INSTITUTIONS AND MAKER ENTREPRENEURSHIP

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Abstract

The nascent research on the maker movement highlights the implicit assumptions embedded in the literature on entrepreneurship and innovation based on a model of closed traditional product development. Instead, the maker culture emphasizes inclusiveness, openness, sharing, and collaboration. To date, we know little about how institutional-level factors impact the probability of a maker hobbyist becoming an entrepreneur. Via a leading maker community, Hackster IO, we collected data from surveying 3,139 global makers from 99 countries during 2016, providing the first quantitative evidence about the maker movement's impact on firm creation. Our results suggest that having access to makerspaces positively correlates with the likelihood of being a maker entrepreneur. This paper provides the first large quantitative evidence on the wide existence of maker entrepreneurship across the world and how intuitional factors impact the creation of maker-founded firms.

1. Introduction

Makers - a name previously used to evoke images of hobbyists tinkering in their basements, now points to a community of high-tech DIYers (Do-it-Yourself) exploring innovative entrepreneurship as part of the global maker movement [1]. Whether in local makerspaces or their own garages, makers build on each other's inventiveness to make smart gadgets, robotic gizmos, autonomous drones, wearable devices, home automation systems, and even medical devices. Using affordable hardware, easy-to-access digital fabrication tools, and shared software and designs, makers can transform their creative ideas into functional products. Far from hobbyists, a few maker-founded firms have become the pioneers of new technologies and grown to be market leaders, such as *DJI*, *3DR* in the drone market, and *Ultimaker and Formlab* in the personal 3D printer market. This new organizational phenomenon is now appealing to policymakers searching for regulatory frameworks, other institutional and regional policies to increase attention and opportunities for makers to boost entrepreneurial activity [2]. In sum, researchers and policymakers are turning to makers who are redefining how entrepreneurial firms are formed, innovations are commercialized, and are shifting the perception of makers from hobbyists to purposive entrepreneurs.

With its emphasis on collaboration and open-access knowledge sharing, Marker entrepreneurship presents an unexamined contrast to established conceptions of technology entrepreneurship. Prior research focusing on how new technology firms start and develop rooted in a deep stream of research that emphasizes navigating resource and competitive pressures [3]. This stream assumes that products are developed in a planned, strategic way in which new firms must be wary of established competitors. Further, new firms must guard valuable resources and knowledge to establish competitive advantage [4]. In contrast, however, the novel behaviors in maker entrepreneurship – autonyms of the norms and cognitions of technology entrepreneurship - are scarcely given attention [5]. Indeed, maker-founded firms' collaborative and open institutional norms differ profoundly from that described in strategic literature but remain unexamined [6].

This paper examines institutional influences on maker entrepreneurship to gain better insights into this rapidly evolving entrepreneurial dynamic. In doing so, we respond to calls for more studies on the conditions that lead to maker-led entrepreneurship so that researchers can better interpret the differences between strategic and maker behaviors [7]. We find evidence of social/cultural influence by finding a regional "saturation effect" where the presence of a single makerspace is influential, but multiple spaces were irrelevant – inconsistent with a resource-based view of entrepreneurship. In addition, the institutional perspective allows us to explore the effects of different national contexts that shape the creation and attributes of maker-founded firms [8]. We accomplish this with data gathered from the global maker community by collecting the first large-scale quantitative dataset of maker entrepreneurs. We surveyed individual makers spanning 3,139 responses from 99 countries by HackerIO, a global maker and engineer community platform. We then matched the individual-level data with both city and country-level data from the World Bank, the Property Rights Alliance, and a private firm - Make Media, to explore how individual and

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institutional level variables jointly impact the likelihood of a maker being an entrepreneur in different economies.

This work contributes to the literature of new venture formation with a specific focus on maker-founded firms, a major outcome of the global maker movement. Recent work emphasizes maker entrepreneurship as a challenge to previous conceptions of the loci of expertise and loci of action in entrepreneurship [6]. By examining global data on makers and their actions, we find that the presence of maker spaces is a social but not resource-based influence on new maker firms., supporting their role as loci of entrepreneurial action. However, we challenge current conceptions of makerspaces as loci of shared expertise and collaborative innovation by showing that the density of maker spaces is irrelevant and that where IP protection is strong, maker entrepreneurship rates are tempered. Thus, we find that makerspaces exert a normative cognitive influence on beginning maker ventures that are most expressed in a relaxed regulatory environment. Overall, by using the lens of institutional analysis, we contribute a view of makerspaces as a force shaping the institutional environment that communicates new norms of technical entrepreneurship that challenge more common views of competitive strategy.

2. BACKGROUND AND HYPOTHESIS DEVELOPMENT

Inspired by the growing phenomenon of the maker movement, management scholars are studying maker-founded firms to extend our understanding of strategy and organizations. This stream highlights how digital technologies, collaborative norms, a shift to use innovation, and low resource costs challenge traditional views of innovation and entrepreneurship [9]. Maker-related studies inform ideas of how the sharing economy reshapes distributed physical manufacturing [10] and renews our understanding of firm-level collaboration and competition under the cooperative and sharing norms [11,12].

One stream emphasizes the project-based team formation and collaborative environment with resources often shared across organizational boundaries. These studies use the burgeoning maker phenomenon to extend our understanding of entrepreneurial teams and the creation of new organizations and jobs in the gig economy [13,14]. This literature describes the maker culture values of *learning-by-doing, sharing, collaborating, and creativity*, which may curate four unique characteristics of maker founders' entrepreneurial behaviors. First, the priority of *learning-by-doing* in the maker culture suggests that a maker might conduct many experimental activities instead of directly transitioning from a maker inventor to an entrepreneur [3]**.** Second, the emphasis on *sharing* suggests that maker entrepreneurs' commercialization activities will reduce the dependence on patent protection as an important means of value appropriability [15]. Third, the prominence of *collaborating* means the product development process might be more likely to be online, community-driven and thus more iterative. It also allows the frequent emergence of cumulative innovations among different products. Fourth, maker products are more likely to be high-tech physical products targeting nascent markets emphasizing *creativity and novelty*. To date, most maker-invented products are launched in the markets of nascent consumer electronics – robotics, autonomous drones etc., and design or education-related tools – manufacturing printers, IoT (internet of things) devices, to name just a few.

2.1 Institutional Influences on Maker Entrepreneurship

The influence of the regulatory, normative, and cultural/cognitive influences on entrepreneurship is well established [8]. Originally positioned as a response to the under-socialized, rational-actor view that saw entrepreneurship arising as a response to market imperfections and cost-benefit calculations. Instead, this stream redirects attention to the institutional factors, such as the cultural and social influences that shape new venture founding [8]. By emphasizing the importance of the institutional environment, theorists have contributed to an understanding of embedded agency, leading to a deeper understanding of constrained individual action, legitimacy, the regulatory environment, and institutional logics. This stream also shows that institutional influences on new forms have unexpected outcomes. When liquor stores in Alberta were allowed to locate outside of the small areas to which they had been previously restricted, they still started in the previously restricted area to maintain legitimacy as liquor stores [16]. Similarly, governments that eliminate regulatory certifications to jump-start new ventures are frustrated because the new firms comply with old certifications to maintain legitimacy with others [17]. Overall, work in this stream established the effects of regulatory barriers on different types of founders, the resistance of ventures to change that challenges their legitimacy, and how new ventures attract resources with legitimizing actions.

Since 2010, the maker movement has attracted scholarly attention to this bottom-up, crowd-based organizational form, with its associated sources of unique institutional and organizational support such as maker-fairs, maker spaces, and even magazines. Typical of these newly emerged phenomena are STEM education centers using DIY electronics and novel fabrication machines, open-source DIY-level IoT software, modular 3D fabrication, hardware, drone, and robotics systems. Given its recent emergence, maker-founded firms are often still in the early stages of growth. Prior literature suggests that they are disposed to model themselves on exiting organizational templates [18]. However, makerspaces seem to offer novel organizational attributes of an intense culture of sharing and learning-by-doing combined with opportunities for makers to learn from their peers in the makerspace. Makerspaces feature shared physical spaces for making, providing not only tools and equipment for design and manufacturing activities, but also a caring community for entrepreneurs to access human capital and knowledge [19]. Accordingly, behaviors and attributes common to the makerspace and not the broader business environment are likely to take hold. Overall, beyond sharing and collaboration, even innovation and the norm to commercialize thus become legitimized when and where makerspaces are established.

Compared to academic labs and industry R&D labs, the culture inside of makerspaces is more informal, transparent, collaborative, and sharing (Lang 2013). Having access to a local makerspace not only enables nascent entrepreneurs to do fast prototyping and testing, but more importantly, it allows entrepreneurs to meet potential customers, co-founders and have more access to various resources [19]. For example, most makerspaces have their own weekly or monthly member events, where makers can meet each other in person. They highlight their inventions and share making experiences. The in-person interactions among members can expand the nascent entrepreneurs' social network, facilitating the process of finding co-founders, early employees, or investors. Furthermore, many makerspaces provide open-house days to the public in the form of a marketplace or maker fairs, inviting their members to exhibit their products. These events are like a temporal market that members can showcase their innovations, share information on future events and transactions are enabled. This favors the emergence of local purchasers, which are a critical factor of user innovation commercialization and change a potential entrepreneur's cognitive mindset. Therefore, makerspaces become an incubator of not only innovative ideas, but also entrepreneurial ideas and entrepreneurial opportunities.

Makerspaces attract those pursuing maker activities to take advantage of the legitimacy and opportunities they provide. It follows then that project commercialization is more likely given the presence of shared cultural norms in these spaces. Prior literature is replete with studies of how peers influence individuals to start firms (Giannetti and Simonov 2009; Nanda and Sørensen 2008). Moreover, we know that entrepreneurs are motivated to start firms in geographical and cultural spaces where they are more legitimate [16,18]. Therefore, we posit:

H1a: *Having access to maker-related organizations (e.g. makerspaces) increases the likelihood of a maker starting a new venture.*

Prior literature argues that institutional environments that affect entrepreneurship are multi-dimensional and multi-level [8,17]. Such ecosystems contain key interdependencies that jointly shape the value creation possible with a technology or product and the cognitive status of potential entrepreneurs. As such, there is a saturation effect, where simply adding more of a single ingredient (i.e., a makerspace) is unlikely to drive additional maker-founded firms. Depending on the availability of other complementary activities and resources in a region, maker entrepreneurship may not be viable, even despite the presence of many makerspaces. For instance, makerspaces are seldom investors or have market expertise, legal help, and other resources that entrepreneurs need to establish and grow their firms.

Given that maker spaces contribute little to what we would consider the resource networks that comprise an entrepreneurial ecosystem, we expect that the encouragement of entrepreneurship from makerspaces will be insensitive to the number of makerspaces in a region. This is consequential because it implies that makerspaces effects on entrepreneurship are via norms and legitimacy and not the provision of economic resources. Therefore, we posit:

H1b**:** *The frequency of maker-related organizations (e.g., makerspaces) in a region does not affect the likelihood of a maker starting a new venture.*

2.2 Regulatory Impacts and Maker-founded Firm Creation.

A cardinal feature of maker entrepreneurs is their collaborative and open access behaviors with respect to the technologies and businesses they develop. This begs the question of exploring the relations between intellectual property protection's effect and makers' incentives of founding a new firm. The reason is that such regulatory protections are a central concern of technology entrepreneurship yet seem incompatible with the open collaboration and shared innovations that characterize maker firms. Two concerns are prominent in comparison to well-planned strategic entrepreneurship. First, functioning prototypes may already exist before the business is formalized or even conceived but lack originality. Makers frequently invent to satisfy their own needs without considering a potential future venture [20]. Their invention is likely to be a remix of existing designs shared by the community. Second, maker innovations are more hobby innovations emphasizing design creativity, such as new structures of physical components or a new layout of a single board computer, instead of fundamental innovations based on discoveries in science. Once released in the market, imitations are almost unavoidable. When considering a business opportunity, a maker needs to balance the investment needed in re-designing for a scaled manufacturing, potential market imitation, and the potential punishment from possible IP infringement. When a society is effective in executing IPR protection, directly commercializing "not-invented-by-me" but "modified-by-me" maker inventions can cause serious thereupon punishment and is treated as non-legit due to transparent personal credit system, which causes long-term punishment. Therefore, we posit that:

H2a: T*he lesser a national intellectual property regime enforces patent protection; it increases the likelihood of a maker starting a new venture*

When a society is ineffective in executing IPR protection, the driver of starting a firm should no more be at risk of being punished due to the effect of societal IPR. Punishment of market copying rarely takes place for startup firms. On the other hand, IPR protection does not have a substantial effect on avoiding market imitation, meaning entrepreneurs need to rely on other complementary resources to secure the competitive advantage. However, intellectual property protection plays a more significant role in a society's industrialization, such as technological infrastructures and manufacturing resources. The decision of starting a firm in IPR weak societies should be more a result of accessible and affordable access to the resources of product development, manufacturing, sales channel and talented labor. In relatively stronger IPR countries where society is more industrialized and citizens are better educated, it is more likely that a maker will find reliable and affordable talents and other resources using his network to start the firm. Therefore, we posit,

H2b: *The more a national intellectual property regime enforces patent protection, it decreases the likelihood of a maker starting a new venture.*

3. Methods

3,139 responses from 99 countries were collected from a novel survey launched in 2016 in the world's largest hardware community, HacksterIO. HacksterIO platform was launched in 2010 and quickly became the biggest hardware community in the world. In 2017, HacksterIO was acquired by a public firm, Avnet. The firms in 2016 hosted 1.1M registered users, and 19K shared DIY projects. This survey generated the largest quantitative dataset (that we are aware of) about the global maker community and their entrepreneurial behaviors. The survey includes 21 general questions to collect respondent's demographic information, technological experiences, making activities and entrepreneurial activities. The survey also includes four questions to determine if the respondent self-identifies as a maker entrepreneur. [1] As maker entrepreneurship is a relatively new term and to date, there is no widely accepted definition, we design several questions to make sure respondents share the exact definition. We are interested in manufacturing-oriented firms with design capability, so we designed a set of questions for sample maker entrepreneurs. The first question is, "*Are you a founder of a firm?*" If respondents choose "yes," then the following two questions are "*Do you work full time for your firm?*" and "*Do you run your business on hardware products?*" If respondents choose "yes" to *"Do you run your business on hardware products?",* then the following question is "*Is/Are the hardware product(s) designed or produced by the founding team?"*. Other make entrepreneur-related questions were designed to collect information about the firm size, sales channels, utilization of open-source modules and current challenges facing entrepreneurs. We have identified 306 (9.7%) maker-founded firms that produce physical products where the makers are full-time founders and 95 maker-founded (3%) firms whose founders do not work full time.

The survey was in English and was launched on the homepage of HacksterIO website for 40 days and included in their weekly newsletters and Twitter channels. The survey can be retweeted to forward to

[1] As the survey was hosted by Hackster firm to understand the market in general, the specific questions about maker entrepreneurship were limited to 4 among the total 25 questions.

other platforms. The growth of respondents is shown in Figure 1. In Figure 2, we can see that 62.0% of total respondents were from HacksterIO Media, including the homepage, newsletter, Facebook group, Twitter, etc. 12.2% of total respondents were from partners and third-party media channels, such as Arduino and other maker media. 25.8% of respondents' sources are unidentified. We use the extrapolation method to check for evidence of non-response bias. Using a t-test, we test whether respondents from the first ten days and last ten days and those from different sources demonstrate statistically significant differences in independent variables. No significant differences were found from the temporal level nor the source level. Therefore, the results suggest that the sample does not suffer from response bias and can represent the maker community.

The reason for the screening is that the small size of human capital reserves will not justify the entry cost of multinationals. Although a handful of inventors do reside in these countries, they are very likely to represent extreme cases. Including these data may cause biases rather than adding explanatory powers. Referring to the World Development Indicators, I remove countries and areas that have less than two million population, less than 1% of gross tertiary school enrollment rate or war-torn countries such as Kosovo, Iran. The weak IPR countries were identified according to Zhao's work, including 34 countries. The rest are defined as strong IPR countries.

3.1 Dependent Variables

The dependent variable for all three hypotheses is whether the respondent is a maker entrepreneur (ME). The data is collected from the four survey questions to create the variable *maker entrepreneur*. Respondents who self-identified as maker entrepreneurs are assigned *the maker entrepreneur* indicator as equal to 1, regardless of whether they are full-time or part-time entrepreneurs. Otherwise, the maker entrepreneur indicator is 0.

3.2 Independent Variables

Having direct access to makerspaces (MSAccess)

To test H1a, respondents' access to makerspaces was used as the independent variable. Data about the *access to makerspace* is collected from the survey question: "*Do you have direct access to or an active participant to the local makerspace within the past 12 months*?" If the respondent chose yes, then *access to makerspace* equals 1. Otherwise, it equals zero.

The frequency of maker-related organizations (MSFreq, MFScore)

To test H1b, the frequency of maker-related organizations in a region does not affect the likelihood of a maker starting a new venture. Two independent variables data is collected and measured. The first one is the frequency of local maker events measured by the historical occurrence of Maker Faires. Maker Faires, one typical form of a cultural event for makers to exhibit their inventions and socialize with each other, can be used as a good indicator of regional appreciation of maker culture. These events act as institutional carriers, transmitting social norms and cultural-cognitive understandings among participants (insert citations on institutional carriers here). Maker Media first organized Maker Faire in 2006. Then, it became an iconic maker event for the global maker community. Maker Faires are usually hosted by local government or non-profit organizations and open to the public. Maker Faires provide chances for makers to meet each other, share cultural norms and values, and showcase and learn from each other's inventions. Meanwhile, Maker Faire is becoming more and more popular among families over the years, as it is regarded as a good opportunity for parents to show the beauty of science and engineering to their children. Therefore, the history of regional maker Faires is a good measurement of local admiration and elevation of making culture due to the role of these events as institutional carriers.

Maker Media offers four types of commercial licenses to grant event hosters to name the event as "Maker Faire", including school level, mini–Maker Faire, Featured Maker Fair and Flagship Maker Fair. Apart from school level Maker Faires, which are hosted privately, all other three levels of Maker Faires are hosted mainly by regional organizations, such as government or non-profit organizations, and invite the public to join. Typically, the organizer needs to estimate the number of maker exhibitors and visitors beforehand to decide which license to purchase. Discussing with Make Faire working staff, the size of participants of different levels are typically doubled in size with each level higher. Therefore, we count one event of a School level as 1, Mini level as 2, Featured level as 3, and Flagship level as 4, which the Maker Faires organizers suggest. In this paper, we only use the cumulative score of Mini, Featured and Flagship level Maker Faires as the measurement of the local maker culture level of the city.

We used respondents' residential city data to measure the influence of Maker Faires. Then, we use Google Map API to calculate the driving time between the respondent's resident city and the list of cities that have hosted maker Faires. If the respondent's residential city is within 30 mins driving (traffic ignored) of the nearest Maker Faire hosts, it will be marked as the same score as the city that has hosted the Maker Faire. If there are two or more Maker Faire host cities within a 30-minute drive of respondents' residential city where the score of the maker culture of the residential city is a sum of scores of all host cities. For example, there are three California cities, Berkeley, San Francisco and San Jose, who have hosted 1 Mini level, 2 Flagship level and 2 Featured level Maker Faires before 2016. The highest score of maker culture was from San Mateo, located in California, the USA, with a score of. The average maker culture score is 2.38, with a standard deviation of 5.82.

Another alternative measure we used is the number of makerspaces located within 30-minutes driving distance from the city where the respondent lives. To measure the presence of makerspaces, we use the same method as how we count the number of Maker Faires and used Google map API (30 minutes distance as threshold) to check the number of makerspaces in the city that respondents located in 2016. We include only all Google map searchable makerspaces, including commercial makerspaces, public makerspaces and makerspaces in private schools or local firms.

Regulatory intellectual property right protection (IPRI)

To test H2a, we, first of all, divide the screened survey sample into strong IPR sub-group and weak IPR sub-group. Regulatory intellectual property rights protection is used as an independent variable measured by the Intellectual Property Rights Index (IPRI) from the Property Rights Alliance (PRA). We choose this measurement because it provides a very comprehensive description of calculation methodology, which includes three core components – legal-political environment, physical property rights, and intellectual property rights. Its Pearson correlation index with Global Entrepreneurship Index is 0.913, showing its significance in entrepreneurship research. PRA has composed the annual IPRI report since 2007 and now covers 129 countries worldwide, which is the most complete index data to match our survey data. The index ranges are from 0 to 10. In this data, the lowest IPRI comes from Venezuela, whose score is 2.73. The highest IPRI score is from Finland at 8.377.

Strong Intellectual Property Right Countries (IP_{Strong})

Strong IP countries are defined as the if IPRI index is bigger than 7, then we define the country as an IP strong country.

Control Variables. The control variables were selected from both individual levels, regional levels and institution levels. From individual levels, *respondents' age, gender, household income, education level, technological background*. All demographic data is collected from survey responses.

The regional variable includes whether the respondent *lives in a 1-hour drive to a city with more than 500K population*. Access to human capital has been proved to be important for nascent entrepreneurs to create a new firm (Lee et al., 2004).

From institutional variables, control variables include *country population, unemployment rate* (Armington & Acs, 2002). *GDP per capita (PPP)* is used to control the average individual opportunity cost. We also include *manufacturing GDP percentage* to measure entrepreneurs' proximity to low-cost, reliable manufacturing resources. We collect data from the World Bank to collect the manufacturing GDP of 2016 to measure the importance of manufacturing in the total national economy. If manufacturing industries more dominate a country's industry portfolio, manufacturing activities should be more commonly seen in both professional and private life. Thus, it is more likely that a nascent entrepreneur can find good manufacturing resources to launch the product. These countries might also have favored material resources, public policies and technological infrastructures for manufacturing, such as cheap labor price, cheap raw materials, high CO2 emission threshold, etc. To control the entrepreneurial intention, we used the *national employment rate* of 2015 from the World Bank database. Employers are defined as "*those workers who, working on their account or with one or a few partners, hold the type of jobs defined as a "self-employment jobs," i.e., jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced). Moreover, in this capacity, have engaged, continuously, one or more persons to work for them as employee(s)*." A summary of the Pearson coefficient correlation table is available on request from the authors.

As we have cross-sectional data from different countries and dummy dependent variables, the regression model is chosen to be mixed-effect logit regression to explain the relationship between dependent and independent variables. We choose mixed-effect logit regression because individual data is clustered on a country level, so we treat the country as a random effect and other control variables as a fixed effect. We treat the relationship between the dependent variable and other independent variables as a simple linear relationship. We use a linear model with an interacted term between IPRI and IP_{Strong} to explore whether IPR has a different effect on maker-firm founding in strong and weak IPR societies. If the H1a is not rejected, we should expect the coefficient α_6 to be significantly positive. If the H1b is not rejected, we should expect that both the coefficients α_3 and α_6 to be insignificant and together also insignificant. If H1b is not rejected, we should expect a non-significant coefficient on both the regional Make Faire score and a regional number of makerspaces, as well as an F-test result showing that the two variables are not significant. If the H2a is not rejected, we should expect the coefficient $\alpha_1 + \alpha_2$ to be significantly negative. If the H2b is not rejected, we should expect the coefficient α_1 to be significantly positive.

$$ME \sim \alpha_0 + \alpha_1 IPRI + \alpha_2 MFScore + \alpha_3 MSFrequency + \alpha_4 MSAccess + \sum_{i=1}^{n} r_i\ CV_i + \text{e}$$

4. RESULTS

In Table 1, the mixed model logit regression shows that the country is not significant as a random effect. For all rest models, simple binomial regression is thus used. To test H1a, we use Model (1~2). Model (1) shows that in both IP strong countries and IP vulnerable countries, respondents who have or used to have makerspace access are more likely to become maker entrepreneurs. Model (1), which describes IP strong countries having access to makerspaces, shows a significant positive coefficient valued at around 0.81, making the odds ratio of being an entrepreneur is exp (0.92) -1 = 125%, meaning it is more likely for the respondents who have access to makerspaces to become an entrepreneur than those who do not have access to makerspaces. Model (2), which describes IP weak countries having access to makerspaces, shows an even more significant positive coefficient valued at around 1.16, making the odds ratio of being an entrepreneur is exp (0.92) -1 = 219%, meaning it is twice as likely for the respondents who have access to makerspaces to become an entrepreneur than those who do not have access to makerspaces in weak IP countries. Therefore, we do not reject H1a that *Having access to maker-related organizations (e.g., makerspaces) increases the likelihood of a maker starting a new venture.*

To test H1b, we observe the coefficient of the local Make Fair index and the local population of makerspaces. In both IP strong and IP weak countries, we found that the Maker Faire index and makerspace index coefficient are not significant. Using F-test to test the overall significance of both variables, we found consistent results. Therefore, we do not reject H2: *The frequency of maker-related organizations (e.g., makerspaces) in a region does not affect the likelihood of starting a new venture.*

To test H2a and H2b, we focus on the IPRI coefficient in Model (1) and Model (2). In Model (1), whose samples represent IP strong countries, the coefficient of IPRI is -2.04, making the odds ratio exp (-2.04) -1 = -87%, meaning one score increase in IP-strong countries, the likelihood of being an entrepreneur drops 87%. In Model (2), whose samples represent IP-weak countries. The coefficient of IPRI is 0.46, making the odds ratio as exp (0.46) -1 = 58%, meaning one score increase in IP-weak countries, the likelihood of being an entrepreneur increase 58%. According to the data, it seems the likelihood of being a maker entrepreneur is more sensitive to IP protection effectiveness in IP strong countries. There are we do not reject H2a, nor do we reject H2b.

5. DISCUSSION

Maker entrepreneurship, a novel entrepreneurial venue in the global engineer, designer and artist community, provides rich data to extend the current understanding of innovation and entrepreneurship theories. Making activities can be treated as a novel form of manufacturing enabled by novel fabrication tools and Internet technologies, although makers are more willing to identify themselves as creative inventors [21]. This paper provides the first large quantitative evidence on the wide existence of maker entrepreneurship across the world and how make-related organizations and intuitional factors impact the creation of maker-founded firms. In this paper, we found that makerspace, a novel organization format incubating innovation whose culture is sharing, collaborating and learning-by-doing, creates opportunities for entrepreneurship. However, a local presence intensity of maker-related organizations culture does not contribute to the likelihood of becoming a maker entrepreneur, which is against the media's advocacy of makerspaces' potential. Meanwhile, the intellectual property right protection as a regulatory institutional profile impacts the creation of maker firms differently in strong and IP-weak countries. In particular, in high intellectual property right index (IPRI) countries, the decreasing rate of being a maker entrepreneur is even faster than the increase rate of being a maker entrepreneur in IP-weak countries. The findings suggest to policymakers that to take advantage of the maker movement to boost the regional economy, helping local makerspaces to increase their membership is more beneficial than purely encouraging creating more makerspaces. From the institution level, when the country-level IP protection strength is very weak, policymakers may need to develop stronger IP laws to promote maker entrepreneurship. While among the countries whose IP protection strength is very strong, policymakers want to make their IP laws more flexible towards maker products to encourage entrepreneurship.

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Table 1 Mixed logistic regression to test H1a, H1b, H2a and H2b

Dependent Variable: Being a make entrepreneur	Model (1): IPRI< 7	Model (2): IPRI> 7	Model (3)
Note	Low IPRI	High IPRI	Quadratic IPRI
Makespace access	1.158*** (.181)	0.816*** (.167)	0.920*** (.118)
IPRI	0.372**	-1.25** (.583)	2.098*** (.639)
IPRI*square			-0.167*** (0.051)
MFScore	-.130* (.069)	.007 (.011)	0.002 (.011)
Local # Makerspaces	**.004** **(.004)**	**0.001** **(.027)**	**.001** **(.002)**
Employer rate%	-0.307*** (.092)	-0.069 (.117)	-0.120* (.055)
GDP capita (PPP)	.221 (.195)	-.188 (.165)	-.267** (.020)
Manufacturing GDP%	-.016 (.029)	.029 (.234)	.023 (.019)
Unemployment %	-.002 (.026)	-.176** (.089)	-.014 (.022)
in >500K city	.106 (.189)	.227 (.197)	.204 (.133)
log country population	.281*** (.077)	-.152* (.084)	.012 (.048)
Gender	-.041 (.448)	.102 (.273)	.013 (.228)
Age: Younger than 14 15 ~ 18 19 ~ 25 26 ~ 36 37 ~ 48 49 ~ 67 68+	ref .788 1.665 2.410** 2.078* 1.979* 4.606***	ref -.463 1.091 1.026 .832 .983 .640	ref .206 1.217 1.626** 1.371* 1.425* 1.611*
Household Income Less than $20K $21K ~ $39K $40K ~ $59K $60K ~ $79K $80K ~ $99K More than 100K Prefer not to say	 -.794 -.997 -.132* -1.480* -.691 ref -1.124*	 -.541 .184 -.410 -.421 -.898* ref .264	 -.035 .063 -.090 -.418* -.746** ref -.213
Background: Software Hardware Both	.421 1.142* .991	1.626*** -.005 -.270	-.915** .268 .049
No observations	971	2087	3069
F test local # makerspace, and MFScore	Chi2 = 4.32 p = 0.116	Chi2 = 0.62 p = 0.76	Chi2 = 0.61 p = 0.74
R square	.163	.076	0.127