

## **Higher Education, Innovation Systems and Entrepreneurship in Mexico**

### **Introduction**

Knowledge is a fundamental resource for the competitiveness of societies. This rationale has justified policies targeting strengthening population skills and knowledge through education, and the discovery of new economic knowledge to encourage innovation through R+D activities. Entrepreneurship is central for these policy efforts to materialize in innovations and their virtuous effects on societies (Audretsch, 2001; Acs et al., 2009), hence it has received policy attention as well. Mexico has implemented policies related to higher education, innovation and entrepreneurship since the 1990's. This paper contends that these policy efforts all together may be producing emerging local systems compatible with the concept of National Systems of Innovation (NSI), which seem to be consistent with entrepreneurship, particularly knowledge based. Methodology includes a panel data to explain different categories of entrepreneurship using *proxy* variables of policy efforts and outcomes from Higher Education Institutions (HEI's).

### **Higher Education, NSI and Policy trends in Mexico**

The concept of National Innovation Systems (NIS) postulates that knowledge ... is produced and accumulated through an interactive and cumulative process of innovation that rests in an institutional context (Etzkowitz & Leydesdorff, 2000); it is defined as the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state (Lundvall, 1992). HEI's under this context, contribute in human capital formation, the dissemination of knowledge produced by scientific research, and the provision of multiple services; as consequence, play a role in economic growth (Ocegueda et al., 2013) and the development of societies. HEI's may also be critical in entrepreneurship, educating human resources through formal courses and extracurricular activities, providing related services (Walter et al., 2011; Bergmann et al, 2016), and through the entrepreneurial activity of faculty

and students (Astebro, et al., 2012). In sum, Universities should provide “thinking, leadership and activity to enhance entrepreneurship capital” (Audretsch, 2014), and thus have a role to play in the NSI.

Some policies have been gradually implemented in Mexico since the 1990’s searching for: 1) improving higher education quality by setting rules governing extraordinary funding and subsidy according to institutional performance and the achievement of specific goals (Mungaray et al., 2016); 2) stimulating R+D activities encouraging innovation at local level, through government and interinstitutional funds with the participation of local governments, HEI’s, enterprises and civil organizations (Mungaray et al., 2011 & Moctezuma, et al., 2017); 3) creating a system of quality graduate programs through accreditation, scholarships for students to improve scientific and innovative skills, and grants to researchers to stimulate research and application of knowledge through the National System of Researchers (SNI); and 4) encouraging entrepreneurship through provision of related services (business incubators, finance, shelters, training programs, etc.), efforts which led to the creation of the National Institute for the Entrepreneur (INADEM). Besides, some federal and local laws were promulgated to organize actors under pro local competitiveness policies inspired in the NSI approach.

### **Methodology**

The empirical model is a panel specified in natural log, where x represent each of the four types of entrepreneurship analyzed in the paper:

$$\ln E_{it}^x = \beta_0 + \beta_1 \ln GPC_{it} + \beta_2 \ln Abs_{it} + \beta_3 \ln Tal_{it} + \beta_4 \ln Sni_{it} + \beta_5 \ln BD_{it} + \beta_6 \ln PO_{it} + \delta_9 \ln BIPU_{it} + \delta_7 TTA_{it} + \delta_8 BI_{it}$$

Data was obtained from several sources during the period 2009-2014 (t) for 32 Mexican states

(i). Total number of enterprises  $E_{it}^T$ , entrepreneurs with schooling level of less than high school  $E_{it}^{<H}$ , entrepreneurs with at least high school  $E_{it}^{>H}$ , GDP and population obtained from National Institute of Geography and Statistics (INEGI). Technological and knowledge based

entrepreneurship  $E_{it}^K$ , obtained from The National Council for Science and Technology (CONACYT). All entrepreneurship variables were expressed in per 100,000 inhabitants. Absorption (Abs) is the proportion of students graduating from high school who entered the first year of college, and talent (Tal), is the percentage of the population aged 25 years or older that has higher, normal or technical education, obtained from the Mexican Institute for Competitiveness (IMCO). Finally, variables representing higher education and scientific research were obtained from the Integrated Information System on Scientific Research, Technological Development and Innovation (SIICYT), where SNI is the number of researchers acknowledged by CONACYT, BD is the number of bachelor's degrees, and PO is the number of graduate programs acknowledged by CONACYT. Each of these variables are normalized by 100 thousand inhabitants. The model also incorporates dummy variables: 1 if the state has technology transfer agencies (TTA) above national average and 1 if the state has a number of business incubators HEI's above national average (BI). Finally, *BIPU* is the proportion of total incubators sponsored by HEI's. These three variables were constructed using data from INADEM and Red OTT.

### **Results and preliminary implications**

The empirical results are exhibited on table 1. It is observed that variables explain substantially better knowledge based entrepreneurship than traditional. Absorption (Abs) is relevant as a measure of HEI's regional coverage, representing regions ability to provide higher education and a more adequate knowledge environment: it explains  $E_{it}^T, E_{it}^{<H}$ , and  $E_{it}^K$ , but not  $E_{it}^{>H}$ , which in turn, was explained by Talent (T) as was  $E_{it}^K$ . Talent, measures the abilities of regions to generate higher skilled individuals, hence supporting more knowledge based entrepreneurship either as entrepreneurs or as workers. Hints of the role of context is provided by GDP per capita (proxy for development), which is only significant for  $E_{it}^K$ . Higher knowledge based entrepreneurship

depends on a more conducive environment (markets, regulations, inputs, rule of law, government performance, leadership, infrastructure, among others).

**Table 1. Econometric results of the panel data random effect model**

	Total entrepreneurship				Entrepreneurship / schooling < high school				Entrepren / schooling = > high school				Entrepren / knowledge based			
	Coef.	Std E	z	Prob	Coef.	Std E	z	Prob	Coef.	Std E	z	Prob	Coef.	Std E	z	Prob
Cons	5.92	1.41	4.19	0.00 (1)	6.42	1.79	3.59	0 (1)	3.03	2.13	1.42	0.16	-3.84	1.41	-2.72	0.006 (1)
lnGPC_it	-0.02	0.14	-0.17	0.86	-0.10	0.18	-0.54	0.59	-0.04	0.21	-0.17	0.87	0.25	0.15	1.68	0.094 (2)
lnAbs_it	0.34	0.16	2.10	0.036 (1)	0.44	0.20	2.25	0.025 (1)	0.08	0.29	0.28	0.78	0.31	0.12	2.66	0.008 (1)
lnTal_it	0.06	0.27	0.24	0.81	-0.03	0.33	-0.09	0.93	0.91	0.42	2.16	0.031 (1)	0.71	0.24	2.97	0.003 (1)
lnSni_it	0.02	0.08	0.23	0.82	0.00	0.10	-0.05	0.96	0.03	0.12	0.28	0.78	0.32	0.08	4.09	0.00 (1)
lnBD_it	-0.15	0.09	-1.73	0.084 (2)	-0.14	0.11	-1.28	0.20	-0.15	0.13	-1.18	0.24	-0.23	0.09	-2.53	0.011 (1)
lnPO_it	-0.04	0.05	-0.73	0.46	-0.04	0.06	-0.61	0.54	-0.07	0.10	-0.75	0.45	0.06	0.04	1.65	0.099 (2)
lnBIPU_it	-0.11	0.08	-1.41	0.16	-0.11	0.11	-1.07	0.28	-0.14	0.11	-1.30	0.19	0.33	0.12	2.83	0.005 (1)
TTA_it	0.05	0.09	0.56	0.58	0.07	0.12	0.56	0.58	0.09	0.13	0.70	0.48	-0.20	0.13	-1.47	0.14
BI_it	0.03	0.09	0.36	0.72	0.02	0.12	0.20	0.84	0.02	0.13	0.15	0.88	-0.18	0.13	-1.36	0.18
Obs	186				186				186				186			
R-sq within	0.05				0.09				0.01				0.23			
R-sq between	0.43				0.24				0.60				0.78			
R-sq overall	0.23				0.16				0.20				0.75			
Wald chi2	24.65				21.36				27.99				158.41			
Prob> chi2	0.00				0.01				0.00				0.00			

Statistical significance 1) 0.05 and 2) 0.10

Results suggest that the number of bachelor's degrees (BD) reduces entrepreneurship (Total  $E_{it}^T$  and knowledge based  $E_{it}^K$ ). The intuition behind this result is that more degrees to choose from, match better professional demand of firms and institutions, promote professional diversity, thus increasing jobs opportunities; it also increases individual's professional satisfaction, reducing the likelihood of opting for entrepreneurship. In turn, graduate degrees are positively related to  $E_{it}^K$ , which enable HEI's to satisfy demand for knowledge specialized jobs or provide specialized services, supporting knowledge based entrepreneurship either through entrepreneurial activity of graduates or as employees. The number of researchers (SNI) is a measure of the scientific capacity and potential to generate economic knowledge leading to innovations. This may be evidencing faculty entrepreneurship or linkages to industries of the researcher as business partners, associates or as part of formal agreements HEI's-Industry. In any case, knowledge and R+D may be finding some channels to disseminate and impact society. Finally, the participation

of HEI's in incubators increases knowledge based entrepreneurship, suggesting complementarity between incubation services and potential university entrepreneurs (students/faculty). Overall, results provide hints of Mexican entrepreneurship and the role of HEI's outcomes and policy efforts regarding human capital formation and R+D. Results support the contention of the existence of emerging features of a NSI with branches situated locally. To our understanding, this research applied to Mexico is novel, though there still analysis and reasoning to make of these results and further research.

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