Article:

Yoon, H, Kim, N, Buisson, B et al. (1 more author) (2018) A Cross-National Study of Knowledge, Government Intervention, and Innovative Nascent Entrepreneurship. Journal of Business Research, 84. pp. 243-252. ISSN 0148-2963

https://doi.org/10.1016/j.jbusres.2017.11.040

A Cross-National Study of Knowledge, Government Intervention, and Innovative Nascent Entrepreneurship

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Abstract

Which kind of government intervention is needed to transform scientific and technological knowledge into innovative nascent entrepreneurship? We answer this question by drawing upon the knowledge spillover theory of entrepreneurship and institutional theory. We empirically examined the moderating effect of government intervention on the relation between knowledge and innovative nascent entrepreneurship with cross-country panel data on 47 countries from 2002 to 2012. Our results first show that a smaller government sector is required to transform technological knowledge into innovative nascent entrepreneurship. In addition, we found that a larger government sector and more regulation of credit, labor, and business increase the transformation of scientific knowledge into innovative nascent entrepreneurship. We contribute to understanding the role of government in transforming scientific and technological knowledge into innovative nascent entrepreneurship.

Keywords: government intervention, innovative nascent entrepreneurship, scientific knowledge, technological knowledge

1. Introduction

National entrepreneurship research has made important contributions by identifying and examining the determinants of different types of entrepreneurship, including opportunity-driven, necessity-driven, formal, and informal entrepreneurship (Acs et al., 2014). Despite these valuable contributions, efforts to understand innovative nascent entrepreneurship have been limited. Innovative nascent entrepreneurship introduces a new product or service—specifically, a product or service that is based on knowledge and intangible assets (Audretsch et al., 2012). Such innovative nascent entrepreneurship requires more attention, as its novel product or services may bring about creative destruction of the current socioeconomic order (Audretsch et al., 2012; Schumpeter, 1912; Soriano and Huarng, 2013).

Knowledge created endogenously results in knowledge spillovers, which allow innovative nascent entrepreneurs to identify and exploit innovative opportunities (Acs et al., 2009). Although a strong consensus exists on the relationship between knowledge spillovers and entrepreneurial activity (Acs et al., 2009), our understanding of the relationship between different types of knowledge and innovative nascent entrepreneurship is still lacking. In fact, scientific knowledge derived from basic academic research serves as an “entry ticket” for innovative nascent entrepreneurship, with its supply-oriented nature (Kim and Lee, 2015; Mansfield, 1991; Mowery and Rosenberg, 1989). In addition, technological knowledge that is demand oriented also serves as a source of innovative nascent entrepreneurial activities (Etzkowitz and Brisolla, 1999; Viotti, 2002). In other words, whereas scientific knowledge is distant from commercialization, technological knowledge is close to commercialization. Although extensive innovation literature argues that the boundary between scientific knowledge and technological knowledge is not as clear as before, mingling scientific knowledge and technological knowledge may be overlooking their key features and characteristics that explain innovative nascent entrepreneurship (Calderini et al., 2007; Heller and Eisenberg, 1998). With this in mind, we examine the effects of scientific knowledge and technological knowledge on innovative nascent entrepreneurship.

Even though knowledge is critical for innovative nascent entrepreneurship, we lack understanding of the boundary conditions for knowledge to result in entrepreneurship. In particular, the available knowledge needs to interact with the institutional environment, so that the knowledge can be transformed into innovative nascent entrepreneurship (Faber and Hesen, 2004; Furman et al., 2002; Guan and Chen, 2012). In fact, several scholars use institutional theory to examine how government intervention contributes to entrepreneurship (Bradley and Klein, 2016; Cullen et al., 2014; Dau and Cuervo-Cazurra, 2014; Kuckertz et al., 2016; Nyström, 2008). Despite their important contributions, the increasing presence of government in stimulating entrepreneurial activity has given rise to a growing need to reexamine the role of government intervention by considering its characteristics. Accordingly, we draw upon institutional theory (North, 1990) to explore which kind of government intervention is needed to transform scientific and technological knowledge into innovative nascent entrepreneurship.

This study contributes to the literature of national entrepreneurship by empirically investigating the determinants of innovative nascent entrepreneurship. We used the Global Entrepreneurship Monitor (GEM) data to measure innovative nascent entrepreneurship at the country level, which is the percentage of the working-age population that are either nascent entrepreneurs or owner-managers of a new business whose product or service is new to at least some customers. This approach helps us to identify how to foster the introduction of novel product or services, which is the core agenda of many national governments, as it is closely related to their national competitiveness (Furman, 2002; Yoon et al., 2015). In addition, we contribute to the knowledge-spillover theory of entrepreneurship and institutional theory by examining the moderating effects of “areas of government intervention” on the relation between different types of knowledge (e.g., scientific knowledge, technological knowledge) and innovative nascent entrepreneurship. In fact, this study uses the Economic Freedom Index[1] from the Fraser Institute as a moderator, which measures reductions in government intervention (Angulo-Guerrero et al., 2017; Kuckertz et al., 2016; Nyström, 2008). We showed that different degrees and kinds of government activity are required for each entrepreneurial source (scientific knowledge and technological knowledge) to result in innovative nascent entrepreneurship.

The next section reviews the relevant literature and develops our hypotheses, followed by an explanation of the data and methodology used in the study. We then present the results of the empirical analyses. Lastly, we discuss the implications of the findings and directions for future research.

[1] After careful examination, the authors find that these data are valid and useable, despite the ideological bias of their source.

2. Knowledge and innovative nascent entrepreneurship

As innovative nascent entrepreneurship is based on knowledge (Audretsch et al., 2012), we build and extend upon the knowledge spillover theory of entrepreneurship, which explains that an environment with more knowledge will create more entrepreneurial opportunities (Acs et al., 2009, 2013). In fact, Acs et al., (2009) finds a strong empirical relationship between knowledge spillovers that come from the stock of technological knowledge, measured by the number of patents and entrepreneurial activity. However, according to the literature on the knowledge innovation process, both upstream knowledge (scientific knowledge—measured by number of academic articles) and downstream knowledge (technological knowledge—measured by number of patents) are important in fostering entrepreneurship (Faber and Hesen, 2004; Furman et al., 2002; Guan and Chen, 2012). Likewise, we still lack understanding of the role of different types of knowledge in entrepreneurship. In addition, previous studies do not take into account wide differences in rates among different types of entrepreneurship (e.g., necessity-driven, formal, and informal entrepreneurship). For instance, necessity-driven entrepreneurs, who lack other options for work, are less likely to rely on scientific knowledge or technological knowledge when starting their business than innovative nascent entrepreneurs, who aim to introduce novel and innovative products or services. To address these issues, we develop hypotheses on the relationship between different types of knowledge and innovative nascent entrepreneurship (see Figure 1).

Insert Figure 1 here

Innovative nascent entrepreneurship is defined as entrepreneurial activities that introduce knowledge-based new products or services (Audretsch et al., 2012). Two types of knowledge are important sources of innovative nascent entrepreneurship. First, on the upstream spectrum, there is scientific knowledge, which is more focused on exploring and establishing the truth, without having a normative component. Mansfield (1991), and Mowery and Rosenberg (1989) argue that the Industrial Revolution and innovation would not have occurred, or would have occurred much later, without the contribution of scientific knowledge, which offers technical breakthroughs because of its supply-oriented nature. In fact, scientific knowledge aims to achieve technical superiority and create new industries in the long run (Calderini et al., 2007; Etzkowitz and Brisolla, 1999). For this reason, scientific knowledge primarily consists of basic research focused on exploring and discovering phenomena that frequently appears in academic journals. This scientific knowledge, with its orientation toward upstream knowledge production, is perceived as less commercializable than technological knowledge (Cohen and Levinthal, 1989; Gambardella, 1992).

Compared with scientific knowledge, technological knowledge is on the downstream spectrum, which is closer to the commercialization process and the demand side because it involves applied research or development projects, which are usually patented (Carlsson et al., 2009; Etzkowitz and Brisolla, 1999; Lee and Yoon, 2015). In fact, the experimental problem-solving approach emphasized in the production of technological knowledge facilitates the process of translating discoveries into innovative entrepreneurial activity (Fleming, 2001). An experimental and hands-on problem-solving approach generates the benefits of contextual diversity, which enhance the applicability of technological knowledge (Amabile, 1988). In addition, technological knowledge is produced by creating and reusing combinations of diverse technological components, which lead to patented technologies. Likewise, technological knowledge, which uses a recombination process to exploit possible complementariness between existing technological components, helps entrepreneurs to incrementally enhance existing solutions (Yayavaram and Ahuja, 2008). This is why technological knowledge generally has substantially more economic value in the short run than scientific knowledge (Carlsson et al., 2009; Etzkowitz and Brisolla, 1999). Hence, we formulate the following hypothesis.

Hypothesis 1: Technological knowledge is expected to contribute more to innovative nascent entrepreneurship than scientific knowledge.

3. The role of government

Sharp debates have taken place about the role of government in entrepreneurship, as conventional wisdom holds that there is a tradeoff between having an interventionist state and enhancing the dynamism of a country's economy (Mazzucato, 2015). Whereas some see the state as a barrier that limits entrepreneurial actions, others believe that the state can foster opportunity and entrepreneurship. The role of government can be traced back to North's (1990, 2005) model of institutional theory, which explains that institutions encourage the convergence of subjective models of the world by providing existing market constructs through which people understand the environment and solve the problems they confront with the knowledge available in the environment. If institutions do not ensure that entrepreneurs or individuals are compensated for the benefits that they create for society, then little incentive exists for such behavior (Baumol, 1990).

Based on the institutional theory, several studies have investigated the relationship between government intervention and entrepreneurship (Castaño et al., 2015; Herrera-Echeverri et al., 2014; Kuckertz et al., 2016; McMullen, 2008; Nyström, 2008; Simón-Moya et al., 2014; Stenholm et al., 2013). Government intervention is measured in five areas: the size of government, the legal structure and security of property rights, access to sound money, the freedom to trade internationally, and the regulation of credit, labor, and business. Using the index of "economic freedom" from the Fraser Institute, Nyström (2008) finds that having a smaller government sector and less regulation tends to increase the rate of self-employment. McMullen et al. (2008) conclude that the government affects entrepreneurial activity differently, depending on the particular freedom restricted by the government and the entrepreneur's motive for engaging in entrepreneurial activity. Stenholm et al. (2013) find that government regulation is negatively associated with the rate of entrepreneurial activity. The common conclusion drawn from these studies is that government intervention has a differential impact, depending on the rate and type of entrepreneurial activity. In the context of our study, government intervention may affect how potential entrepreneurs access and deploy available knowledge to pursue and create innovative nascent entrepreneurship.

In addition to having a direct relationship, government intervention and innovative nascent entrepreneurship have a moderating relationship, as innovative nascent entrepreneurial activities result from interaction between the available knowledge and economic actors' latitude, which is embedded in the institutional environment (Faber and Hesen, 2004; Furman et al., 2002; Guan and Chen, 2012). This integrative approach combining the knowledge spillover theory of entrepreneurship and the institutional view enhances understanding of innovative entrepreneurial activities. Although the knowledge spillover theory of entrepreneurship and the institutional view are both prominent in the literature on national entrepreneurship, each perspective provides only part of the story. In fact, although institutional intervention may influence entrepreneurs' willingness to start innovative businesses, they may not be able to do so without the necessary technological resources (e.g., scientific knowledge and technological knowledge). In a similar way, the knowledge spillover theory of entrepreneurship does not explicitly address how entrepreneurs balance competitive and institutional pressures. In other words, the two theoretical lenses are complementary. In what follows, we hypothesize their possible interactions.

It is generally argued that commercializing scientific knowledge (upstream knowledge) is difficult, as most of it is published or unrealized in a device (and, thus, for either reason, not patentable) or may have economic value at most in the distant future (Carlsson et al., 2009). Private actors are reluctant to invest in scientific knowledge, which is immature and risky from a commercial perspective. Scientific knowledge usually requires a long-term investment and a commitment to further develop it into a commercial product with economic potential (Mazzucato, 2015). Also, the rules of market competition are not compatible with social priorities and free circulation of knowledge within the scientific community, where scientific knowledge is produced (Calderini et al., 2007). In this sense, the government has the authority to allocate resources and to support and structure a country's innovation infrastructure and, thus, help constitute "the institutional environment in which entrepreneurial decisions is made" (Minniti, 2008, 779). Such government intervention helps scientific knowledge to become more commercially mature by removing resource constraints (Mazzucato, 2015). Furthermore, government intervention can shape the incentives and skills that are necessary for entrepreneurs to take advantage of available scientific knowledge (McMullen et al., 2008). This is why the role of the government is important in scientific knowledge, as it can proactively support the development and commercialization of scientific knowledge with a long-term strategic intent and commitment (Lee and Yoon, 2015).

Whereas scientific knowledge is often oriented to the pursuit of knowledge for its own sake, technological knowledge, because of its applicability and flexibility, is intended to create products and solve problems (Carlsson et al., 2009; Etzkowitz and Brisolla, 1999). Likewise, technological knowledge derives from short-term demand and the pursuit of market goals that are favor short-term exploitable research trajectories (Calderini et al., 2007). This is why it is relatively easier for entrepreneurs and private actors to take advantage of technological knowledge for entrepreneurial activity, as the commercialization of technological knowledge is less risky and requires less commitment than the commercialization of scientific knowledge. Also, technological knowledge usually has already been turned into intellectual property, which can be directly exploited and commercialized by actual agents of innovation and entrepreneurship (Etzkowitz and Brisolla, 1999; Guan and Chen, 2012; Viotti, 2002). In fact, its economic potential can be realized mainly through the expansion of business activities at existing firms using technological knowledge, via spin-off to new entities or licensing agreements with other firms (Carlsson et al., 2009). As private actors and actual agents of innovation and entrepreneurship are at the forefront and interact with demand-side customers and users, they know best about the potential for successfully commercializing technological knowledge. In addition, the major negative effect of government intervention in transforming technological knowledge to innovative nascent entrepreneurship is its creation of barriers to entry by vested interests (Mahmood and Rufin, 2005). Vested interests oppose the commercialization of technological knowledge, because beneficiaries of government intervention such as state-owned enterprises and established firms would suffer from increased competition from the entry of new entrepreneurial firms with better technologies, which could be immediately deployed (Mahmood and Rufin, 2005). Taken together, whereas scientific knowledge requires more government intervention to achieve innovative nascent entrepreneurship, technological knowledge requires less government intervention. Hence, we formulate the following hypotheses.

Hypothesis 2a: A higher degree of government intervention strengthens the relationship between scientific knowledge and innovative nascent entrepreneurship.

Hypothesis 2b: A lower degree of government intervention strengthens the relationship between technological knowledge and innovative nascent entrepreneurship.

4. Methodology

We employ a cross-country panel from the Global Entrepreneurship Monitor (GEM) from 2002 to 2012. GEM is the largest survey of entrepreneurial activities, covering over 90 countries, and has been widely used in national entrepreneurship research (Reynolds et al., 2005). GEM measures entrepreneurship at the individual level and aggregates data at the country level, which is the unit of analyses in our study. Many studies have shown GEM data to be largely consistent with other datasets on new firms, such as the World Bank's Entrepreneurship Survey (Reynolds et al., 2005). We combined GEM data with measures from the World Intellectual Property Organization (WIPO), World Development Indicators from the World Bank, and the areas of government activity from the Fraser Institute. Table 1 presents an overview of the variables used in this study.

Insert Table 1 here

For the dependent variable, we used GEM data to measure innovative nascent entrepreneurship at the national level. To reflect the notion of "nascent entrepreneurship," we adopted a variable from GEM called "Total early-stage entrepreneurial activity (TEA)," which is the percentage of the working-age (18-64) population that are either nascent entrepreneurs or owner-managers of a new business. Also, to take into account the notion of "innovative entrepreneurship," we used a variable from GEM that measures the percentage of TEA whose product or service is new to at least some customers. We multiply these two measures and come up with a value that represents the national rate of innovative nascent entrepreneurship.

To measure our two independent variables, "scientific knowledge" and "technological knowledge," we have adopted the concept of stock, as knowledge is not depleted by being used; rather, it accumulates but depreciates over time (Hall et al., 2005). In other words, the current level of scientific knowledge and technological knowledge is determined not only by its current knowledge production activities but also by its past productive activities (Hall et al., 2005; Simeth and Cincera, 2015). In addition, because the stock of knowledge is the output of investments into research and development (R&D) activities, we constructed all our knowledge-relevant variables in terms of a ratio of R&D expenditure stock per $1 million (Hall et al., 2005; Simeth and Cincera, 2015). To construct the variable "scientific knowledge," we used the World Development Indicators from the World Bank. Specifically, we referred to the number of scientific articles published in academic journals classified by the Institute for Scientific Information's Science Citation Index (SCI) and Social Sciences Citation Index (SSCI) in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. Our approach is justified, as the progress and investigation of scientific ideas are documented mostly in the form of articles in academic journals (Arora et al., 2017; Kim and Lee, 2015; Taylor and Wilson, 2012). Technological knowledge was constructed with patent data from the WIPO, which collects data on the number of patents filed in each country in the world per year. We used the number of patent applications filed in each country regardless of the technological field. Using patents as a proxy for technological knowledge is common in entrepreneurship research (Acs et al., 2009, 2013). In the absence of more direct measures and to be consistent with convention, we use these proxies to measure scientific knowledge and technological knowledge.

To test the role of “areas of government intervention,” this study used the categories in Index of Economic Freedom from the Fraser Institute as moderating variables, to measure five areas of government intervention: (1) the size of government; (2) the legal system and the security of property rights; (3) sound money; (4) the freedom to trade internationally; and (5) regulation. We adopted the original scales of the raw data, which ranges from 0 to 10; countries with greater government intervention receive lower ratings, and countries with less government intervention receive higher ratings. Whereas countries with high measures of economic freedom are commonly recognized as having pro-market institutions and less government intervention in economic activities, countries with low measures of economic freedom are seen as economies with more government intervention and formal institutions that regulate the market and coordinate the interaction of firms and firm relations with other economic actors (Dau and Cuervo-Cazurra, 2014).

For control variables, we used the national gross domestic product (GDP) per capita, R&D expenditure, GDP growth, and the unemployment rate, obtained from the World Bank (Dau and Cuervo-Cazurra, 2014; Kim and Lee, 2015; Pathak et al., 2013).

After integrating the dataset from a number of sources and excluding observations with missing values, our final sample consisted of 47 countries from 2002 to 2012, with a total of 285 country-year observations. Ten countries are in the Americas (Argentina, Brazil, Canada, Chile, Colombia, Ecuador, Guatemala, Mexico, Peru, and United States), 21 countries are in Europe (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom), 10 countries are in the Asia-Pacific (Australia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippines, Singapore, and Thailand), and 6 countries are in other regions (Egypt, Iran, Israel, Jordan, South Africa, and, Tunisia). Using this final sample, we tested the following model:

$$\begin{aligned}\text{Innovative Nascent Entrepreneurship}_{it} &= \beta_1 \text{Scientific Knowledge}_{it-1} + \beta_2 \text{Technological Knowledge}_{it-1} \\ &+ \beta_3 \text{"Areas of Government Activity"}_{it-1} \big(+\beta_4 \text{Scientific Knowledge}_{it-1} \\ &\times \text{"Areas of Government Activity"}_{it-1} + \beta_5 \text{Technological Knowledge}_{it-1} \\ &\times \text{"Areas of Government Activity"}_{it-1}\big) + \beta_6 \textit{Control Variable}_{it-1} + \text{country}_i \\ &+ \text{year}_t + \epsilon_{it}\end{aligned}$$

where *i* is the country and *t* is the year.

We included year and country dummy variables in our analysis. Simultaneity issues might arise between innovative nascent entrepreneurship and the variables of interest, such as knowledge and government activity indices. To deal with them, all independent variables are lagged by a year. Use of a time lag is justified, as some time is required for knowledge to be transformed into innovative nascent entrepreneurship.

Insert Table 2 here

Table 2 presents the descriptive statistics and correlation matrix of the variables used in the empirical analyses. Concerns might arise about the correlation between technological knowledge and scientific knowledge, which may raise the issue of multicollinearity. Despite some correlations, the value of variance inflation factors (VIFs) for all the variables is lower than 5.00. This indicates that the variables do not exhibit multicollinearity.

5. Results

5.1. Effects of knowledge and "areas of government intervention" on innovative nascent entrepreneurship

To test H1, we ran estimations by using a country-fixed effects panel regression as shown in Table 3. Across all the models in Table 3, technological knowledge is significantly and positively associated with innovative nascent entrepreneurship ($p < 0.05$), while scientific knowledge is significantly and negatively associated with innovative nascent entrepreneurship ($p < 0.01$). This implies that downstream technological knowledge contributes more to innovative nascent entrepreneurship than upstream scientific knowledge, which is commercially immature and distant from the commercialization process. Our observation is consistent with the arguments in previous studies that technological knowledge has more economic potential than scientific knowledge and can easily be exploited and commercialized by entrepreneurs (Carlsson et al., 2009). At the same time, it is surprising to find the significantly negative relation between scientific knowledge and innovative nascent entrepreneurship. This relationship can be explained by the fact that scientific research is often conducted as "knowledge for knowledge's sake," rather than as “knowledge for application” (Mansfield, 1991). Also, scientific knowledge lacks applicability, as it may not yet have been followed up on and selected for commercial potential (Carlsson et al., 2009; Viotti, 2002). These features may lead innovative nascent entrepreneurs to perceive scientific knowledge in a negative way. Although scientific knowledge lacks applicability and entails high risk in the short term, policy makers should not understate the importance of scientific knowledge, as it could provide a foundation for expanding technological frontiers and achieve technological breakthroughs because of its exploratory nature in the long term (Arora et al., 2017).

Insert Table 3 here

In addition, the results in Table 3 show that, although all the areas of “economic freedom” have positive coefficients, only the size of government ($p < 0.01$) and regulations ($p < 0.01$) are statistically significant. This indicates that a smaller government sector and less regulation of credit, labor, and business increase innovative nascent entrepreneurship (Nyström, 2008). In fact, a large government or public sector can decrease the scope of the market available for potential entrepreneurs (except for military procurement), and a large government sector characterized by a generous social security system may not encourage entrepreneurs to engage in innovative nascent entrepreneurship (Henrekson, 2005). Also, burdensome regulations on access to credit, excessive protection of labor (e.g., unemployment benefits, labor union power), and the bureaucracy associated with running a business do not help create innovative nascent entrepreneurship.

5.2. The moderating effect of "areas of government intervention"

The size of government and regulations were the only government characteristics that are significantly related with innovative nascent entrepreneurship, so we focused on them in examining their moderating effects on the relationship between each type of knowledge (scientific knowledge and technological knowledge) and innovative nascent entrepreneurship (see Table 4). To avoid possible multicollinearity problems, we calculated interaction terms with a mean-centering approach.

The main effects of scientific knowledge, technological knowledge, and the two areas of government intervention maintain their statistical significance, even after interaction terms are added. The results of Models 1 and 4 in Table 4 are consistent with the results of Models 1 and 5 in Table 3. Models 2, 3, 5, and 6 in Table 4 present these moderating effects of "the size of government" and "regulations" on the relationship between each type of knowledge and innovative nascent entrepreneurship.

Insert Table 4 here

As indicated in Model 2 of Table 4, the size of government significantly and positively moderates the relationship between technological knowledge and innovative nascent entrepreneurship. This means that having a smaller government is desirable for transforming technological knowledge into innovative nascent entrepreneurship. Regulations do not significantly moderate the relationship between technological knowledge and innovative nascent entrepreneurship, as shown in Model 5 of Table 4. Supporting our H2b, we found that less government intervention in terms of having a smaller government strengthens the relationship between technological knowledge and innovative nascent entrepreneurship.

Model 3 of Table 4 shows that, although the moderating effect of the size of government on the relation between scientific knowledge and innovative nascent entrepreneurship is statistically insignificant, the negative relationship between innovative nascent entrepreneurship and scientific knowledge is attenuated by the size of government. We can infer from the coefficient (-0.025 in Model 3) that having a bigger government can help commercially immature scientific knowledge to be transformed into innovative nascent entrepreneurship. Model 6 of Table 4 indicates that the moderating effect of regulations on the relation between scientific knowledge and innovative nascent entrepreneurship is also statistically insignificant. However, we can infer from the coefficient (-0.123 in Model 6) that having more regulations on credit, labor, and business may be more desirable for transforming scientific knowledge into innovative nascent entrepreneurship. Supporting our H2a, we found that having more government intervention in terms of having a bigger government and more regulations can strengthen the relationship between scientific knowledge and innovative nascent entrepreneurship.

5.3. Robustness checks

One possible concern is that our results are subject to endogeneity issues. Some unobservable factors might be correlated with technological knowledge and scientific knowledge. To address this concern, we employ a recently developed instrument-free method to handle endogeneity, as suggested by Park and Gupta (2012). They suggest that the correlation between the (structural) error term and the explanatory variables can be captured by joint estimation via copulas, and they show that after the correlation is properly captured, the estimates are consistent. They provided an easy way to implement the proposed method in the regression analysis, which adds more variables to the model. They show that consistent estimates of explanatory variables could be obtained after the inverse normal of the marginal distribution of the endogenous variables is added to the model (Park and Gupta, 2012, 572-573), as these added variables capture the correlations. In our empirical model, the main possible endogenous variables are $\text{Scientific Knowledge}_{it-1}$, $\text{Technological Knowledge}_{it-1}$, and $\text{"Areas of Government Activity"}_{it-1}$. The interaction terms of knowledge with areas of government activities are also subject to endogeneity. Therefore, we constructed additional variables.

$$\text{Scientific Knowledge}_{it-1}{}^{E} = \Phi^{-1}(H(\text{Scientific Knowledge}_{it-1})),$$

$$\text{Technological Knowledge}_{it-1}{}^{E} = \Phi^{-1}(H(\text{Technological Knowledge}_{it-1})),$$

$$\text{"Areas of Government Activity"}_{it-1}{}^{E} = \Phi^{-1}(H(\text{"Areas of Government Activity"}_{it-1})),$$

$$\text{Scientific Knowledge}_{it-1} \times \text{"Areas of Government Activity"}_{it-1}{}^{E}$$

$$= \Phi^{-1}(H(\text{Scientific Knowledge}_{it-1} \times \text{"Areas of Government Activity"}_{it-1})) \quad \text{and}$$

$$\text{Technological Knowledge}_{it-1} \times \text{"Areas of Government Activity"}_{it-1}{}^{E}$$

$$= \Phi^{-1}(H(\text{Technological Knowledge}_{it-1} \times \text{"Areas of Government Activity"}_{it-1}))$$

where H(.) is a nonparametric empirical density function and Φ-1(.) is an inverse normal function.

Insert Table 5 here

Insert Table 6 here

Tables 5 and 6 show the results of our robustness checks. The tables include additional variables (marked with a superscript E) that deal with possible endogeneity as proposed by Park and Gupta (2012). These variables capture the correlation between their explanatory variables and the (structural) error term. For instance, the coefficients of technological knowledge in the tables are consistent estimators, as Technological Knowledge^{E} captures the correlation and considers endogeneity. Although the results are weakened in some models, most of our main findings are not compromised, as shown in Tables 3 and 4, except Model 2 of Table 6. In that model, technological knowledge and the size of government are no longer statistically significant. However, the statistically significant interaction term between the size of government and technological knowledge is consistent with the main findings of our previous empirical models. Lastly, our results obtained from fsQCA to examine the conditional role of "areas of government intervention" remain qualitatively the same.

6. Discussion and conclusion

This study builds upon and expands the knowledge spillover theory by testing the effects of different types of knowledge on innovative nascent entrepreneurship at the national level. We also proposed key institutional conditions affecting the relation between knowledge and innovative nascent entrepreneurship using characteristics of government that represent reduction in government intervention. In this sense, our study contributes to the literature on national entrepreneurship by drawing upon the knowledge spillover theory of entrepreneurship and institutional theory.

With regard to our central question on the role of "areas of government intervention" in transforming knowledge into innovative nascent entrepreneurship, we first found that having a small government sector is desirable for expanding technological knowledge into innovative nascent entrepreneurship. In this sense, making a shift from a government-led to a private-led approach seems more suitable for transforming technological knowledge into entrepreneurial activities. As for the role of government intervention in transforming scientific knowledge into innovative nascent entrepreneurship, we found statistically insignificant moderating effects derived from government characteristics. However, our analytical result at least led us to infer from the coefficients that a long-term commitment of resources through public spending and more government regulation of credit, labor, and business may be needed to transform scientific knowledge into innovative nascent entrepreneurship.

Our findings have several limitations that open new avenues for future research. Because of the absence of more direct measures, we used the existing conventional approach to measure scientific knowledge (journal articles) and technological knowledge (patents). This leaves room for researchers to determine the boundary between scientific knowledge and technological knowledge, which is not as clear as it used to be (Coates et al., 2001). Indeed, in Figure 1, one might have expected to see an arrow from scientific knowledge to technological knowledge, to show that the latter flows from the former. The arrow is absent because (1) a hypothesized relationship between science and technology would be tangential to this paper's main thrust, which is measuring the relationship between each of them and innovation nascent entrepreneurship, and (2) because technological knowledge in country A may stem from scientific advances in country B. Thus, not only the degree of government intervention but also the origin of knowledge and technology could play a key role in shaping entrepreneurial activities. In fact, government-created technology (e.g., the internet), which was not patented, gave entrepreneurs the latitude to create internet and web-based start-ups. In this sense, future studies could examine the relationship between the origin of knowledge (or technology) and entrepreneurship.

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Figure 1. Conceptual Framework

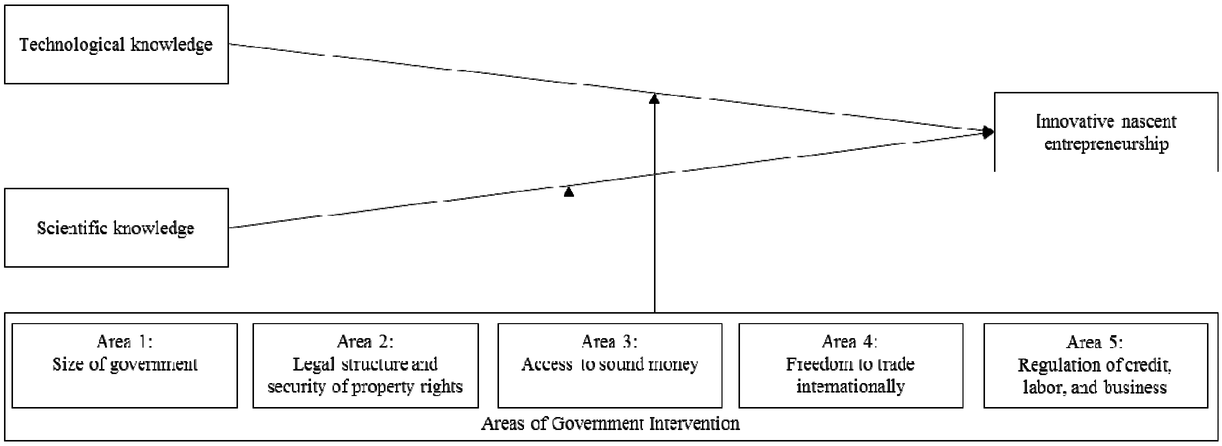

Table 1. Overview of Variables

Variables	Descriptions	Sources
Innovative Nascent Entrepreneurship (Dependent)	Percentage of working-age population that are either nascent entrepreneurs or owner-managers of a new business whose product or service is new to at least some customers	GEM
Scientific Knowledge (Main Effect)	Stock value of the number of scientific journal articles per $1 million R&D expenditure stock	World Bank
Technological Knowledge (Main Effect)	Stock value of the number of patent application per $1 million R&D expenditure stock	WIPO
Areas of Government Activity (Main Effect and Moderator)	Scores on each area including (1) size of government; (2) legal system and security of property rights; (3) sound money; (4) freedom to trade internationally; and (5) regulation	Fraser Institute
GDP per Capita (Control)	Amount of GDP per Capita divided by $1,000	World Bank
R&D Expenditure Stock (Control)	Stock value of the national R&D spending per $10 billion	World Bank
GDP Growth (Control)	Percentage of GDP growth	World Bank
Unemployment Rate (Control)	Percentage of total labor force that is without work but available for and seeking employment	World Bank

Table 2. Descriptive Statistics and Correlations

	Variable	Mean	S.D	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	Technological Knowledge	3.876	6.534	0.105	59.466	1										
(2)	Scientific Knowledge	2.003	2.196	0.364	22.383	0.51	1									
(3)	Area 1: Size of government	5.796	1.327	3.227	9.004	0.43	0.32	1								
(4)	Area 2: Legal system and security of property rights	6.865	1.751	2.754	9.503	-0.44	-0.23	-0.53	1							
(5)	Area 3: Sound money	8.834	1.14	3.826	9.887	-0.36	-0.20	-0.45	0.65	1						
(6)	Area 4: Freedom to trade internationally	7.77	0.937	4.745	9.35	-0.27	-0.13	-0.40	0.71	0.71	1					
(7)	Area 5: Regulation	6.871	0.875	4.602	8.628	-0.11	-0.14	-0.20	0.58	0.43	0.48	1				
(8)	GDP per capita ($1,000)	22.798	16.176	0.589	59.037	-0.50	-0.39	-0.47	0.83	0.71	0.74	0.59	1			
(9)	R&D expenditure stock ($10 bill)	14.173	31.51	0.005	200.82	-0.14	-0.23	0.07	0.20	0.28	0.15	0.33	0.38	1		
(10)	GDP growth rate	2.795	3.586	-10.894	15.24	0.17	0.15	0.16	-0.24	-0.38	-0.28	-0.11	-0.35	-0.15	1	
(11)	Unemployment rate	7.919	4.321	1.2	27.1	-0.02	0.23	0.07	-0.20	-0.11	-0.19	-0.22	-0.27	-0.17	-0.14	1

Table 3. Knowledge and Areas of Government Characteristics as Main Predictors to Innovative Nascent Entrepreneurship

	(1)	(2)	(3)	(4)	(5)
Technological Knowledge	0.308**	0.300**	0.298**	0.300**	0.302**
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Scientific Knowledge	-1.019***	-0.984***	-0.982***	-0.993***	-1.015***
	(0.28)	(0.29)	(0.29)	(0.29)	(0.28)
Area 1: Size of government	0.673**				
	(0.27)				
Area 2: Legal system and security of property rights		0.258			
		(0.35)			
Area 3: Sound money			0.096		
			(0.23)		
Area 4: Freedom to trade internationally				0.387	
				(0.50)	
Area 5: Regulation					1.345***
					(0.43)
GDP per capita ($1,000)	-0.114	-0.171	-0.102	-0.105	-0.085
	(0.13)	(0.14)	(0.13)	(0.13)	(0.14)
R&D expenditure stock ($10 bill)	0.002	-0.004	-0.002	-0.004	-0.005
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP growth rate	-0.036	-0.044	-0.045	-0.038	-0.044
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Unemployment rate	-0.107	-0.135*	-0.136*	-0.140**	-0.135*
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Year	Included	Included	Included	Included	Included
Country	Included	Included	Included	Included	Included
Constant	5.643*	6.297	7.320**	4.563	-0.588
	(3.18)	(4.01)	(3.70)	(5.60)	(4.08)
r2	0.843	0.839	0.838	0.839	0.845
N	285	285	285	285	285

Note: Standard errors are in parentheses; statistical significance as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Areas of Government Characteristics as Moderators between Knowledge and Innovative Nascent Entrepreneurship

	(1)	(2)	(3)	(4)	(5)	(6)
Technological Knowledge	0.308**	0.202*	0.312**	0.302**	0.312**	0.322**
	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.12)
Scientific Knowledge	-1.019***	-1.367***	-0.993***	-1.015***	-1.054***	-1.001***
	(0.28)	(0.27)	(0.31)	(0.28)	(0.32)	(0.28)
Area 1: Size of government	0.673**	0.734***	0.645**			
	(0.27)	(0.25)	(0.31)			
Size of government x Technological Knowledge		0.168*** (0.03)				
Size of government x Scientific Knowledge			-0.025 (0.13)			
Area 5: Regulation				1.345***	1.410***	1.179**
				(0.43)	(0.51)	(0.49)
Regulation x Technological Knowledge					0.016 (0.07)	
Regulation x Scientific Knowledge						-0.123 (0.18)
GDP per capita ($1,000)	-0.171	-0.192	-0.169	-0.105	-0.099	-0.125
	(0.14)	(0.13)	(0.14)	(0.13)	(0.13)	(0.14)
R&D expenditure stock ($10 bill)	-0.004	0.002	-0.004	-0.002	-0.002	-0.004
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP growth rate	-0.044	-0.016	-0.043	-0.056	-0.058	-0.050
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Unemployment rate	-0.135*	-0.181***	-0.134*	-0.086	-0.084	-0.100
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Year	Included	Included	Included	Included	Included	Included
Country	Included	Included	Included	Included	Included	Included
Constant	5.643*	6.666**	5.707*	-0.588	-1.071	0.871
	(3.18)	(2.99)	(3.20)	(4.08)	(4.55)	(4.63)
r2	0.843	0.861	0.843	0.845	0.845	0.846
N	285	285	285	285	285	285

Note: Standard errors are in parentheses; statistical significance as follows: * p < 0.1, ** p < 0.05, *** p < 0.01.

Table 5. Knowledge and Areas of Government Characteristics as Main Predictors to Innovative Nascent Entrepreneurship

	(1)	(2)	(3)	(4)	(5)
Technological Knowledge	0.269**	0.307**	0.285**	0.268**	0.280**
	(0.13)	(0.14)	(0.14)	(0.13)	(0.13)
Technological Knowledge[E]	-0.293	-0.113	-0.108	-0.01	-0.197
	(0.46)	(0.46)	(0.46)	(0.47)	(0.46)
Scientific Knowledge	-0.940***	-0.993***	-0.955***	-0.963***	-0.988***
	(0.30)	(0.31)	(0.30)	(0.30)	(0.30)
Scientific Knowledge[E]	0.126	0.094	0.055	0.076	0.018
	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Area 1					
Size of government	0.778***				
	(0.28)				
Size of government[E]	-0.341*				
	(0.19)				
Area 2					
Legal system and security of property rights		0.215			
		(0.37)			
Legal system and security of property rights[E]		-0.201			
		(0.30)			
Area 3					
Sound money			0.074		
			(0.26)		
Sound money[E]			0.045		
			(0.25)		
Area 4					
Freedom to trade internationally				0.530	
				(0.52)	
Freedom to trade internationally[E]				0.638**	
				(0.25)	
Area 5					
Regulation					1.343***
					(0.44)
Regulation[E]					0.074
					(0.21)
GDP per capita ($1,000)	-0.151	-0.113	-0.112	-0.130	-0.110
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
R&D expenditure stock ($10 bill)	0.000	0.000	-0.003	-0.009	-0.001
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP growth rate	-0.04	-0.042	-0.036	-0.024	-0.058
	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
Unemployment rate	-0.173**	-0.150**	-0.141*	-0.177**	-0.088
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)

Year	Included	Included	Included	Included	Included
Country	Included	Included	Included	Included	Included
Constant	4.947	6.897	7.640*	4.920	-0.371
	(3.31)	(4.28)	(4.11)	(5.58)	(4.15)
r2	0.845	0.839	0.839	0.843	0.846
N	285	285	285	285	285

Note: Standard errors are in parentheses; statistical significance as follows: * p < 0.1, ** p < 0.05, *** p < 0.01. Variables with a superscript E are additional regressors to deal with possible endogeneity as proposed by Park and Gupta (2012).

Table 6. Areas of Government Characteristics as Moderators between Knowledge and Innovative Nascent Entrepreneurship

	(1)	(2)	(3)	(4)	(5)	(6)
Technological Knowledge	0.269**	0.142	0.339**	0.280**	0.286**	0.289**
	(0.13)	(0.13)	(0.14)	(0.13)	(0.14)	(0.14)
Technological Knowledge^E	-0.293	-0.511	-0.145	-0.197	-0.187	-0.085
	(0.46)	(0.45)	(0.46)	(0.46)	(0.47)	(0.47)
Scientific Knowledge	-0.940***	-1.270***	-0.726**	-0.988***	-1.005***	-0.893***
	(0.30)	(0.29)	(0.33)	(0.30)	(0.35)	(0.30)
Scientific Knowledge^E	0.126	0.151	0.163	0.018	0.014	0.027
	(0.24)	(0.23)	(0.24)	(0.24)	(0.24)	(0.24)
Area 1	0.778***	0.792***	0.599*			
Size of government	(0.28)	(0.26)	(0.31)			
Size of government^E	-0.341*	0.017	-0.806***			
	(0.19)	(0.25)	(0.25)			
Size of government x Technological Knowledge		0.180*** (0.03)				
Size of government x Technological Knowledge^E		0.170 (0.23)				
Size of government x Scientific Knowledge			-0.170 (0.14)			
Size of government x Scientific Knowledge^E			0.625*** (0.22)			
Area 5				1.343***	1.375**	1.093**
Regulation				(0.44)	(0.54)	(0.52)
Regulation^E				0.074	0.051	-0.095
				(0.21)	(0.25)	(0.26)
Regulation x Technological Knowledge					0.009 (0.07)	
Regulation x Technological Knowledge^E					0.030 (0.25)	
Regulation x Scientific Knowledge						-0.142 (0.19)
Regulation x Scientific Knowledge^E						0.343 (0.26)
GDP per capita ($1,000)	-0.151	-0.216	-0.110	-0.110	-0.105	-0.109
	(0.14)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)
R&D expenditure stock ($10 bill.)	0.000	0.004	-0.003	-0.001	-0.001	-0.006

	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP growth rate	-0.040	-0.017	-0.043	-0.058	-0.060	-0.056
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Unemployment rate	-0.173**	-0.190***	-0.149**	-0.088	-0.088	-0.100
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
Year	Included	Included	Included	Included	Included	Included
Country	Included	Included	Included	Included	Included	Included
Constant	4.947	6.946**	4.251	-0.371	-0.647	1.061
	(3.31)	(3.16)	(3.27)	(4.15)	(4.66)	(4.69)
r2	0.845	0.863	0.851	0.846	0.846	0.847
N	285	285	285	285	285	285

Note: Standard errors are in parentheses; statistical significance as follows: * p < 0.1, ** p < 0.05, *** p < 0.01. Variables with a superscript E are additional regressors to deal with possible endogeneity as proposed by Park and Gupta (2012).