the P-value represents the independence probability between each variable of the BN and intentions as the target node.

We then set our target to high intention with a desired average value above 3.57. Table 5 shows all statistics related to the estimation of the quality of the used learning method. K-fold is used for using different learning and testing sets in order to estimate the quality of the learning method and therefore the resulting BN.

Table 5. Evaluation of the target intention (above 3.57)

Target: Intention	
Value	High (>3.57)
Gini Index	60.58%
Relative Gini Index	82.48%
Lift Index	2.063
Relative Lift Index	88.83%
ROC Index	91.24%
Calibration Index	43.35%
Binary Log-Loss	0.320
R	0.688
R^2	0.473
RMSE	0.391
NRMSE	11.41%
Overall Precision	71.60%
Mean Precision	62.86%
Overall Reliability	71.84%
Mean Reliability	72.30%

The relationship of all BN variables with the target intention set above 3.57 (high intention) is given in Table 6.

Table 6. Local analyses with target node set to high intention

Node	Mutual Information	Relative Significance	Mean Value	Max Bayes Factor			Min Bayes Factor		
Attitude	0.113	1.000	4.201	>4	76.24%	1.843	≤ 3.2	5.95%	0.344
Self-efficacy	0.053	0.471	3.327	>3.36	49.65%	1.693	≤ 2.64	10.81%	0.412
Subjective norms	0.053	0.470	4.099	>4.14	48.85%	1.721	≤ 3.29	6.99%	0.365
Opportunity feasibility	0.024	0.208	3.551	>3.5	54.21%	1.417	≤ 2.67	7.08%	0.675
Family and friends' support	0.020	0.178	1.698	Strongly Agree	52.50%	1.339	Disagree	2.50%	0.477
Country opportunity feasibility	0.009	0.078	4.011	>4.2	38.08%	1.272	≤ 3.2	18.79%	0.742
Perceived risk	0.003	0.027	2.988	>3.25	30.33%	1.143	≤ 3.25	35.21%	0.864
University opportunity feasibility	0.002	0.018	3.587	>3.73	43.29%	1.113	≤ 2.6	7.50%	0.838
Obstacles	0.001	0.006	3.273	>3.6	28.91%	1.077	≤ 3.6	54.83%	0.955

Table 6 shows, in descending order, the BN variables according to their relative contribution to high intention. Mutual information is the amount of information that each variable brings to the knowledge of high intention. Relative significance represents the ratio between the mutual information and its maximum value. The mean value is the variables' mean value while the Bayes Factor represents the impact of observing an intention above 3.57 on the other variables. The posterior probability of the variables (probability of the variable conditional to high intention) that represents the maximum Bayes Factor is highlighted in green, while the posterior probability of the variables that represent the minimum Bayes Factor is highlighted in red.

The results from Tables 4 and 6 indicate that attitude, self-efficacy, subjective norms, and opportunity feasibility are the four most influential variables in the model. These variables are followed by family and friends' support, country opportunity feasibility, and perceived risk, which account for a relatively important degree of influence, whereas obstacles and university opportunity feasibility are the variables with a lower influence on entrepreneurial intention (Figure 3).

**Figure 3: Direct effects on high intention (> 3.57)**
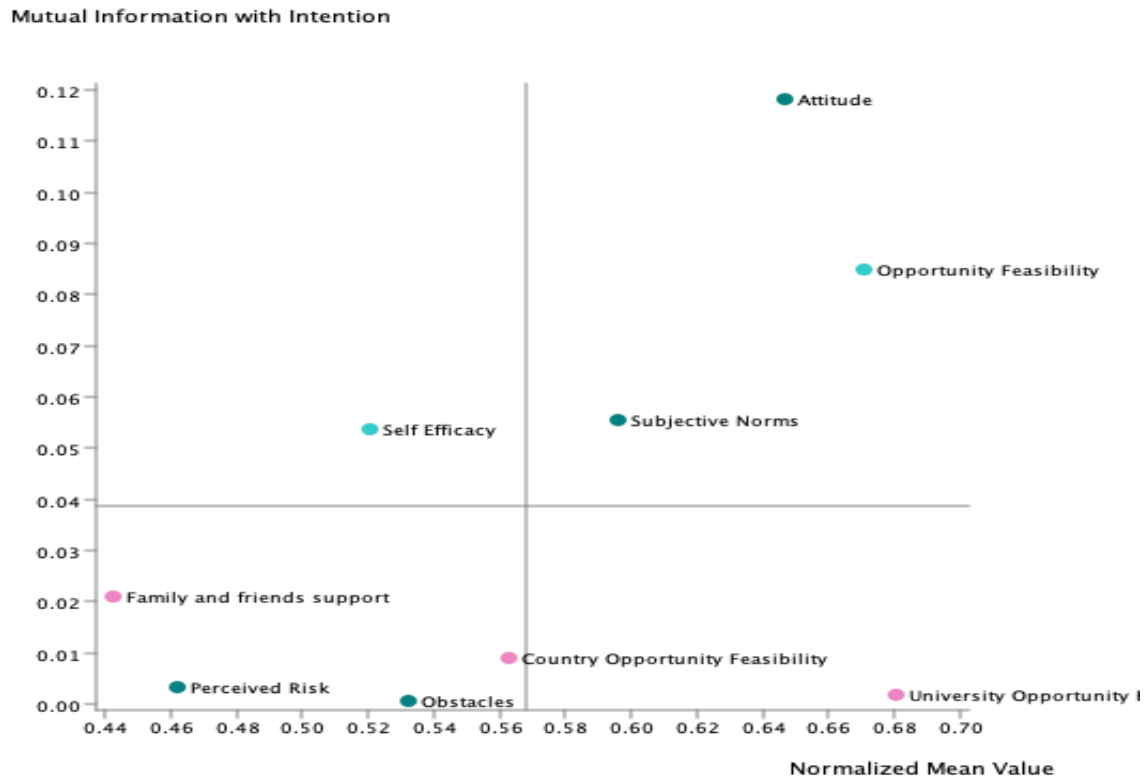
Based on the BN model, when the high level of the self-efficacy variable was set to 100 percent using a 'what if' analysis, the intentions target (above 3.57) increased from 23.56 percent to 39.86 percent, while intentions increased from 23.56 percent to 43.42 percent when the attitude variable was set to the highest level (above four). Furthermore, when the subjective norms variable was set to the highest level (above 4.14), attitudes increased sharply from 41.36 percent to 91.30 percent while intention increased from 23.56 percent to 40.53 percent. Therefore, the most probable explanation for intentions to be above 3.57 is as follows: attitudes above four, self-efficacy between 2.64 and 3.36, opportunity feasibility above 3.5, obstacles above 3.6, subjective norms above 4.14, perceived risk above 3.25, country opportunity feasibility above 4.2, and family and friends' support set to strongly agree. This means that high intention requires high degrees of attitudes, subjective norms, country opportunity feasibility, obstacles, perceived risk, and family and friends' support, and moderate degrees of self-efficacy.

We then use an optimization tool called a target dynamic profile based on a greedy search algorithm that generates an ordered list of priorities leading toward achieving the optimization goal, which maximizes the mean value of entrepreneurial intentions. Results are shown in Table 7 and Figure 4 below.

Table 7: Dynamic profile intention (above 3.57): Probability maximization

Node	Hypothesis (H)	Posterior Probability P(High Intention|H)	Marginal Likelihood P(H)	Likelihood P(H| High Intention)	Bayes Factor BF(High Intention,H)*
A priori		23.5552%	100.0000%		
Attitude	>4 (high)	43.4213%	41.3580%	76.2388%	1.8434
Self-efficacy	>3.36 (high)	64.7651%	12.1266%	33.3421%	2.7495
Opportunity feasibility	>3.5 (high)	84.7826%	4.6410%	16.7046%	3.5993

*BF(High Intention,H)=P(High Intention|H)/P(High Intention)

Figure 4: Dynamic profile for high intention (> 3.57)
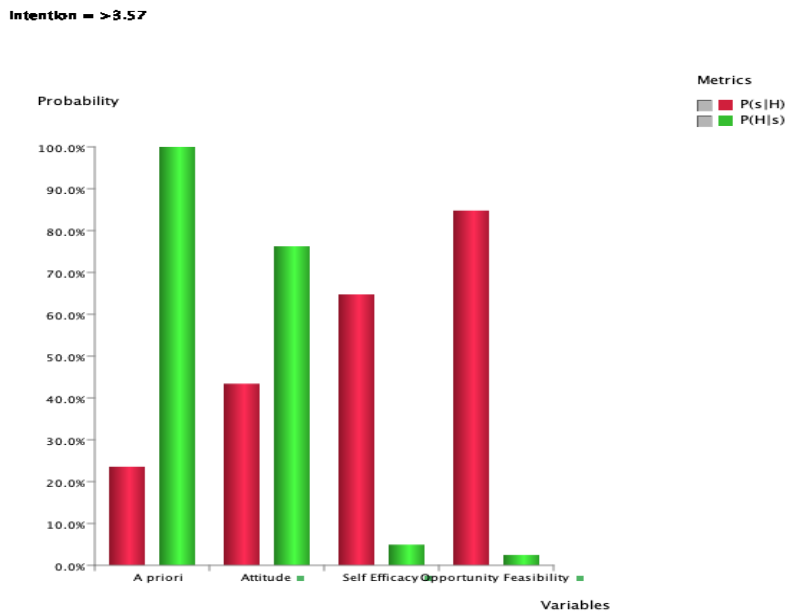
The target dynamic profile also allows us to see the mean value of the other nodes that are not directly connected to intention and therefore not directly included in the policy recommendation.

Table 8: Dynamic target profile: Effect on other nodes

Node	Prior Mean Value	Posterior Mean Value
Subjective norms	3.8349	4.0750
Family and friends' support	1.7716	1.6982
Country opportunity feasibility	3.8642	4.0114
University opportunity feasibility	3.5263	3.5866
Perceived risk	2.9699	2.9881
Obstacles	3.2559	3.2728

The prior mean value column indicates the expected values of the variables *prior* to the optimization, while the posterior mean value column reports the expected value of the variables *after* setting the evidence as per the policy recommendations. This information is useful for seeing the complete picture with regard to the optimum solution, including the nodes determined by the recommended policy, plus the other nodes. In our case and from Tables 7 and 8, high intentions can be achieved by high attitudes, high self-efficacy, high opportunity feasibility, and high subjective norms.

Discussion

The most important result of the study is that entrepreneurial intentions among Emirati youth, represented by the sampled group of Emirati students, are highly affected by attitudes toward entrepreneurship, self-efficacy, and opportunity feasibility. The latter is shown to affect intention directly in many other studies such as López et al. (2012) using BNs, but also in studies using traditional methods of hypothesis testing such as Shapero and Sokol (1982) and Krueger et al. (2000). Additionally, our results agree with the emphasis on the opportunity feasibility of entrepreneurship (McMullen and Shepherd, 2006). Furthermore, our results are in agreement with the theory of planned behavior (TPB), which claims that entrepreneurial intention is the product of attitudes toward entrepreneurship, subjective norms, and locus of control (Ajzen and Fishbein, 2005).

In our BN model, the subjective norms variable has a direct effect on attitudes and an indirect effect on intentions through attitudes as a mediator, which supports the findings of Shapero and Sokol (1982) and Sampedro et al. (2014). Knowing that subjective norms directly affect attitudes and indirectly affect intentions (with attitudes as a mediator) will help policymakers emphasize the factors that can improve someone's subjective and social norms. In our study, we do not assume any hypothesis to build the model, and this result, similar to Sampedro et al. (2014), is found directly by the BN model. This shows the strength of the BN framework and validates the theory.

One of the strengths of our study is the inclusion of self-efficacy and attitudes toward entrepreneurship in the intention model, and showing that both have direct effects on intention. This result is different from the conclusion of Ruiz-Ruano and Puga (2019), who find that attitudes have an influence on intentions, which is mediated by self-efficacy. However, it is important to note that the study by Ruiz-Ruano and Puga (2019) was done among an older group of university faculty compared to our sample of youth, which may explain the difference.

In our BN model, the attitudes variable has a direct relationship with intentions, a common result found in almost all traditional models, such as TPB. The direct relationship between self-efficacy and intentions was also proposed by different models such as McMullen and Shepherd (2006), Sampedro et al. (2014), Heuer and Lian (2013), and Schlaegel and Koening (2014). Furthermore, no direct relationship is found between country opportunity feasibility and entrepreneurial

intentions; rather, it is an indirect relationship mediated by attitudes. In López et al. (2012), however, resource feasibility is found to be a direct influencer of intentions. In addition, obstacles and perceived risk are connected in our BN model, a common result in traditional methods, but in López et al. (2012), obstacles and perceived risk are found to be independent. We believe that they should be connected since the multiple risks faced by entrepreneurs and other obstacles may be magnified by the same (or similar) factors.

The family and friends' support variable plays an important role in entrepreneurial intentions as indicated by our BN model. It directly affects subjective norms and indirectly affects attitudes and intentions, which is a similar result to that of López et al. (2012). The results of the study show that 48.5 percent of the students have one or both of their parents working as entrepreneurs; 21 percent stated that their mothers are entrepreneurs. Furthermore, 70.7 percent of the participants agreed or strongly agreed about the important role of family and friends in supporting entrepreneurs.

Furthermore, university opportunity feasibility is a direct answer to country opportunity feasibility, which is a strong indication of the role of governments in fostering entrepreneurship and therefore encouraging universities to do the same by strengthening their education programs and training. It is also worth mentioning that there has been a surge in the number of entrepreneurship education programs in most universities. The role of education in enhancing entrepreneurship attitudes and intentions and how entrepreneurship education programs can be effectively embedded into the university curricula should be examined in more detail to enhance our knowledge and propose specific programs that help build future entrepreneurs. Moreover, improving attitudes and self-efficacy can be achieved through education. The role of early school experience and its impact on intentions and attitudes toward entrepreneurship has already been shown in research (López et al., 2012). Furthermore, in the last edition of the Global GUESSS Report 2021 (Sieger et al., 2021), when authors looked at the influencing factors, they considered the university context. The average university entrepreneurial climate for the UAE was 4.7 on a scale of 1 to 7 (with a maximum of 5.8 and a minimum of 2.8). This is an indication that universities in the UAE should further improve their entrepreneurship programs and courses to create a better entrepreneurial spirit among students. The results of our study show that only 25.3 percent of the students have taken a specialized course in entrepreneurship, only 19.8 percent believe that their ability to prepare a business plan is above average, and only 12.7 percent believe that their knowledge of market research techniques is above average. Accordingly, universities should change their entrepreneurship courses in all majors to include important skills required to succeed as an entrepreneur.

Policy implications
Our study adds to the knowledge and understanding of entrepreneurial intentions and the attitudes of Emirati students using an innovative BN framework. It helps us not only find relationships

among the different factors related to entrepreneurship but also assess the effects of changes in these variables on intentions, a noted advantage of using a BN instead of the traditional methods of hypothesis testing. This study is useful and needed for the development of new hypotheses related to factors that affect entrepreneurial intentions and attitudes, which can be tested in a predictive context.

Our model was the best from a statistical point of view but also confirms theoretical aspects as indicated in the existing research. In addition, with the help of a BN framework, we are able to explicitly present the relationships between intentions, attitudes, and all other factors, and how intention changes with the change in those factors. These results can be used by professionals and academics while proposing entrepreneurship training and courses. It is important to include all aspects that improve self-efficacy and attitudes toward entrepreneurship. Universities – in collaboration with the industry – can have a leading role in improving opportunity feasibility. Higher education institutions must play a key role in developing entrepreneurial skills among their students through well-designed programs and tailored courses to address students' requirements on specific topics related to entrepreneurial activities. Universities should act as facilitators and follow a similar way of funding faculty research and provide students with or help them secure funds to start their projects and, of course, give back to the community and the country by hiring other students. We also strongly encourage researchers in this field to increase their efforts to investigate the factors affecting entrepreneurial intentions and think outside the box as non-traditional businesses are now the backbone of the economy.

The results can also be used by professionals as a tool for proposing new policies such as the need for country support and other means of improving attitudes, individual self-efficacy, and more opportunity feasibility. The BN model can be used to simulate the results of implementing such policies without the need to collect new data.

Self-efficacy has an impact on entrepreneurial intentions, which means that empowering youth with practical skills for preparing a business plan, running and financing a business, knowing the market research techniques and threats, having a good understanding of intellectual property and equity finance, and being alert to business opportunities and new ideas are of great importance to advance entrepreneurial intentions among Emirati youth. There are a variety of measures that help improve self-efficacy, such as continuously offering training and entrepreneurship courses by experts. Furthermore, the collaboration between universities and industry will increase students' exposure to business ideas and opportunities.

As subjective norms directly impact attitudes, which, in turn, impact intentions, policymakers should recognize and encourage entrepreneurs for their contributions to the national economy and for creating jobs for Emiratis. Local and federal authorities can help grow entrepreneurship

intentions among students by implementing incentives to help new and future entrepreneurs realize their expectations while contributing to employment and the economy.

Since family and friends' support has a positive impact on the subjective norms of Emirati youth, involving families and friends in programs designed for universities and other entrepreneurial youth hubs may help enhance youth attitudes toward entrepreneurship. The inclusion of families in strategies related to improving students' entrepreneurial intentions will have a strong positive impact on directing youth toward entrepreneurial activities.

Table 9

Stakeholder	Theme	Recommendation
Youth entrepreneurs	Opportunities and innovation	Focus on opportunities of starting new businesses and innovations.
Family and friends	Financial and moral support	Encourage and support youth to establish their own businesses rather than opt for government jobs.
University	Quality education	Improve the quality of entrepreneurship education and offer incubation facilities for new ideas.
Government	Infrastructure	Focus on improving small businesses' infrastructure and laws that support small businesses and venture capital.
Business community	Know-how support	As part of their social responsibility, the business community should offer technical support to new small businesses and sign business deals with them.
Banking sector	Financial support	The banking sector must make it easier for entrepreneurs to secure finance for their new businesses.

Conclusion

Our study adds to the knowledge and understanding of the entrepreneurial intentions and attitudes of Emirati students using an innovative BN framework. It helps us not only find relationships among the different factors related to entrepreneurship but also assess the effects of changes in these variables on intentions, a noted advantage of using a BN instead of the traditional methods of hypothesis testing. This study is useful and needed for the development of new hypotheses related to factors that affect entrepreneurial intentions and attitudes, which can be tested in a predictive context.

Our study may have some limitations due to the exclusion of other influential variables such as skills, motivations, and other relevant environmental, economic, and policy factors such as the impact of GDP growth rate in terms of expectations and labor mobility in the UAE. However, we focus on the main factors that may have direct effects on intentions according to theory and leave out the explorations of the effects of other factors (such as risk, innovation, and motivation) to future studies on the topic.

Furthermore, the family and friends' support variable we use is based on only one statement that measures moral support. In future studies, we will include economic factor decompositions

for family and friends' support, such as financing, bailing-out, risk-sharing, and advisory support. We also suggest looking at the role of training programs by comparing the effect on entrepreneurial intentions before and after training programs.

We also think it will be interesting to extend the BN analysis to include a BN pooling equilibrium in future work since out-of-equilibrium beliefs will include risk factors, which are critically important to entrepreneurship attitude. Also, we propose considering some variables as partially collective nodes, such as perceived risk, which includes individual risk aversion and collective country/sectoral risk.

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