FEASIBILITY OF TECHNOLOGY ENTREPRENEURSHIP AMONG BULGARIAN STEM STUDENTS: THE ROLE OF UNIVERSITY

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Abstract: Technology entrepreneurship involves the creation of a new business whose products and services are based on the application of scientific or technological knowledge. Technology entrepreneurship may play an important role for economic development in the context of increasing globalization. Little research attention has been devoted to the antecedents of the feasibility of technology entrepreneurship. The objective of this study is to identify university determinants of the feasibility of technology entrepreneurship among students enrolled in majors in the fields of science, technology, engineering and mathematics (STEM) in Bulgarian universities. The study uses a sample of 879 university students in STEM majors and applies a binary logistic regression to identify university factors related to the high feasibility of technology entrepreneurship. The results of the present study indicate that university support for entrepreneurship, industry ties and research excellence are related to the feasibility of technology entrepreneurship among Bulgarian STEM students. The empirical findings can help to devise policies and measures for enhancing the feasibility of technology entrepreneurship among STEM students.

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Introduction

Technology entrepreneurship has attracted significant attention by academics and policy makers in the context of increasing globalization. It was acknowledged that technology entrepreneurship may have an important contribution to increasing economic growth, value creation and wealth (Bailetti, 2012). The first publications in this field appeared just several decades ago (Borges et al., 2010). Technology entrepreneurship is defined as the creation of a new business that uses scientific or technological knowledge for the production of products and provision of services (Allen, 1992). Several review articles reveal that the available research on technology entrepreneurship is focused mainly on the creation and management of technological companies (Bailetti, 2012; Spiegel and Marxt, 2011). The available research does not shed light on the reasons for technology entrepreneurship (Shane and Venkataraman, 2003). There is a need of greater understanding about the role of university in technology entrepreneurship (Mosey et al., 2017) and the factors contributing to the formation of positive attitudes towards technology entrepreneurship among students (Yordanova and Filipe, 2018).

The research objective of this study is to identify university determinants of the feasibility of technology entrepreneurship among students enrolled in STEM majors in Bulgarian universities. During the last three decades Bulgaria implemented profound political, economic, social and institutional reforms. The transition from a centrally planned economy to a market economy was a slow process which eventually brought an increase in the living standard and economic growth. In 2007 Bulgaria accessed the EU. Despite the adoption of various policies and measures to stimulate entrepreneurship, early-stage entrepreneurial activity in Bulgaria is below the EU average (European Commission, 2019, 2018b, 2017, 2016). The rate of the opportunity-driven entrepreneurial activity has been declining since 2016 and in 2018 it reaches its lowest annual value for the period 2015-2018 (European Commission, 2019, 2018b, 2017, 2016). The early-stage entrepreneurial activity in Bulgaria is characterized by low expectations for job creation, low innovativeness and low internationalization. The empirical findings of this study can contribute to enhancing the feasibility of technology entrepreneurship among STEM students which can influence positively their entrepreneurial intentions and behavior.

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This paper has the following structure. The second section presents the background of the study. The third section discusses the research methodology. The fourth section presents the empirical findings of the study. The final section provides conclusions, implications for policy makers and educators as well as directions for future research on this topic.

Literature review

Gans and Stern (2003) define technology entrepreneurship as "the founding of small, start-up firms developing inventions and technology with significant potential commercial application". According to Spiegel and Marxt (2011), technology entrepreneurship investigates the development of competitive advantage in both emerging and existing technological companies. Burgelman et al. (2004) argue that technology entrepreneurship involves specific activities enabling innovation. Garud and Karnøe (2003) note that various actors such as technology entrepreneurs, customers, actors developing complementary assets, etc. take part in a technopreneurial process and influence the creation of a new technology. Value creation is an important outcome of technology entrepreneurship (Bailetti, 2012). Spiegel and Marxt (2011) identify three levels of analysis in technology entrepreneurship: 1) the product/service; 2) the business/firm; and 3) the system as a whole. Technology entrepreneurship is considered a specific form of entrepreneurial entry which is based on innovation (Hsu, 2008). Bailetti (2012) differentiate technology entrepreneurship from the general management practices adopted in small businesses.

Attitudes are relevant for understanding entrepreneurial behavior because this type of behavior is characterized by uncertainty and ambiguity (Forbes, 1999). Technoprepreneurial behavior is determined by technopreneurial intentions which in turn are determined by technopreneurial attitudes (Krueger et al., 2000; Krueger and Brazeal, 1994; Shapero and Sokol, 1982). The feasibility of entrepreneurship is an attitudinal variable that is an element in various theoretical models of entrepreneurial intentions (Krueger et al., 2000; Krueger and Brazeal, 1994; Shapero and Sokol, 1982). According to these models, the feasibility of technology entrepreneurship is an important antecedent of technopreneurial intentions. The feasibility of technology entrepreneurship indicates to what extent an individual feels capable of establishing a new technology venture (Shapero and Sokol, 1982). Despite the empirical evidence supporting the significant association between feasibility of entrepreneurship and entrepreneurial intentions (Krueger et al., 2000), there is a lack of understanding about the antecedents of the feasibility of entrepreneurship (Krueger and Brazeal, 1994; Rideout and Gray, 2013).

A large body of literature reveals that university-related factors play an important role for entrepreneurship among students. However, there is a lack of understanding about the role of university for technology entrepreneurship in particular (Mosey et al., 2017). The existing research reveals that entrepreneurship education and training is associated with entrepreneurship outcomes, entrepreneurship-related human capital assets (Martin et al., 2013), entrepreneurial intentions (Dickson, Solomon and Weaver, 2008), entrepreneurial capabilities and competences, and entrepreneurial behavior (Rideout and Gray, 2013). Entrepreneurship education influences positively entrepreneurial attitudes and entrepreneurial intentions of STEM students (Fayolle and Gailly, 2015; Soutaris et al., 2007). Various types of university support for entrepreneurship have positive effects on students' entrepreneurial intentions, entrepreneurial self-efficacy (Saeed et al., 2015), and progressive engagement in entrepreneurship (Minola et al., 2016). University research positively influences the entrepreneurial effectiveness of universities (Van Looy et al., 2011), the creation of knowledge-intensive firms (Bonaccorsi et al., 2014), and technology entrepreneurship among students and new graduates (Beyhan and Findik, 2018). Guerrero and Urbano (2012) demonstrate that faculty attitudes toward entrepreneurship and role models are a critical factor for the development of an entrepreneurial university. Walter et al. (2013) find that industry ties positively influence self-employment intentions among students and conclude that intensive connections between universities and industry partners inspire potential entrepreneurs.

Research Methodology

This study relies on a survey about technopreneurial attitudes among students in STEM fields in 15 Bulgarian universities. The survey was conducted in 2015 and 2016. The sample includes 879 STEM students, who do not possess a company and have not taken any steps to create a business yet. The sample is composed mainly of undergraduate students. Female students are less than 40% of the sample. The feasibility of technology entrepreneurship is measured with an index composed of 5 items on a 7-

point Likert scale (Drennan et al., 2005; Krueger et al, 2000). The Cronbach's alpha of the scale is 0.739. The dependent variable feasibility of technology entrepreneurship (FEASIBILITY_TE) is a binary variably and takes the value of 1 if the level of the respondent's feasibility of technology entrepreneurship is above the median and a value of 0 if otherwise. Several independent variables are used in the analysis. The binary variable entrepreneurship education (ENTR_EDU) reveals if the respondent is/was enrolled in an entrepreneurship course within the university (value 1) or not (value 0). Kraaijenbrink et al. (2010) recommend considering perceptual measures of university support for entrepreneurship. The variable concept development support by the university (CONCEPT_DEV) indicates a respondent's perceptions of the support provided by the university for business concept development. It is measured with a 4-item, 7-point Likert scale (Kraaijenbrink et al., 2010). The Cronbach's alpha of the scale is 0.925. The variable research excellence (RES_EXC) indicates the H-index of the university in the scientific field of study of the respondent in the database Scopus. The variable industry ties (IND_TIES) indicates the level of activities of industry partners at university (Walter et al., 2013). Students were asked to assess the frequency of such activities with 2 items on a 7-point Likert scale (Walter et al., 2013). The Cronbach's alpha of the scale is 0.915. The variable (PROF_ATTITUDES) reveals the presence of positive attitudes towards entrepreneurship among university professors (value 1) or otherwise (value 0).

The study controls for differences in role models, social network support, willingness to take risks, age, gender, and previous experience in a technology firm. The variable age (AGE) indicates the age of the respondents in number of years. The binary variable gender (GENDER) reveals if the respondent is male (value 1) or female (value 0). The binary variable of positive entrepreneurial role models (ROLE_MODELS) indicates the presence of positive entrepreneurial role models among parents, relatives, friends, and acquaintances (value 1) or not (value 0) (Walter et al., 2013). The binary variable social network support (SOC_NET_SUP) takes a value of 1 if the respondent can rely on support from his/her social network in case she/he becomes an entrepreneur and a value of 0 if otherwise (Walter et al., 2013). The binary variable regarding previous experience in a technology business (TECH_EXP) takes a value of 1 if the respondent has acquired professional experience in such a business and a value of 0 otherwise. The variable willingness to take risks (RISK) is measured with 4 items adopted from Gomez-Mejia and Balkin (1989) (Cronbach's alpha = 0.847). The dependent variable in this study is binary. Therefore, we apply a binary logistic regression for data analysis which is performed with the statistical package SPSS, version 25.

Empirical evidence

Table 1 contains the results of a binary logistic regression exploring the effects of several university factors on the likelihood of a high feasibility of technology entrepreneurship. Chi-square statistics are used to test the significance level of the model. The model will predict the likelihood of high feasibility of technology entrepreneurship among students at a 99% confidence level. There are no multicollinearity problems because the VIF values for the variables in the regression are within the acceptable limits (less than 2). The overall predictive ability of the model to correctly classify students by their low or high feasibility of technology entrepreneurship is 78.4%. Three university factors significantly influence the likelihood for a high feasibility of technology entrepreneurship. The variable RES_EXC negatively influences the odds for a high feasibility of technology entrepreneurship ($p < 0.05$). Students in research-oriented universities are less likely to exhibit a high feasibility of technology entrepreneurship that students in other universities ($p < 0.05$). The variable CONCEPT_DEV affects positively the odds of a high feasibility of technology entrepreneurship. Students enrolled in universities which provide greater concept development support are more likely to exhibit a high feasibility of technology entrepreneurship ($p < 0.01$). The variable IND_TIES has a positive effect on the odds of a high feasibility of technology entrepreneurship. The coefficient of the variable ENTR_EDU is not significant ($p > 0.05$). Participation in entrepreneurship education is not related to the likelihood of a high feasibility of technology entrepreneurship. The variable PROF_ATTITUDES has no effect on the dependent variable ($p > 0.5$). Students' perceptions of positive attitudes towards entrepreneurship among university professors are not related to the odds of a high feasibility of technology entrepreneurship ($p > 0.5$).

Only the control variable SOC_NET_SUP exerts a significant influence on the likelihood of a high feasibility of technology entrepreneurship ($p < 0.01$). The support from the social network is positively associated with a high feasibility of technology entrepreneurship among STEM students. The likelihood

of a high feasibility of technology entrepreneurship is not associated with the other control variables GENDER, RISK, AGE, ROLE_MODELS and TECH_EXP.

Table 1: Results from a binary logistic regression.

Variable	Coefficient (B)	S. E. (B)	Sig.
GENDER	-0.075	0.181	0.678
AGE	0.010	0.017	0.546
RISK	-0.008	0.017	0.626
TECH_EXP	-0.214	0.162	0.187
ROLE_MODELS	0.188	0.181	0.298
SOC_NET_SUP	0.896	0.212	0.000
ENTR_EDU	0.273	0.190	0.151
CONCEPT_DEV	0.040	0.014	0.004
RES_EXC	-0.040	0.017	0.018
PROF_ATTITUDES	-0.052	0.190	0.784
IND_TIES	0.138	0.048	0.004
Constant	-2.747	0.578	0.000
Model Chi-square	70.257***		
-2 Log likelihood	847.416		
% correct predictions	78.4%		

*** $p < 0.001$

Source: Author

Discussion and Conclusions

Although there is growing literature on technology entrepreneurship, the development of positive technopreneurial attitudes has received relatively little research attention. Based on a sample of 879 STEM students, the current study examines the role of university factors in forming STEM students' feasibility of technology entrepreneurship. Our empirical analysis establishes that several university factors significantly influence the feasibility of technology entrepreneurship in the studied sample. The odds of a high feasibility is positively associated with concept development support and industry ties and negatively associated with university research excellence. Students in universities providing greater concept development support or universities with better industry ties are more likely to report a high feasibility of technology entrepreneurship than students from other universities. These findings reinforce previous studies demonstrating the importance of university support (Saeed et al., 2015; Kraaijenbrink et al., 2010) and intensive connections between industry and university (Walter et al., 2013) for entrepreneurship among students. The odds of a high feasibility is negatively associated with university research excellence. Students in less research-oriented universities are more likely to exhibit a high feasibility of technology entrepreneurship than students in more research-oriented universities. This supports Walter et al.'s (2013) study which identifies a negative link between students' self-employment intentions and university research orientation. The participation in entrepreneurship education and the perceptions of positive attitudes towards entrepreneurship among university professors are not related to the odds of a high feasibility of technology entrepreneurship. The empirical evidence of this study is in contradiction to Peterman and Kennedy's (2003) findings about the positive relationship between the perceived feasibility of entrepreneurship among students and entrepreneurship education. These results raise questions about the selection of content and didactic approaches in entrepreneurship education and how they are conductive for enhancing the feasibility of technology entrepreneurship among STEM students. Linton and Xu (2021) acknowledge the need of more appropriate and useful methods for technology entrepreneurship education. Fayolle et al. (2021) suggest that the technology entrepreneurship curriculum should be based on experiential, active and cooperative learning pedagogy.

The study has several limitations. First, the findings of this study should be interpreted carefully because the analysis is based on a convenient sample. Second, data may be subjected to cognitive biases and errors because students were asked to report their attitudes and perceptions. Third, the study is limited to the Bulgarian context and the findings may not be extended to other contexts and economies. It does not control for differences related to the content and teaching methods of entrepreneurship courses in which respondents participate or participated within their universities. Finally, this study cannot confirm causal relationships due to the cross-sectional nature of the research.

We propose several directions for future research on the feasibility of technology entrepreneurship among students. Future empirical studies should confirm our findings in other contexts. Future research should investigate the effects of other university-related factors such as entrepreneurship education content and teaching methods. In addition to attitudes, future studies should identify the most important motives and barriers to technology entrepreneurship among students. It is necessary to use a longitudinal design to identify causal links between the feasibility of technology entrepreneurship and the university factors included in this study.

Our empirical results have important practical implications. The findings about the positive and significant influence of university support for entrepreneurship, university research excellence and industry ties on students' perceived feasibility of technology entrepreneurship can help University managers and policy makers to devise specific policies and measures within universities for stimulating technology entrepreneurship among students. Academics should pay more attention to the content and teaching methods used in entrepreneurship courses for STEM students for such courses to be able to enhance students' perceived feasibility of technology entrepreneurship.

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References

Bailetti, T. (2012). Technology entrepreneurship: overview, definition, and distinctive aspects. Technology Innovation Management Review, 2(2), 5-12.

Beyhan, B., & Findik, D. (2018). Student and graduate entrepreneurship: ambidextrous universities create more nascent entrepreneurs. The Journal of Technology Transfer, 43(5), 1346-1374.

Bonaccorsi, A., Colombo, M.G., Guerini, M., & Rossi-Lamastra, C. (2014). The impact of local and external university knowledge on the creation of knowledge-intensive firms: Evidence from the Italian case. Small Business Economics, 43, 261–287.

Borges Jr, C. V., Filion, L. J., & Simard, G. (2010). Estudo comparativo entre o processo de criação de empresas tecnológicas e o de empresas tradicionais. RAI-Revista de Administração e Inovação, 7(2), 3-21.

Burgelman, R. A., Christensen, C. M., & Wheelwright, S. C. (2004). Strategic management of technology and innovation. Chicago: Irwin.

Dickson, P. H., Solomon, G. T., & Weaver, K. M. (2008). Entrepreneurial selection and success: does education matter?. Journal of small business and enterprise development, 15(2), 239-258.

Drennan, J., Kennedy, J., & Renfrow, P. (2005). Impact of childhood experiences on the development of entrepreneurial intentions. The International Journal of Entrepreneurship and Innovation, 6(4), 231-238.

Fayolle, A., & Gailly, B. (2008). From craft to science: Teaching models and learning processes in entrepreneurship education. Journal of European Industrial Training, 32(7), 569–593.

Fayolle, A., Lamine, W., Mian, S., & Phan, P. (2021). Effective models of science, technology and engineering entrepreneurship education: current and future research. The Journal of Technology Transfer, 46(2), 277-287.

Forbes, D. P. (1999). Cognitive approaches to new venture creation. International Journal of Management Reviews, 1(4), 415-439.

Garud, R., & Karnøe, P. (2003). Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Research policy, 32(2), 277-300.

Gomez-Mejia, L. R., & Balkin, D. B. (1989). Effectiveness of individual and aggregate compensation strategies, Industrial Relations, 28(3), 431-445.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. The journal of technology transfer, 37(1), 43-74.

Hsu, D. H. (2008). Technology-based entrepreneurship. Handbook of Technology and Innovation Management. Blackwell Publishers, Ltd: Oxford, 367-387.

Kraaijenbrink, J., Bos, G., & Groen, A. (2010). What do students think of the entrepreneurial support given by their universities?. International Journal of Entrepreneurship and Small Business, 9(1), 110-125.

Krueger Jr, N. F., & Brazeal, D. V. (1994). Entrepreneurial potential and potential entrepreneurs. Entrepreneurship theory and practice, 18(3), 91-104.

Krueger, N., Reilly, M., & Carsrud, A. (2000). Competing models of entrepreneurial intentions. Journal of Business Venturing, 15 (5-6), 411-432.

Linton, J. D., & Xu, W. (2021). Research on science and technological entrepreneurship education: What needs to happen

next?. The Journal of Technology Transfer, 46(2), 393-406.

Martin, B. C., McNally, J. J., & Kay, M. J. (2013). Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. Journal of Business Venturing, 28(2), 211-224.

Minola, T., Donina, D. & Meoli, M. (2016). Students climbing the entrepreneurial ladder: Does university internationalization pay off?, Small Business Economics, 47(3), 565-587.

Mosey, S., Guerrero, M., & Greenman, A. (2017). Technology entrepreneurship research opportunities: insights from across Europe. The Journal of Technology Transfer, 42(1), 1-9.

Peterman, N. E., & Kennedy, J. (2003). Enterprise education: Influencing students' perceptions of entrepreneurship. Entrepreneurship theory and practice, 28(2), 129-144.

Pittaway, L., & Cope, J. (2007). Entrepreneurship Education: A Systematic Review of the Evidence. International Small Business Journal, 25(5), 479-510.

Rideout, E. C., & Gray, D. O. (2013). Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university-based entrepreneurship education. Journal of Small Business Management, 51(3), 329-351.

Saeed, S., Yousafzai, S. Y., Yani De Soriano, M., & Muffatto, M. (2015), "The role of perceived university support in the formation of students' entrepreneurial intention", Journal of Small Business Management, 53(4), 1127-1145.

Shane, S., & Venkataraman, S. (2003). Guest editors' introduction to the special issue on technology entrepreneurship. Research policy, 32(2), 181-184.

Shapero, A., & Sokol, L. (1982). The social dimensions of entrepreneurship. In C. A. Kent, D. L. Sexton, & K. H. Vesper (Eds.), Encylclopedia of entrepreneurship (pp. 72-90). Englewood Cliffs, NJ: Prentice-Hall.

Souitaris, V., Zerbinati, S., & Al-Laham, A. (2007). Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. Journal of Business venturing, 22(4), 566-591.

Spiegel, M., & Marxt, C. (2011, December). Defining technology entrepreneurship. In *2011 IEEE International Conference on Industrial Engineering and Engineering Management* (pp. 1623-1627). IEEE.

Van Looy, B., Landoni, P., Callaert, J., Van Pottelsberghe, B., Sapsalis, E., & Debackere, K. (2011). Entrepreneurial effectiveness of European universities: An empirical assessment of antecedents and trade-offs. Research Policy, 40, 553–564.

Yordanova, D., & Filipe, J. A. (2018). Desirability of Technology Entrepreneurship among Bulgarian STEM Students: The Role of Entrepreneurship Education. European Research Studies Journal, 21(3), 446-462.