



Bayesian network analysis for the dynamic prediction of early stage entrepreneurial activity index

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ABSTRACT

Entrepreneurship plays a critical role for the development and well-being of society. Illustration of its dynamic relationship with entrepreneurial attitudes and aspirations can provide a guideline for the cause of such activities. However, a time-lagged causal relationship among these concepts has not yet been established. In this study, we examine a dynamic relationship among early stage entrepreneurial attitudes, activities, and aspirations using Bayesian network (BN) analysis. In addition, we propose an early stage entrepreneurial activity index that can predict the percentage of both nascent entrepreneur and new business owner using the variables related to entrepreneurial attitudes of the previous year. This index, in turn, can be used to predict various aspects of entrepreneurial aspiration of the following year. The proposed index turns out to have very high prediction accuracy and is expected to provide effective policies to boost future entrepreneurial activity and aspiration.

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1. Introduction

The Global Entrepreneurship Monitor (GEM) project is “an annual assessment of the entrepreneurial activity, aspirations and attitudes of individuals across a wide range of countries (Bosma, Wennekers, & Amoros, 2011)”. The GEM focuses on three main objectives: “(1) to measure differences in entrepreneurial attitudes, activity and aspirations among economies, (2) to uncover factors determining the nature and level of national entrepreneurial activity, and (3) to identify policy implications for enhancing entrepreneurship in an economy (Bosma et al., 2011).”

To identify the flow of entrepreneurial activities related to national economic growth from a society, culture, and politics, the GEM study constructed a conceptual framework of the original GEM model (Bygrave, Hay, Ng, & Reynolds, 2003). GEM considers that national economic growth is the result of such set of entrepreneurship activities. The initial GEM model was to develop to integrate advances in understanding the entrepreneurial process and to allow for further exploration of patterns detection (Herrington, Kew, & Kew, 2010). On the other hand, recently a GEM model was reworked based on the combination of three main components: entrepreneurial attitudes, entrepreneurial activity, and entrepreneurial aspirations (Bosma et al., 2011). According to Hesses, van Gelderen, and Thurik (2008), entrepreneurial motivations of perceived opportunity for entrepreneurship have relevance to entrepreneurial aspirations. In addition, if an individual exhibits

positive attitudes toward entrepreneurship, the tendency to be a potential entrepreneur or get involved in entrepreneurial activity will increase (Krueger, 2007; Krueger & Brazeal, 1994).

Entrepreneurial attitudes, entrepreneurial activity, and entrepreneurial aspirations are latent variables and are comprised of many observable variables. However, none of the existing studies consider the dynamic causal relationship among the observable variables of entrepreneurial attitudes, activity, and aspirations, although Sohn and Ju (submitted for publication) attempted to model the relationship among these three factors. In addition, no research was conducted to reflect potential time-lagged causal relationship among them. If such a relationship is identified, it can be utilized to predict the degree of future entrepreneurial activity levels of various nations and corresponding entrepreneurial policies can be set to take necessary actions to vitalize entrepreneurial activities.

The main purpose of this study is to identify a dynamic causal relationship among measurement variables of entrepreneurial attitudes, early stage entrepreneurial activity, and aspirations at a national level. We utilize a Bayesian network (BN) to identify such a relationship. The BN is a powerful formalism for representing the joint probability distribution of a set of related variables. It can represent an area of knowledge and uncertainties of related variables, enabling reasoning with uncertainties.

Moreover, we propose an index for early stage entrepreneurial activity that can be used to predict the level of future early stage entrepreneurial activity reflecting causal relationships found through BN. We compare this index to the Total early-stage Entrepreneurial Activity (TEA) index (Bosma, Acs, Eutio, Coduras,

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& Levie, 2009). The TEA index is a composite measure of the current year's degree of early stage entrepreneurial activity representing the percentage of both nascent entrepreneur and new business owner and therefore cannot be used for prediction.

We expect that our findings will contribute to the understanding of the dynamic relationship among national entrepreneurial attitude, activity, and aspirations. This can be used as feedback information to boost entrepreneurship.

This paper is organized as follows. In Section 2, we review the existing literature of GEM. In Section 3, we introduce a proposed BN as well as the data used in this study. In Section 4, we discuss the results of our analysis. Finally, we conclude our study and suggest areas for future research in Section 5.

2. Literature review and research hypotheses

GEM employs a comprehensive socio-economic approach and takes into account the degree of involvement in entrepreneurial activity within a country, illustrating different types and phases of entrepreneurship. Especially, the approach and the focus on the individual as an entrepreneur differentiate GEM measures from other data sets that measure new business registrations. GEM project uses several measurement variables for three factors (attitudes, activity and aspirations), respectively, as described in Table 1 (Bosma et al., 2011).

There have been many studies of GEM. Acs and Szerb (2009) developed the global entrepreneurship index that combined entrepreneurial attitudes, activity, and aspirations with relevant measures of the favorability of the environment for entrepreneurship. In this paper, the authors found that proposed index is strongly correlated with economic development, and so it can be used to highlight both strong and weak aspects of entrepreneurship in a nation.

Moreover, many previous studies investigated the relationship among entrepreneurial attitudes, activity, and aspirations as follows. Schwarz, Wdowiak, Almer-Jarz, and Breitnecker (2009) investigated influential factors for entrepreneurial activity, and found that attitudes toward entrepreneurship (e.g. entrepreneurial intention and perceived capabilities) positively affect interest in business foundation and business ownership. Moreover, they also found that entrepreneurial attitudes are positively related to entrepreneurial activity (Schwarz et al., 2009). Giannetti and Simonov (2009) showed that social and cultural activities can have positive impact on individual decision to become an entrepreneur. Moreover, Comeche and Loras (2010) proposed “the variables of attitude that, from the point of view of collaborators (team members) and of the style of management adopted by businessmen (leaders) determine the right conditions for confirming the possibility of the existence of entrepreneurship in the firm”.

Additionally, Estrin, Korosteleva, and Mickiewicz (2009) stated that the determinants of entrepreneurial activity growth positively related to high-growth aspirations of productivity. Troilo (2011) showed that increasing entrepreneurial activities can lead to the expectation of high job growth and market expansion. According to Pete et al. (2011), entrepreneurial aspirations which are defined by GEM reports reflect the qualitative characteristic of entrepreneurial activity, and entrepreneurial aspirations can significantly affect the economic impact of entrepreneurial activities. In this paper, the author proposed logistic regression model to find significant factors among entrepreneurial attitude variables and economic variables that are affected by entrepreneurial aspirations. Farmer, Yao, and Kung-Mcintyre (2011) found that entrepreneurial activity is affected by individual perceptions and entrepreneurial aspirations.

Bosma et al. (2009) indicated that “positive attitudes towards entrepreneurship may increase entrepreneurial aspirations, which in turn positively affect attitudes as more positive role models appear”. Positive aspirations may change the attitudes. Autio and Pathak (2010) found that individual's experience, perception, personal awareness, and fear of failure are related to individual's entrepreneurial growth aspirations.

According to Bosma (2012), understanding of the relationship between entrepreneurial attitudes, activity, and aspirations can lead to economic growth; therefore, it is important to develop a conceptual model with respect to entrepreneurial attitudes, activity, and aspirations. No study in this area has been empirically investigated such relationship. Moreover, a potential time-lagged relationship among the measurement variables of these three factors has not been studied. It can take time for one attribute to affect others. Based on this reasoning, Hypotheses 1 and 2 were established to reflect the time-lagged relationship among the measurement variables of entrepreneurial activity, attitudes, and aspirations.

Hypothesis 1. Entrepreneurial attitudes of the previous year will have a positive effect on entrepreneurial activity in the current year, which will have a positive effect on entrepreneurial aspirations in the following year.

$$(A: \text{Attitudes}(t_{-1}) \rightarrow B: \text{Activity}(t) \rightarrow C: \text{Aspirations}(t_{+1}))$$

Hypothesis 2. Entrepreneurial attitudes of the previous year will have a positive effect on entrepreneurial aspiration in the current year, which will have a positive effect on entrepreneurial activity in the following year, and will subsequently have a positive effect on entrepreneurial attitudes in the next year.

$$(A: \text{Attitudes}(t_{-1}) \rightarrow C: \text{Aspirations}(t) \rightarrow B: \text{Activity}(t_{+1}))$$

Bayesian network analysis was used to test these hypotheses.

Table 1
Variables observed by GEM project.

Category	Measurement variable	Variable name
Entrepreneurial attitudes	Perceived opportunities	Attitude1 for 200x
	Perceived capabilities	Attitude2 for 200x
	Entrepreneurial intention	Attitude3 for 200x
	Entrepreneurship as desirable career choice	Attitude4 for 200x
	Media attention for entrepreneurship	Attitude5 for 200x
	Potential entrepreneurial activity rate	Attitude6 for 200x
Entrepreneurial activity	Nascent entrepreneurship rate	Activity1 for 200x
	New business ownership rate	Activity2 for 200x
Entrepreneurial aspirations	High-growth expectation early-stage entrepreneurial activity (HEA)	Aspiration1 for 200x
	New product-market oriented early-stage entrepreneurial activity	Aspiration2 for 200x
	International-oriented early-stage entrepreneurial activity	Aspiration3 for 200x

*In the variable name, the 200x represents the year of the dataset. For instance, variable name of *Perceived opportunities* for the 2007 dataset is “Attitude1 for 2007.”

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