A System Dynamic Approach to Modelling the Endogenous and Exogenous Determinants of the Entrepreneurship Process

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Abstract. The importance of entrepreneurship for economic development and overall social well-being is widely recognised by researchers, experts, and policy makers. Researchers have identified a variety of endogenous and exogenous determinants, such as individual-level factors, external macro-level factors, and country-level cultural factors, which can moderate the raise in entrepreneurial activity. From the other side, there is a feedback loop between entrepreneurship affecting economic growth and being, in turn, affected by country wealth. The main objective of this study is to build a model to capture the relationship between entrepreneurship and external macro-level determinants, and to explore the possible effects of changes in entrepreneurship supply-and-demand factors. The research applies system dynamics simulation and proposes a dynamic macro-level model of entrepreneurship. The model equations are developed based on regression analysis. The results show that although entrepreneurship does have a positive impact on the economy, this effect can be mitigated by other factors. Furthermore, even though an improvement in the external determinants level results in increased entrepreneurship activity and consequent economic growth over a longer period, the effect may depend on factors such as overall country population development, and especially the proportion of adult populations, institutional factors, and individual intentions towards entrepreneurship.

Keywords. Entrepreneurship, External factors, Economic growth, System dynamics.

1 Introduction

The importance of entrepreneurship for economic development and overall social well-being is widely recognised by researchers, experts, and policy-makers (Bosma et al. 2012; Cumming et al., 2014; Fritsch, 2013; Gilbert et al., 2004, and others). Entrepreneurial ventures are not only remarkable sources of new workplaces (Morrison et al., 2003; White and Reynolds, 1996), but also powerful generators for innovations (Acs and Varga, 2005).

An increase in entrepreneurial activity can be affected by individual-level factors (van Gelderen et al., 2006; Ferreira et al., 2012; Rauch and Frese, 2007), external macro-level factors (Casero et al., 2013; Stenholm et al., 2013), and country-level cultural factors (Petrakis, 2014; Sambharya and Musteen, 2014; Thai and Turkina, 2014).

An important outcome of entrepreneurship research is the recognition of the feedback loop between entrepreneurship rates and the national economy, when entrepreneurship affecting economic growth is in turn affected by national wealth (Petrakis, 2014; Shane 2003; Wennekers et al., 2005). However, this interconnection of entrepreneurship, internal (entrepreneurial intention), and external (institutional) factors (e.g. national wealth level and economic growth) remains understudied and is not explained by traditional cognitive analysis. The paper contributes to this research gap.

The eclectic theory of entrepreneurship presented by Verheul et al. (2002) provides a comprehensive framework in which external macro-level determinants, forming supply and demand for entrepreneurship, eventually affect the decision process of individuals. Discrepancies between supply and demand may lead to a non-optimal level of entrepreneurship. Hence, it is unclear to what extent the system can self-adjust and recover after a sudden external impact, and whether governmental interventions (e.g. through policy changes) can facilitate this process.

The main objective of this study is to build a model to capture the relationship between entrepreneurship and external macro-level determinants, and to explore the possible effects of changes in entrepreneurship supply-and-demand factors.

The research implements a system dynamics (SD) approach. The system dynamics simulation has proved its usefulness in military, logistics, management, and organisational studies (see, for examples and overview, e.g. Gary et al., 2008; Harrison et al., 2007; Kortelainen et al., 2010; Sterman, 2000). In entrepreneurial studies, system dynamics modelling has been used for analysing the decision-making process (Kefan et al., 2011) and studying the influence of fairness perceptions on the cooperation between new ventures and universities (van Burg and van Oorschot, 2013). However, the evidence for system dynamics model adoption in the entrepreneurship literature is still scarce (Zali et al., 2014).

We aim to contribute to the ongoing academic discussion by proposing a *dynamic macro-level model of entrepreneurship*. The model is based on the eclectic theory of entrepreneurship and takes into account the variety of external factors derived from the literature. We also aim to understand the relationship between entrepreneurship and economic growth. The developed model provides insights for the estimation of the possible policy impact on such a relationship.

However, as with any other model, our model is a trade-off between accuracy and complexity. Therefore, at this stage, we do not aim for exact predictions (which would require a much more detailed country-specific data analysis than is possible from open databases), but rather aim to estimate the general system behaviour under specified conditions and with stated assumptions.

The rest of the paper is structured as follow: the second part discusses the existing literature on the topic, the third part describes the system dynamics model, the fourth part contains the scenarios developed to test the research propositions, results, and discussion, whereas the fifth part summarises the results of the study.

In this study, we focus on two streams in entrepreneurial literature. The first examines the actual impact of entrepreneurship on a country's economy, whereas the second examines factors affecting entrepreneurial activity.

2 Literature review

Entrepreneurship theory can be traced back to the 18th century, when the concept of the entrepreneur was introduced by Cantillon. In a broad sense, entrepreneurship is a "process of starting and continuing to expand business" (Hart, 2003). In theory, a potential entrepreneur has possibilities to explore the opportunity without establishing a new firm (Shane and Venkataraman, 2000). On the other hand, venture creation is traditionally considered an essential outcome of the entrepreneurial process (Bygrave and Hofer, 1991; Gartner et al., 2010; Shook et al., 2003).

2.1 Entrepreneurial impact on the economy

Although entrepreneurship is often considered as a desirable phenomenon, van Stel et al. (2005) found that its positive impact on the economy, particularly on GDP growth rates, can be observed only for relatively high-income countries. Furthermore, the entrepreneur population is not homogenous and, consequently, different types of entrepreneurs may have different effects on economic growth. Following the classification developed in Global Entrepreneurship Monitor (GEM) studies, researchers often distinguish between 1) improvement and opportunity-driven, and 2) necessity-driven entrepreneurs. For the first group, the decision to become self-employed is voluntary and justified often not only by monetary reasons. However, for necessity-driven entrepreneurs, self-employment is the only option to achieve an income, as a so-called "last resort" (GEM, 2014). Sometimes a high-expectation group is also defined (GEM provides such data). In contrast to opportunity-driven entrepreneurs, who still may be just lifestyle entrepreneurs without high-growth aspirations (Freel and Robson, 2004), people belonging to the high-expectation group demonstrate a strong desire to expand their business and achieve significant growth rates (Bowen and De Clerq, 2008).

Applying a modified form of the Cobb-Douglas production function, Wong et al. (2005) found that only high-growth potential entrepreneurship has a significant impact on economic growth. Valliere and Peterson (2009), using a rich set of control variables attributed to three economic growth theories, emphasised that such a positive effect of high-expectation entrepreneurship emerges only in developed economies. Therefore, the research results reveal that the positive impact of entrepreneurship on economic development depends on the prevalence of high-expectation entrepreneurs and on the country's stage of economic development (van Stel et al., 2005; Valliere and Peterson, 2009.

2.2 Determinants of entrepreneurship

The variety of studies on entrepreneurship determinants varies by the level of analysis: macro, meso, and micro (Verheul et al., 2002). On a macro level, researchers focus on contextual country or regional characteristics, such as institutional, regulatory, and cultural variables (Bowen and De Clerq, 2008; Carree et al., 2002; Linan and Fernandez-Serrano, 2014; Thai and Turkina, 2014). Meso-level analysis covers specific industry and market settings (Carree and Thurik, 2000; Klepper, 2002). On the micro level of analysis, the main determinants of entrepreneurial activity are individual characteristics such as social capital and psychological profile (Ferreira, 2012; Rauch and Frese, 2007; Van Gelderen et al., 2006).

Even though some scholars tend to focus on individual-level analysis (e.g. Gartner et al., 2010), the importance of external context is also well recognised (Bowen and Clerq, 2008; Sambharya and Musteen, 2014; Urbano and Alvarez, 2014). The commonly applied institutional theory (Busenitz et al., 2000; Bruton et al., 2010) studies three dimensions, shaping the entrepreneurial activity in the country: regulatory, cognitive, and normative dimensions. Regulatory dimensions capture laws and policies imposed by the national government. Cognitive dimensions represent the perceptions about knowledge possessed by prospective entrepreneurs. The normative dimension addresses the informal norms and cultural beliefs adopted in the country.

However, the eclectic theory of entrepreneurship (Verheul et al., 2002) offers an extended framework that aims to combine the contextual factors with individual characteristics. The rate of entrepreneurship (i.e. the percentage of the population involved in entrepreneurial activities) depends on supply-and-demand factors influencing the individual decision-making process. The demand factors consist of variables representing economic and technical development level and determine the pool of opportunities available. The supply factors (particularly population characteristics, demographic dynamics, level of income, education level) determine the number of individuals considering an entrepreneurial career (potential entrepreneurs). By altering the external context through regulation policy, the government can attempt to regulate the rates of entrepreneurship (lines G in Figure 1).

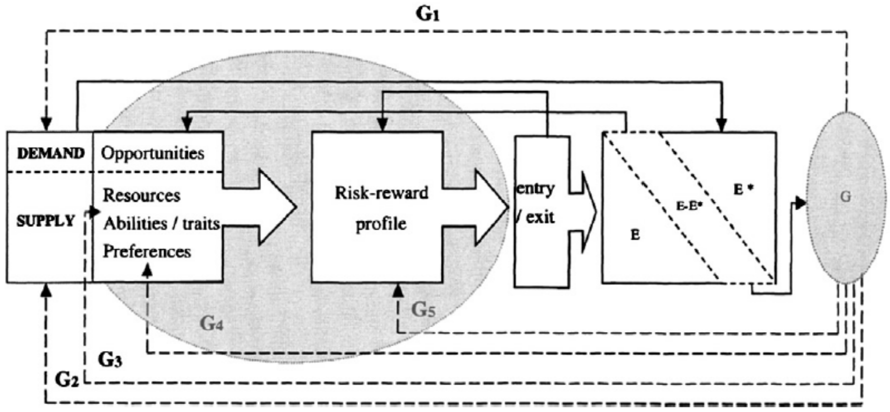

Fig. 1. Framework of determinants of entrepreneurship (adopted from Verheul et al., 2002)

Drawing on this theory, Wennekers et al. (2005) demonstrated the U-shaped relationship between entrepreneurial activity and national wealth. Casero et al. (2013) later extended these results. Comparing the discovered U-shape curve with the level of institutional development, they proposed that in factor-driven economies, improvement of institutional conditions leads to growth in regular employment, thus decreasing the entrepreneurship rates (reverse relationship). At the same time, in innovation-driven economies, a direct relationship between the institutional environment and entrepreneurship can be observed. In such economies, entrepreneurship is considered as self-realisation rather than as a "last resort" in the absence of employment. The transition economies lie somewhere between these two trends, forming the middle part of the graph (Casero et al. 2013).

Therefore, we start building our propositions on the existence of bilateral relationships between entrepreneurship activity and economic growth (Linan and Fernandez-Serrano, 2014; Shane, 2003; Valliere and Peterson, 2009; Wong et al., 2005). Furthermore, these relationships depend on the national level of economic development and contextual factors, including both institutional and cultural dimensions (Casero et al., 2013; Linan and Fernandez-Serrano, 2014; Stenholm et al., 2013; Wennekers et al., 2005). Thus, changes in contextual factors may affect entrepreneurship rates and consequently have an impact on the GDP growth (Acs and Varga, 2005; van Stel et al., 2005; Verheul et al., 2002). On the other hand, sudden changes in GDP growth rates due to external factors (e.g. an economic crisis) may affect the rates of entrepreneurship (Shane, 2003).

With our model, we aim to test several propositions:

(1) The entrepreneurial system is self-adjusting and will recover after an external shock has affected supply/demand factors.

(2) Governmental interventions can mitigate the negative effect of an external shock on the system.

(3) In the long run, entrepreneurship is affected by national trends such as population dynamics.

3 The system dynamics model

System dynamics methodology has been developing since the 1960s (Forrester, 1989) and has been proved to be a powerful tool for studying complex systems. The prerequisite of system dynamics-system thinking is an approach assuming pervasive interconnections between parts of the system. System dynamics deals with dynamic complexity, where the non-linear system behaviour results from the constellation of feedback loops, rather than with detailed complexity, which occurs due to the multiplicity of possible alternatives (Sterman, 2000).

In developing our model, we used the stages recommended for the system dynamics modelling process by Dooley (2002) and Sterman (2000). First, based on the existing literature, we develop a conceptual design and propose theoretical causal relationships to be tested. Second, we elaborate on the actual model equations. For that, we obtain the data (our model is based on the secondary data from the Global Entrepreneurship Monitor (GEM), Global Competitiveness Index (GCI), and World Bank databases). Then we perform a statistical analysis of the proposed causal relationships and create the model equations. The third step is to validate the results against the real data. After the model is validated and all the necessary corrections are introduced, we can shift to the fourth step, which consists of running experimental scenarios, result analysis, and interpretation.

3.1 The causal model

In this study, we combine the eclectic theory of entrepreneurship explaining the entrepreneurial rates through supply-and-demand factors (Verheul et al., 2002) with the approach applied by Wong et al. (2005) and Valliere and Peterson (2009), in which entrepreneurial activity is one of the factors explaining the rate of GDP growth. Wong et al. (2005) derived a modification of the Cobb-Douglas production function, where economic growth is explained through the stock of physical capital, labour, and disembodied factor productivity.

In our model, capital is measured as GDP per capita, and labour is measured as the country's population. The productivity factor consists of the entrepreneurship activity prevalence (we consider the total activity rate, as well as opportunity and necessity; see Table 1 for details) and the innovation level (indicator from the Global Competitiveness Index). The equation is therefore:

$$GDP_{growth} = \alpha_0 + \alpha_1 GDP_{per\ capita} + \alpha_2 GDP_{growth\ lag} + \alpha_3 POP + \alpha_4 TEA + \alpha_5 NEA + \alpha_6 OEA + \alpha_7 INN \quad (1)$$

where:

GDP_{growth} – annual GDP growth rate;
$GDP_{per\ capita}$ – GDP per capita (PPP);
$GDP_{growth\ lag}$ – GDP growth rate for the previous year;
POP – country population;
TEA – total entrepreneurship activity rate;
NEA – necessity-driven entrepreneur share;
OEA – opportunity- and improvement-driven entrepreneur share;
INN – index for country innovation capability.

The next step is to define the factors affecting entrepreneurship rates. The eclectic theory identifies objective demand and supply factors that affect the individual decision-making process. Shane and Venkataraman (2000) also propose two essential components for entrepreneurship: opportunities and individuals willing to explore them. Consequently, we define the demand as the factors determining opportunities, which arise from economic and technical development: economic growth (rates of GDP growth), potential market size (overall population), and national technological and innovation level. Supply, on the other hand, is defined by population characteristics such as proportion of adult population, unemployment rates, average wealth (GDP per capita), education quality, and cultural characteristics. Following Morris et al. (1994) and Shambharya and Musteen (2014), we define three main country-level cultural characteristics affecting entrepreneurship: power distance, uncertainty avoidance, and collectivism. These dimensions were originally introduced by Hofstede (1984, 2001) and have been applied in numerous studies on entrepreneurship as determinants of cultural environment (Bruton et al., 2010). Consequently, the entrepreneurial intentions are modelled as follows:

$$EIN = \alpha_0 + \alpha_1 POP_{adult} + \alpha_2 UNP + \alpha_3 GDP_{per\ capita} + \alpha_4 PDA + \alpha_5 IND + \alpha_6 UA + \alpha_7 POP + \alpha_8 GDP_{growth\ lag} + \alpha_9 TEC + \alpha_{10} INN + \alpha_{11} EDU \quad (2)$$

where:

EIN – entrepreneurial intentions;

POP_{adult} – share of adult population;
UNP – unemployment rate;
$GDP_{per\ capita}$ – GDP per capita (PPP);
PDA – power distance dimension;
IND – individualism dimension;
UA – uncertainty avoidance dimension;
POP – country population;
GDPgrowth lag – GDP growth rate for the previous year;
TEC – technological readiness;
INN – innovation;
EDU – higher education and training.

However, not all individuals who consider entrepreneurship to be a viable career option eventually become entrepreneurs. Factors such as taxes, labour market regulations, bureaucracy, and the actual venture registration process (the number of steps a potential entrepreneur should accomplish in order to get official status) can influence the rate of start-up emergence (Acs et al., 2008; Choo and Wong, 2006). In addition, unfavourable institutional conditions may increase the time needed for the process of venture creation (Klapper et al., 2006; Misra et al., 2012). That, in turn, may affect the actual number of new firms created, because some people may give up during the process or the opportunity may just expire (Levie and Autio, 2008). Consequently, we propose that the institutional regulatory dimension (overall institution quality, as well as market regulations) alters the transition from entrepreneurial intention to actual activity. In addition to the direct effect, we also examine possible moderation, so the equation is therefore:

$$TEA\ (NEA, OEA)\ = \alpha_0 + \alpha_1 EIN + \alpha_2 LMK + \alpha_3 GMK + \alpha_4 FIN + \alpha_5 INS + \alpha_6 LMK * EIN + \alpha_7 GMK * EIN + \alpha_8 FIN * EIN + \alpha_9 INS * EIN \quad (3)$$

where

TEA (NEA, OEA - we propose separate equations for each activity index) total, necessity, and opportunity entrepreneurship rates;
EIN – entrepreneurial intentions;
LMK – labour market efficiency;
GMK – goods market efficiency;
FIN – financial market development;
INS – institutions (quality)

Figure 2 presents a conceptual causal model diagram. To simplify the visual representation and readability, we did not include proposed causal linkages to variables OEA and NEA. At this stage of model development, we consider them equal to the TEA causal linkages. The main feature of the model is inclusion of the complex feedback loop between entrepreneurial activities (TEA, OEA, and NEA) and national economic growth (GDP growth). In theory, that should lead to the establishment of some optimal level of entrepreneurship (when the supply of potential entrepreneurs is aligned with the pool of opportunities); however, that level is also affected by other external factors, which may lead to deviations from the equilibrium state of the model.

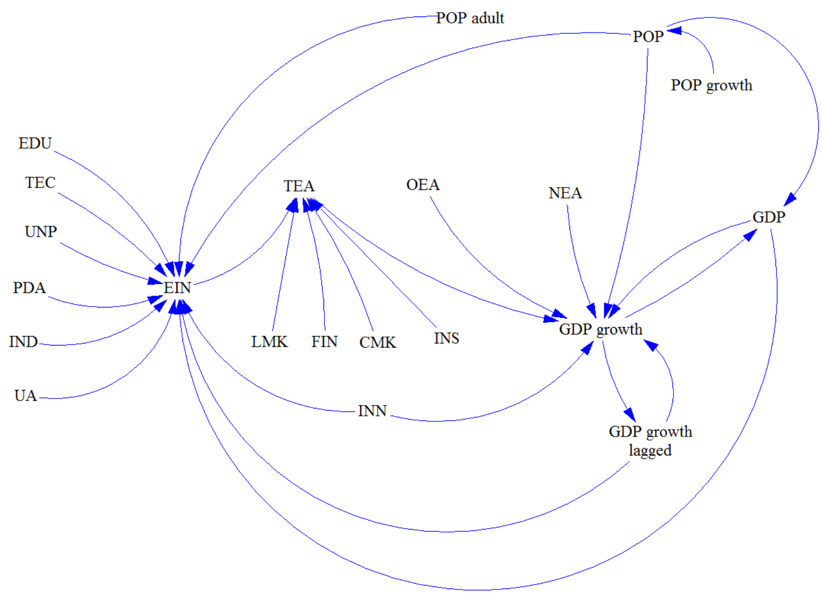

Fig. 2. Conceptual causal diagram

3.2 Data and variables

In our model, we used secondary data gathered from three main sources: the Global Entrepreneurship Monitor, Global Competitiveness Report, and World Bank Database. In order to assess the country-level cultural dimensions, we used Hofstede indicators (http://geert-hofstede.com/countries.html). The overview of the variables is provided in Table 1.

Table 1. Variables

Variable	Definition	Source
GDP growth	Annual GDP growth rate (%)	World Bank
GDP growth lagged	Annual GDP growth rate for previous year (%)	World Bank
GDP	GDP per capita, PPP (current USD)	World Bank
POP	Total country population (people)	World Bank
POP growth	Annual population growth rate (%)	World Bank
POP adult	Share of the national adult population (% to the overall country population)	World Bank
UNP	Unemployment rate (% total labour force)	World Bank
TEA	Total early-stage entrepreneurial activity (% to 18-64 population)	GEM
OEA	Improvement-driven opportunity entrepreneurial activity (% to TEA)	GEM
NEA	Necessity-driven entrepreneurial activity (% to TEA)	GEM
EIN	Entrepreneurial intentions (intent to start a business within 3 years) (% to 18-64 population, people involved in TEA excluded)	GEM

INN	Innovation (combined index, score 1-7)*	GCI
TEC	Technological readiness (combined index, score 1-7)*	GCI
LMK	Labour market efficiency (combined index, score 1-7)*	GCI
GMK	Goods market efficiency (combined index, score 1-7)*	GCI
FIN	Financial market development (combined index, score 1-7)*	GCI
INS	Institutions (combined index, score 1-7)*	GCI
EDU	Higher education and training (combined index, score 1-7)*	GCI
PDA	Power distance (non-dimensional relative scores)	The Hofstede Centre
IND	Individualism (non-dimensional relative scores)	The Hofstede Centre
UA	Uncertainty avoidance (non-dimensional relative scores)	The Hofstede Centre

**In GCI indexes, a value of 7 represents the highest possible score and 1 the lowest. The scale is continuous.*

Aiming to increase model applicability in different countries, we based our regressions on international datasets rather than on country-specific longitudinal data. An additional reason for that decision was the lack of historical data for certain variables. Thus, the latest time point available for the indicators from GCI is 2008 (in earlier reports, some indicators were not included). Therefore, for the development of model equations, we applied the data from 2013, which in our case was the latest year without a significant amount of missing data.

3.3 Model equations development

In order to develop actual model equations, we used the theoretical causal propositions developed in Chapter 3.1. We tested them on our dataset, consisting of 66 countries. As mentioned before, the relationship between entrepreneurship and economic growth may significantly differ between countries at various development stages (van Stel et al., 2005). In a similar way, the institutional effect may vary (Valliere and Peterson, 2009). To account for that effect, we divide our sample into three groups according to the classification of economies provided in the Global Competitiveness Report (WEF, 2012). GEM applies a similar classification. Stage 1 is factor-driven economies; Stage 2 is efficiency-driven, and Stage 3 is innovation-driven.

In our sample, Stage 1 is represented by the following countries: Algeria, Angola, Botswana, Ghana, India, Iran, Malawi, Nigeria, the Philippines, Uganda, Vietnam, and Zambia.

Stage 2 includes Argentina, Barbados, Bosnia and Herzegovina, Brazil, Chile, China, Colombia, Croatia, Ecuador, Estonia, Guatemala, Hungary, Indonesia, Jamaica, Latvia, Lithuania, Macedonia, Malaysia, Mexico, Namibia, Panama, Peru, Poland, Romania, Russia, South Africa, Surinam, Thailand, Turkey, and Uruguay.

Stage 3 countries are Belgium, Canada, the Czech Republic, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Puerto Rico, Singapore, Slovenia, Spain, Sweden, Switzerland, Trinidad & Tobago, the United

Kingdom, and the United States.

The sample sizes for each stage are consequently as follows: Stage 1: n=12; Stage 2: n=30; Stage 3: n=24.

We added the variables GDP and POP to the equation in logarithmic form. The descriptive statistics and correlations are presented in the appendix. To examine the proposed relationships, we used stepwise linear regressions. This enables us to create the equations consisting only of significant variables, which we can then input into the model.

Unfortunately, due to the small number of valid observations, we had to exclude the Stage 1 countries from the analysis. We also excluded Stage 2 countries from the analysis, due to the low explanatory power of the model and consequently the lack of a strong relationship between the rate of entrepreneurship and the growth of GDP. Therefore, we were not able to build a meaningful equation 1 for this group, which made creation of the model impossible for these groups of countries. These results correlate with van Stel et al. (2005), who also noticed the lack of a significant relationship between entrepreneurial activity and economic growth for developing economies.

Surprisingly, we also did not find a significant effect on GDP growth for Stage 3 countries, neither from total early stage entrepreneurial activities (TEA), nor from necessity or opportunity or improvement entrepreneurship. We tested the model with data for different years (2009-2012) and found the significant ($p<0.01$) coefficient for TEA for 2010 but not for other years. On the other hand, model with the data for 2012 has significant coefficients for NEA and OEA ($p<0.05$). Such inconsistency in the results can be explained by the small size of the sample, which limits the reliability of regression analysis. Unfortunately, the available data does not allow analysis on the larger sample.

Taking into account these issues, we slightly increased the significance level ($p<0.2$) in order to be able to build the model. After that, we included the TEA variable in the equation (1). Other entrepreneurship activity indicators are insignificant even at this liberal level (for 2013 data). Therefore, after the estimation of equation 1, we continued our analysis only for Stage 3 countries.

To test possible moderation effects in model 3 (see equation 3), we first estimated the model without interaction terms. Among institutional-level determinants (LMK, GMK, FIN, INS) only labour market efficiency appeared to have a significant effect on total entrepreneurial activities (TEA). Therefore, for the following regression, we entered only one interaction term (LMK*EIN). However, the estimation revealed the insufficient significance of this additional predictor; therefore, it was not included in the final equation.

The following table (Table 2) provides the stepwise regression results for all four models described in part 3.1. For the first model, we also provide the estimation results for Stage 2 countries; however, we do not consider them in the further models.

Table 2. Regression results

	Model 1, Stage 2	Model 1, Stage 3	Model 2	Model 3
GDP growth	dependent	dependent	na	na
GDP growth lagged	1.183	0.639	x	na
GDP	x	x	-15.639	na
POP	x	x	-4.533	na
POP adult	na	na	0.646	na
UNP	na	na	x	na
TEA	-0.092 (Sig. 0.2703)	0.053 (Sig. 0.1875)	na	dependent
OEA	x	x	na	na
NEA	0.137	x	na	na
EIN	na	na	dependent	0.533
INN	x	x	9.171	na
TEC	na	na	x	na
LMK	na	na	na	2.103
EDU	na	na	-17.924	
GMK	na	na	na	x
FIN	na	na	na	x
INS	na	na	na	x
PDA	na	na	x	na
IND	na	na	x	na
UA	na	na	x	na
LMK*EIN	na	na	na	x
GMK*EIN*	na	na	na	na
FIN*EIN*	na	na	na	na
INS*EIN*	na	na	na	na
F	7.98	76.39	22.83	28.76
Adjusted R^2	0.428	0.867	0.865	0.735
Durbin-Watson	1.535	2.180	2.771	1.682
Pr>ChiSq	0.886	0.492	0.469	0.458

Dependent variables: Model 1: GDP growth; Model 2: EIN; Model 3: TEA.
The table contains unstandardized coefficients
All independent variables (except when separately mentioned) are significant at 5%
All models are significant at 1%
x – the variable was excluded from the final model
NA – the variable was not included in the model estimation
** were not included in the model (see the explanation above)*

The accomplished statistical analysis resulted in the correction of the theoretical causal diagram, as some variables appeared to be non-significant. Noticeably, only three external factors (higher education and training, innovation, and labour market efficiency) have significant coefficients and are therefore included in the model equations. The negative sign for higher education can be explained by the fact that although a better-educated individuals are more likely to discover and successfully explore an entrepreneurial opportunity (Lim et al., 2010; Rotefoss and Kolvereid, 2005), they also have better regular employment prospects (Shane 2003).

Interestingly, in our models we were unable to identify the impact of cultural setting on entrepreneurship. Although this contradicts other recent findings (e.g. Linan and Fernandez-Serrano, 2014; Petrakis, 2014; Wennekers et al., 2007), we could explain such a confusing result by the small sample size and relatively low variance in cultural variables within Stage 3 countries. On the other hand, although the exclusion of cultural variables can provide a certain bias for international comparison, it should not have a dramatic impact on a single country simulation.

The actual equations entered in the model are as follows:

$$GDP_{growth} = 0.11 + 0.64 * GDP_{growth\ lag} + 0.054 * TEA \quad \textbf{(1*)}$$

$$EIN = 127.12 + 0.646 * POP_{adult} - 15.639 * GDP - 4.535 * POP + 9.171 * INN - 17.924 * EDU \quad \textbf{(2*)}$$

$$TEA = -8.933 + 0.533 * EIN + 2.103 * LMK \quad \textbf{(3*)}$$

The new causal diagram is presented in Figure 3.

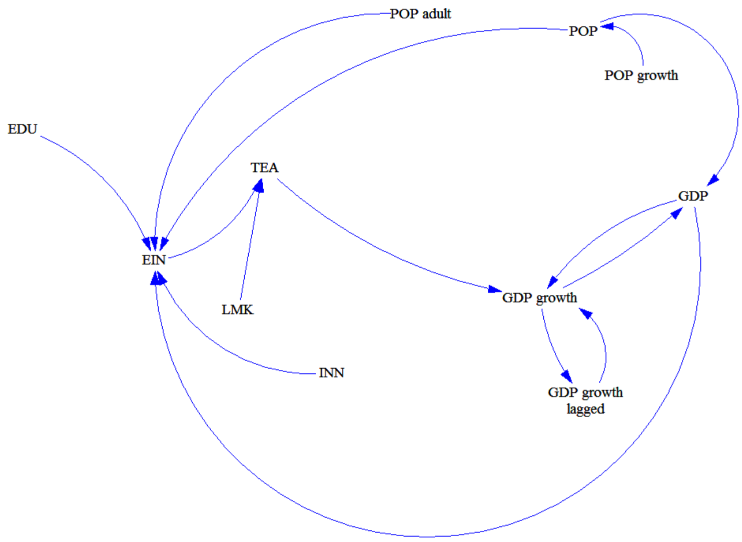

Fig. 3. Modified causal diagram used in the model

3.4 Model validation

The actual model was developed in the Vensim software package. After building the model, we did several simulation runs to validate the model. The validation is accomplished by comparing the simulated data with historical data for the period 2011-2014. We did not start our simulation from an earlier period in attempt to avoid the bias caused by the economic downturn in 2008.

For simulation purposes, we first choose Finland. The feature of this country is that although Finland has been among the world's most competitive economies for several years (4th place in 2014-2015, see the global competitiveness reports for details), the level of entrepreneurship activity is below the average for innovation-driven countries (5.29% versus 7.84% in 2013, according to GEM data). Thus, it is interesting to study whether there are reserves and possibilities to promote entrepreneurship through further institutional development, and whether there is a positive economic effect from these actions.

The model has two exogenous driving factors: population growth and adult population share. The following figure (Figure 4) presents the historical changes for the first factor, along with linear and non-linear regression lines.

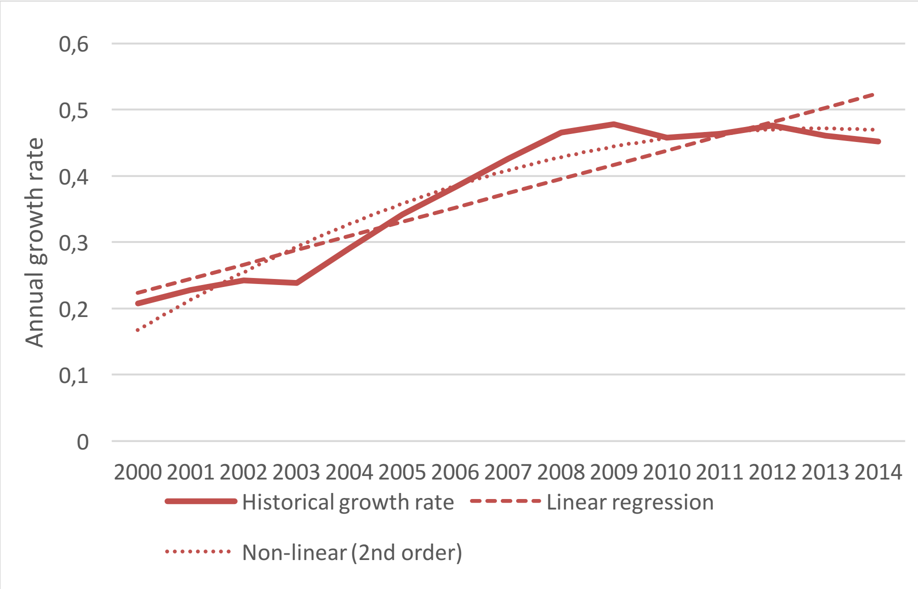

Fig. 4. The changes in Finnish population annual growth rate

The non-linear regression line provides a noticeable better fit ($R^2 = 0.936$ versus 0.845 for linear). The further increase in order produces a further increase in R^2, however it creates the danger of model overfitting. Therefore, for our simulation, we use the second-order regression equation:

$$POP_{growth} = -0.0018 * x^2 + 0.051 * x + 0.1183 \quad \textbf{(4)}$$

where:

POP_{growth} – annual rate of population growth;

x – time step (in our simulation due to the nature of the annual data values, we use a time set equal to one year).

Applying similar considerations for the second factor (adult population share), we came to the following equation:

$$POP_{adult} = -0.0262 * x^2 + 0.2467 * x + 66.443 \quad \textbf{(5)}$$

where:

POP_{adult} – annual rate of population growth;

x – time step (in our simulation due to the nature of the annual data values, we use a time set equal to one year).

The application of the non-linear model provides a noticeable improvement in fit

(R^2=0.926 versus R^2= 0.692).

Our model produces a number of variables as the result of running simulations. However, the main interest is in variables representing TEA and GDP growth. We also control for GDP per capita, total country population, and entrepreneurial intention emergence.

The errors are presented in the Table 3. Simulated TEA and entrepreneurial intention rates exceed the historical values drawn from statistics. Moreover, the error in GDP growth rate (predicted versus historical) is very high. This can be explained by some external factors affecting the national economy. Indeed, in our model, we focus on capturing the impact of entrepreneurship and, for the sake of simplicity, exclude most other factors. Thus, in the case of Finland, the GDP growth decrease is explained by the troubles in the country's main industries - technology (Nokia) and paper.

For further validation, we choose Norway - a country also demonstrating a high level of economic development and low entrepreneurship rates, but contrary to Finland not showing such a dramatic GDP growth rate drop for the analysed period. It is important to note that Norway has cultural characteristics that are quite similar to Finland, so that minimises the possibility for bias due to unobserved cultural impact (for cultural variables, see discussion in Chapter 3.3) The population growth rate and adult population share have consequently been modelled in a similar way, R^2 = 0.808 and 0.977. The equations are:

$$POP_{growth} = -0.0029 * x^2 + 0.1096 * x + 0.3007 \quad \textbf{(4*)}$$

$$POP_{adult} = -0.0126 * x^2 + 0.2955 * x + 64.405 \quad \textbf{(5*)}$$

where:

POP_{growth} – annual rate of population growth;

POP_{adult} – annual rate of population growth;

x – time step (in our simulation due to the nature of the annual data values, we use a time set equal to one year).

The results of comparing simulated and real data are also presented in Table 5. Compared to Finland, this model provides predictions that are more reliable. Especially noticeable are the differences between the real and predicted values in the same range for all key variables (GDP growth, TEA). The simulated values, on average, are slightly lower than in the real data.

Table 3. Average absolute errors in simulated data

	GDP per capita PPP	GDP growth	Entrepreneurial intentions	TEA
Finland	3.4%	518.9%	24.4%	27.4%
Norway	3.5%	40%	35.8%	10.9%

Therefore, we can conclude that our model provides quite reliable results under static conditions. However, it cannot predict sudden GDP growth rate changes if the reason for such changes lies outside the model boundaries. In other words, the model accounts only for the entrepreneurship effect and cannot fully predict national economic behaviour. Nevertheless, bearing in mind such a limitation, the model is still able to produce the results to test our propositions. Particularly, in the next chapter, we first examine the possible impact on TEA rates and consequently on national GDP growth provided by changes in the external environment, and then evaluate the reciprocal effect of changes in GDP growth rates on the national entrepreneurship activities.

4 Model simulation

After the validation of the model, we tested our research propositions. The following chapter consists of three parts. First, we present the scenarios developed to test the propositions; second, we report the results of the simulation; and finally, we discuss the results.

4.1 Scenarios

We have chosen the Norway model as the basis simulation, because this model better fits the historical data. Following the research propositions, we aim to explore how changes in supply and demand affect the system behaviour, and to what extent government interventions can control these changes.

The model has five exogenous variables determining supply, demand, and transition from intention to entrepreneurial activities: the share of adult population, higher education and training, total population, innovation, and labour market efficiency (Table 4).

Table 4 The list of exogenous variables included in the model (the sign in parentheses denotes the impact "+" positive, "-" negative)

Intention (supply)	Intention (demand)	TEA
POP adult (+)	POP (-)	LMK (+)
EDU (-)	INN (+)	

Additionally, we have an endogenous variable, GDP per capita (depends on GDP growth rate), which relates to the supply side and has a negative relationship with entrepreneurial intention emergence.

To test our propositions, we first study the behaviour of our baseline model (*scenario 0*) with standard settings, and then compare it with two alternative scenarios.

In the *first scenario*, we model the behaviour of the baseline system with increased supply. In the model, the supply can be increased by growing the share of adult population, decreasing the level of higher education, or by economic downturn. Taking into account that during peace time, dramatic changes in national population structures are quite unlikely to occur in a short period of time (1-2 years), we do not introduce any alterations in adult population dynamics. At the same time, the adoption of a policy to intentionally decrease the level of higher education seems counter-intuitive, thus we also do not change the level of the variable EDU. In order to change the supply, we modify the rates of GDP growth. In particular, we model a situation when the GDP growth rate becomes negative (i.e. we introduce a sudden drop of -200% of the current value) for a one-year period (see Table 6). This pattern resembles the situation in many European countries during the economic meltdown in 2008. It is interesting to examine how fast the system recovers after the shock and what level the main indicators reach by the end of simulation period.

The *second scenario* is similar to the first scenario, but this time, we aim to model governmental intervention. Thus, in the second year after the initial GDP growth decrease, we improve the external factors (innovation and labour market efficiency) by 10%. In the first year of "crisis", the variables remain unchanged. The idea is to emulate the lagged reaction to sudden economic shock and to perform measures aiming to eliminate the effect of the shock. Therefore, we are interested to see whether such intervention provides any noticeable improvement to the system condition, and how we can compare it to the unchanged, baseline model behaviour.

All simulation runs start with the same initial conditions, such as population, GDP, and GDP growth rate, which allows us the comparison of the system state by the end of the simulation period.

The basic assumptions of the scenarios are summarised in Table 5.

Table 5. Scenario assumptions

Simulation period	20 years
Time units	years
Starting period	2011
Country of analysis	Norway
Initial conditions (at time=0) Equal for all scenarios	Population: 2011 level GDP: 2011 level; GDP growth: 2011 level
GDP growth rate	Scenario 0: no external changes, fully endogenous Scenarios 1, 2: time steps 0-4: fully endogenous time step 5: -200% from the initial rate time steps 6-20: fully endogenous
Innovation and labour market efficiency	Scenarios 0,1: no changes, remain constant for the whole simulation period (set at the level 2011-2012) Scenario 2: time steps 0-5: set at the level 2011-2012 time step 6-20: 10% increase (the level reached by time step 7 remains the same until the end of the simulation period)

4.2 Simulation Results

The baseline model behaviour (Scenario 0) is presented in Figure 5. In spite of positive rates of GDP growth, for most of the simulation period, the system experiences a decrease in GDP per capita. This happens because population growth at the beginning of the simulation outpaces the growth of GDP (Figure 6). However, later, when the population growth rate becomes lower than GDP growth, the system is able to start growing. However, that late growth does not change the pattern for TEA. In our model, TEA experiences constant decline. Moreover, the rate of the decline increases. Such behaviour can be explained by the decline in the adult population share, resulting in a decrease in the supply of potential entrepreneurs.

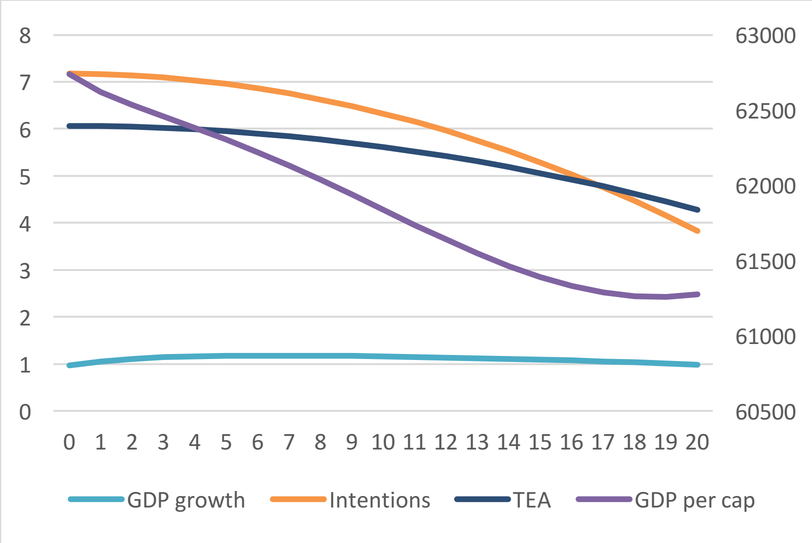

Fig. 5. The baseline model behaviour (Scenario 0)

Another interesting phenomenon occurs at the end of the simulation period, when TEA overcomes the entrepreneurial intentions. The increased share of necessity-driven entrepreneurship could account for this. Such people may not necessarily have strong intentions towards entrepreneurship careers (that is why we do not have an increase in intention rates), but are rather forced to become self-employed due to the absence of viable alternatives.

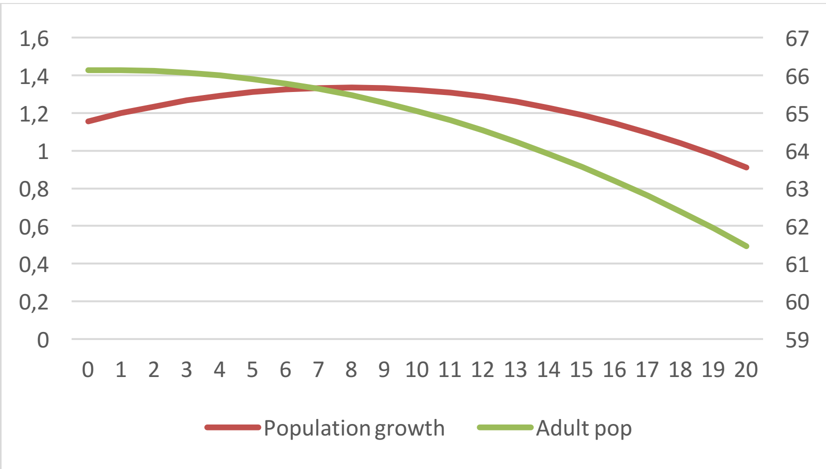

Fig. 6. The demographic trends in the model (valid for all scenarios)

Comparing the baseline model with the conceptual scenarios, we see that even a model without governmental interventions (Scenario 1) demonstrates quite a short recovery period (Figure 7). Thus, the system demonstrates positive growth rates already 1.5 years after the initial shock. The full recovery time is longer; only by time step 14 does the system reach the same growth rates as the baseline model. Interestingly, after that, the system in scenario 1 continues growth at higher rates than the baseline model. The increase in growth rates reaches almost 3% (1.017% for scenario 1 versus 0.987% for scenario 0) by the end of the simulation period.

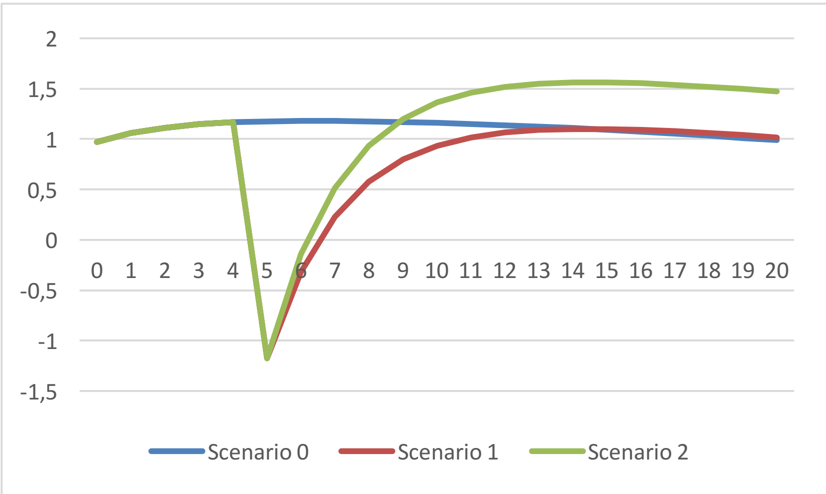

Fig. 7. GDP growth rates

Scenario 2, with governmental interventions, demonstrates even better results (faster recovery time and higher GDP growth rates by the end of the period). The overall advantage over scenario 1 reaches 31% in the final simulation year. However, in spite of an advantage in absolute numbers, all three scenarios demonstrate the tendency towards a decrease in GDP growth rates. Furthermore, even though scenarios 1 and 2, by the end of the simulation period, showed growth at higher rates than scenario 0, that is not enough to generate the same level of GDP per capita (Table 6), although the differences are relatively small (less than 1% for scenario 2 and 5.9% for scenario 1).

Interestingly, scenarios 1 and 2 also demonstrate higher rates of TEA and entrepreneurial intentions than the baseline model. However, only scenario 2 is able to maintain rates of entrepreneurial intentions exceeding TEA.

Table 6 Simulation results summary

	Scenario 0	**Scenario 1**	**Scenario 2**
GDP per capita* (PPP, USD)	61276	57639	61023
GDP growth (%)*	0.987	1.017	1.473
TEA (%)*	4.282	4.504	7.527

	Scenario 0	Scenario 1	Scenario 2
Entrepreneurial intentions (%)*	3.83	4.246	7.986
Time to reach positive GDP growth (after shock)	na	1.5 years	1.2 years
Recovery time (time to reach baseline model GDP growth rates)	na	10 years	4 years

**Results by the end of the simulation period*

4.3 Discussion of the results

In the discussion, we first consider the issues that occurred during the model-building process, and then continue with the discussion of the simulation results. Thus, although our model captures a number of important relationships, we were not able to identify the impact of different types of entrepreneurs on the economy. These results are expected for factor-driven and efficiency-driven economies, while for innovation-driven economies, improvement- and opportunity-driven entrepreneurs, as well as high-expectancy entrepreneurs, are believed to have a greater positive impact (Valliere and Peterson, 2009, Wong et al., 2005).

On the other hand, we consider the causality problem – that is, whether the prevalence of necessity-driven entrepreneurs provides a negative effect on economic growth or vice versa, so that the economic slowdown causes an increase in the number of such individuals. The results of the simulation (scenario 0) demonstrate that under defined conditions (a decrease in economic growth rates, as well as overall GDP per capita) overall TEA may be greater than the entrepreneurial intention level. This means that the number of people involved in entrepreneurial activities is greater than the number of people considering an entrepreneurial career. This extra input is attributed to the growing share of necessity-driven entrepreneurs - people who may not have strong entrepreneurial intentions, and so are not counted at the initial stage of the model, but appear only at the TEA stage.

Moreover, considering the entrepreneurial impact on the economy, we should not exclude non-innovative entrepreneurs. First, the impact of radical, "equilibrium disturbing" innovation developed by the Schumpeterian type of entrepreneur may not always be positive (Agarwal et al., 2007). At the same time, taking into account the relative scarcity of such entrepreneurs, we should not neglect low-innovation or even replicative ventures (also created by necessity-driven entrepreneurs), which, though they are less likely to have a significant impact on economic growth, are present in greater numbers and may eventually produce a similar effect (Levie and Autio, 2008; Shane, 2003).

However, considering the actual impact delivered by entrepreneurship, we have to accept that it is relatively limited (thus, the regression coefficient in the equation is small). Moreover, the significance level is not appropriate for commonly applied standards. Analysis with the data for different years results in even more confusing outcomes when the impact of entrepreneurship is significant for one year and not significant for others. Compared with the previous research findings, we see a confusing picture, in which one author finds a positive impact of entrepreneurship

(Cummings et al., 2014), while others provide some notions critical of that effect (Veciana and Urbano, 2008).

Moreover, it seems that an entrepreneurial system is susceptible to external factors. While isolated, it can recover from a shock quite fast (scenarios 1 and 2), but in real circumstances, the behaviour might be different (consider the case of Finland). The expected positive effect cannot eliminate the negative effect from other factors affecting the country's economy. This explains the over-optimistic predictions of GDP growth rates for Finland.

Interestingly, not all the proposed factors appeared to have a significant impact in our model. Thus, we were able to identify only three external determinants, which are directly affected by policy regulations: innovation, labour market efficiency, and higher education. On the other hand, the impact from cultural variables appears non-significant, which contradicts other findings (Linan and Fernandez-Serrano, 2014; Petrakis, 2014). We may attribute this confusing result to the relatively small sample size. However, although excluding these factors from the model should not provide a bias for the general behaviour estimation (as well as a comparison of countries with similar cultural characteristics), the possible unobserved effect may play a role in the evaluation of policy measures results. Therefore, we propose the necessity of the impact of cultural variables on entrepreneurship and their interconnections with other external factors for further research (see, e.g., Misra et al., 2012).

The first proposition holds true, and the eventual growth rates are even higher than in the baseline scenario, although we cannot consider scenario 1 better because the overall figures for GDP per capita are lower. Furthermore, in a real situation, such an economic downturn will also influence other factors, which are not included in the model. Therefore, the actual recovery time might be longer. In this situation, the government interventions modelled in scenario 2 are necessary measures. However, it might be questionable whether it is possible to achieve such noticeable improvements in a relatively short time. Moreover, taking into account a controversial finding regarding the economic impact of entrepreneurship, we might also question whether such measures should be of primary importance.

We should also consider a possible increase in necessity-driven entrepreneurs. For them, lacking the necessary experience and networks, the additional support becomes especially important. At the same time, even people with high intentions towards entrepreneurship are subject to failure in the harsh economic conditions. Therefore, the improvement of external conditions, provided by direct support for entrepreneurs by means of, for example, business incubators, may result in sufficient improvement in the system conditions and faster recovery from an economic recession.

Regarding our third proposition, we found that demographic characteristics might play a significant role in the long-term development of the entrepreneurial system. Although the population demographic indicators are a well-recognised determinant of entrepreneurship (Bowen and Clerq, 2008; Shane 2003, Verheul et al., 2002; Wennekers et al., 2005), their long-term impact on entrepreneurial activities is understudied. Our model reveals that, in spite of favourable external factors, the population decrease and, more importantly, the decrease in the adult population share will negatively affect entrepreneurship activities and, consequently, to some extent, economic growth rates.

At the end of the simulation (scenario 0), population decline led to certain growth in GDP per capita, but combined with an even more severe decline in the adult population share, this eventually resulted in an increased decline in TEA. A discussion of demographic policy goes beyond the scope of this paper. It seems that policy-makers aiming to improve entrepreneurial conditions also need to take into account the current demographic situation and further trends.

5 Conclusion

This paper demonstrates the dynamic macro-level model of entrepreneurship. The main feature of the model is the combination of external determinants of entrepreneurial activities with the economic effect of entrepreneurship. Therefore, the model is able to capture the complex non-linear behaviour generated through the feedback loop. We constructed model equations based on regression analysis of multi-country data, which improves model applicability in different institutional settings and enables country comparison.

The secondary data used in model equation building comes from open sources such as the Global Entrepreneurship Monitor, Global Competitiveness Index, and World Bank databases. The model was validated using historical data for 2011-2014. For this purpose, we used data from Finland and Norway. The reason for that choice is that both countries are developed economies (and consequently have high levels of entrepreneurship determinants) and demonstrate low levels of entrepreneurial activity (below the average level for innovation-driven economies). Both countries also have similar cultural values, which limits the risk of possible bias due to the unobserved effect of cultural variables, which we excluded from our model.

We aimed to explore the behaviour of the entrepreneurial system model and test the research propositions. The main outcome is that, although isolated from other external factors affecting the economic state, the system is able to generate positive economic growths rates and even recover after a sudden shock. The long-term system behaviour depends on factors such as overall country population development and especially the proportion of the adult population. Indeed, these macro-level factors affect numerous aspects of the national economy, and entrepreneurship is dependent on them.

Moreover, the study raises the question of the proper understanding of the role of entrepreneurship in a country's economic growth. Even though the positive role of entrepreneurship is a fact, the actual contribution to the economy may vary. Thus, a simplified understanding of entrepreneurship as a universal solution for economic problems may not provide the desired outcomes. Moreover, we found that considering entrepreneurship as the only economic growth factor may produce over-optimistic results, which do not correlate well with the real situation.

The results of this work have several academic implications and raise some questions for further discussion. It is clear that there is a need for a comprehensive model of entrepreneurship, which would include not only the determinants of entrepreneurship, but would consider the impact that entrepreneurial activities have on the national economy and overall society. In other words, to better understand the entrepreneurship phenomenon and its importance, we need to capture the feedback loop between the factors that have an impact on entrepreneurship, and the impact that entrepreneurs have on these factors.

The policy and managerial implications lie in the need to understand the system complexity. The improvement of one factor may have a direct effect, but may be unable to change a long-term trend caused by, for example, national demographic development. Furthermore, the external determinants may have different effects on entrepreneurship and other economic and societal factors. Thus, the level of higher education has a negative impact on the emergence of entrepreneurial intentions. However, it seems strange to recommend decreasing the higher education rate in order to stimulate entrepreneurial activity. Entrepreneurship is just one part of a complex economic system; therefore, all the measures aiming to alter the level of entrepreneurship require a holistic approach.

The major limitation of the developed model lies in the compromise between accuracy and complexity. The application of multi-country data, although it enables the application of the model to various countries, inevitably results in increased error rates, compared to a tailored model based on one country's time-series data. Another limitation, which prohibited us from creating more precise tailored models, is data availability. Being limited to open databases, we did not have enough historical data to conduct a meaningful statistical analysis for each specific country. Small sample size might be also a reason for confusing results regarding the impact of entrepreneurship as well as non-significant coefficients for cultural variables.

A valuable direction for further research can be an expansion of the system dynamic model, aiming at the more accurate capture of overall national economic behaviour. The development of specifically tailored country models will undoubtedly increase the precision of predictions and enable better understanding of national specifics, when different factors may be of different importance for each specific economy.

Acknowledgements

The authors would like to thank the editors and anonymous reviewers for the constructive comments and suggestions that have contributed to improving the quality of this paper.

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Appendix

Table A1. Descriptive statistics

Variable	Mean	Std Dev	Minimum	Maximum
GDP growth	2.423	3.558	-15.262	9.322
GDP growth lagged	2.140	3.418	-6.572	10.247
GDP	4.250	0.364	2.893	4.817
POP	7.263	0.753	5.454	9.133
POP growth	0.814	1.022	-1.283	3.336
POP adult	65.345	5.324	49.185	73.094
UNP	10.454	7.420	0.770	29.650
TEA	13.799	8.804	3.428	39.905
OEA	46.969	13.453	18.378	76.034
NEA	25.280	11.547	4.000	60.981
EIN	23.861	15.459	2.595	66.689
INN	3.761	0.905	2.1	5.8
TEC	4.342	1.074	2.4	6.2
LMK	4.326	0.567	2.9	5.8
GMK	4.383	0.518	3	5.6
FIN	4.288	0.727	2.4	5.8
INS	4.195	0.808	2.8	6.1
EDU	4.553	0.900	2.1	6.3
PDA	61.102	19.827	13	100
IND	43.186	23.219	6	91
UA	65.966	23.137	8	100

Table A2. Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
GDP growth	1.000																				
GDP growth lagged	0.732*	1.000																			
GDP	-0.426*	-0.429*	1.000																		
POP	0.319*	0.205	-0.153	1.000																	
POP growth	0.439*	0.489*	-0.619*	0.271*	1.000																
POP adult	-0.326*	-0.259*	0.567*	-0.024	-0.714*	1.000															
UNP	-0.293	-0.424*	-0.089	-0.237	-0.328*	0.059	1.000														
TEA	0.425*	0.562*	-0.657*	0.028	0.595*	-0.532*	-0.078	1.000													
OEA	-0.074	0.083	0.376*	-0.074	-0.077	0.180	-0.560*	-0.157	1.000												
NEA	0.253*	0.001	-0.512*	0.152	0.075	-0.075	0.531*	0.151	-0.604*	1.000											
EIN	0.522*	0.453*	-0.785*	-0.027	0.613*	-0.566*	0.046	0.786*	-0.252*	0.341*	1.000										
INN	-0.258*	-0.222	0.644*	0.074	-0.229	0.180	-0.161	-0.429*	0.415*	-0.430*	-0.587*	1.000									
TEC	-0.508*	-0.404*	0.831*	-0.171	-0.514*	0.356*	-0.025	-0.562*	0.385*	-0.500*	-0.734*	0.852*	1.000								
LMK	-0.059	0.130	0.272*	-0.125	-0.103	0.041	-0.133	-0.030	0.435*	-0.366*	-0.224	0.628*	0.556*	1.000							
GMK	-0.134	-0.041	0.518*	-0.048	-0.241	0.226	-0.167	-0.271*	0.385*	-0.377*	-0.475*	0.800*	0.724*	0.728*	1.000						
FIN	0.025	0.226	0.261*	0.004	-0.013	0.087	-0.305*	-0.035	0.355*	-0.313*	-0.207	0.632*	0.483*	0.713*	0.777*	1.000					
INS	-0.249*	-0.147	0.565*	-0.188	-0.245*	0.171	-0.070	-0.308*	0.419*	-0.458*	-0.448*	0.838*	0.775*	0.698*	0.850*	0.726*	1.000				
EDU	-0.519*	-0.428*	0.854*	-0.117	-0.643*	0.567*	-0.091	-0.618*	0.372	-0.427*	-0.758*	0.804*	0.931*	0.461*	0.677*	0.430*	0.715*	1.000			
PDA	0.461*	0.393*	-0.536*	0.252	0.293*	-0.109	-0.028	0.284*	-0.289*	0.410*	0.340*	-0.572*	-0.614*	-0.349*	-0.403*	-0.267*	-0.545*	-0.564*	1.000		
IND	-0.486*	-0.427*	0.578*	-0.047	-0.328*	0.115	0.049	-0.520*	0.157	-0.285*	-0.572*	0.550*	0.639*	0.357*	0.417*	0.292*	0.526*	0.592*	-0.695*	1.000	
UA	-0.207	-0.210	0.170	-0.094	-0.210	0.014	0.081	-0.195	-0.179	0.068	-0.103	-0.224	-0.003	-0.502*	-0.370*	-0.429*	-0.352*	0.012	0.204	-0.119	1.000

**Significant at least 5%*