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A theoretical model of values and behaviors that shape technology region emergence in developing contexts

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Abstract The research on emerging cluster regions often focuses on infrastructure that is needed to create these regions at the macro-economic level, with minimal consideration of the micro-level human factors that drive these regions. In this study, we develop a theoretical model of micro-level behaviors—that is individual level—that are needed within regions to produce the knowledge, entrepreneurial, and market making functions of innovation systems. Our core argument is that it is through a critical mass of individuals with these behaviors, that an innovation system that supports technology regions will emerge.

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The geographic concentration of firms, employees, and industry institutions has localized the production of technology and innovation within regions (Audretsch and Feldman 1996). This localization results in the formation of regional innovation systems (Cooke 2001; Diez 2001; Yu and Jackson 2011), which scholars define as the embodiment of entrepreneurship behaviors, knowledge search, creation, and dissemination, and the activities associated with the mobilization of resources and establishing of legitimacy for new markets (Bergek et al. 2008; Chaminade and Edquist 2005; Hekkert et al. 2007). In such environments, the resources that are needed to create and sustain new technologies are commonly found within the region where the technology innovation system exists. These regions, which are also commonly referred to as technology or geographic clusters, now exist in many cities around the world. More importantly, officials in other regions desire to create technology clusters to benefit from the economic development and growth that has accompanied successful regions (Dohse and Soltwedel 2006; Gilbert et al. 2004; Ketels et al. 2006).

While the literature suggests several macro-level attributes that lead to technology cluster formation (e.g., Feld 2012; Porter 1998), this information has not yet been sufficient for helping most city officials create

technology clusters. In fact, despite the push to establish clusters in many regions, clusters have been slow to form even in developed countries. Many regions in developing countries are without strong levels of innovation that are needed to support technology clusters (Lee 2016). One reason for weak innovation in these regions is relatively poor skill levels that limit human capital in the region (Rosenfeld 2003), and make it difficult for innovation systems to function. Rosenfeld (2003) acknowledges that human capital and low levels of other critical resources reduce the likelihood that regions in a developing country would have the capacity to host technology clusters. Consequently, without clusters to research, developing countries have seldom been the focus of this strand of research (Gilbert 2017), which has left a paucity of understanding about the characteristics that will generate clusters in developing countries. Thus, as the developing world needs economic development that maximizes use of its entire population (Stallings 2016), there is a tremendous need for research that initiates a conversation around the capacity of the local population to envision actions with the potential to create technologies, firms, and industries (Anderson 1983).

The premise of this research is that developing countries will require a critical mass of individuals who operate in the mindsets that produce technologies and foster the emergence of new businesses or industries, if they will see technology clusters emerge. This research goes beyond discussion of specific actors or roles that are needed for clusters to function (Fornahl et al. 2015; Kasabov 2010; Sydow et al. 2010), as these actors do not exist in ample supply in developing countries (Rosenfeld 2003). Instead, we give attention to the micro-behaviors that enable the creation and dissemination of knowledge, that motivate a search for knowledge, that drive entrepreneurial behaviors, and that mobilize resources and create markets. The focus on developing countries is necessary due to their prominence as the locus of global growth for the world's population. With many countries investing in infrastructure to support technology clusters (Diez 2003; Ketels et al. 2006; Witte et al. 2003), there is an imperative need for scholarship that contributes to our understanding of the stimulants of cluster formation in regions where historically they have not existed.

Therefore, we present a model of micro-level behaviors that support the functions of regional innovation systems, and hold the potential to foster clusters in developing countries. Specifically, we propose a set of values and beliefs that are necessary to initiate knowledge search, creation, and dissemination; entrepreneurship behaviors; and resource mobilization and market creation within regions. The research contributes to the literature in several ways. First, it is the first study to our knowledge that integrates micro- and macro-level factors into a comprehensive understanding of individual values and behaviors that support the regional innovation systems that underlie technology clusters. This framework necessarily incorporates a human behavioral perspective into the conversation on the infrastructure that is needed for technology clusters.

Second, the model presented is a framework that enables regional officials to assess the extent to which their populations hold the values and beliefs that foster and support technology innovation systems. As such, it is also a road map for shaping education and innovation policy. The manuscript is developed to first overview the factors that support the emergence of regional innovation systems, with specific attention given to the knowledge, entrepreneurial, and market making functions. It then discusses these concepts according to how they contribute to a culture for regional innovation. The manuscript concludes with a discussion of the implication of this work for aspiring entrepreneurs and regional policy officials.

1 Technology innovation systems and macro- and micro-level supports

Innovation systems generate, diffuse, and use innovation (Edquist 2005). In recent decades, they have been acknowledged as being geographically bounded (Cooke 2001; Yu and Jackson 2011). In fact, several regions with successful innovation systems, such as Silicon Valley in the USA where many of the world's most innovative technology firms operate, and nations such as Israel, where its high levels of innovation have given it the nickname Startup Nation (Senor and Singer 2009), have gained significant societal acclaim. The innovation success within some regions has piqued the interest of many in creating innovation regions within cities (Diez 2003; Dilaver et al. 2014; Ketels et al. 2006; Witte et al. 2003).

To date, the majority of the successful innovative clusters operate from developed countries (Gilbert 2017). However, even in developing countries where

non-technology-oriented industry clusters exist, those clusters are said to not function in the same manner as traditional clusters have been described elsewhere (Rabellotti 1995; Rabellotti and Schmitz 1999; Schmitz 1995). Some scholars (e.g., Lee 2016) have suggested that these differences are due to the lack of innovative culture within developing countries. Culture creates within us, "a deep sensitivity to what is important and worthy of sacrifice. It forms within us what is moral and spiritual, of what is most worthy in our lives, by helping us to understand the deep human reality of our origins and our destiny. It helps to discern through all the data, all the ideas, all the alternatives and land on what counts in life" (Naughton and Cornwall 2010, p. 10). It defines societal boundaries (Mueller and Thomas 2000), and is well-known to influence patterns of entrepreneurial behavior (Hopp and Stephan 2012) not only in terms of whether individuals choose entrepreneurship (Halliru 2013) but also in terms of their overall ambitions (Hopp and Stephan 2012) and how they choose to operate their firms (Ntseane 2004).

In extant literature on clusters, culture has been recognized as an integral component that distinguishes successful cluster regions from others (Pohl and Heiduk 2002; Saxenian 1994). For example, Saxenian (1994) describes an overall commitment of Silicon Valley employees to advancing a technology that did not similarly exist in Route 128 employees. In Silicon Valley, technology achievement was more important than individual firm success, while in Route 128, by contrast, the individuals exhibited stronger commitment to individual firms than to a technology. Thus, Saxenian concluded that regional cultures were responsible for the different observed outcomes across the two technology regions. Kellerman (2002) similarly determined the traditions of domestic and international communication, only in this case between members of the Jewish community, combined with scholastic learning and the need for security, to motivate a search for innovative solutions. These characteristics proved critical to the development of Israel's high technology strengths. What these studies ultimately suggest is that a regional culture must create a supportive environment for innovation and entrepreneurial firms (e.g., Dilaver et al. 2014; Finegold et al. 2004; Pohoata et al. 2013; Sternberg and Litzenberger 2004).

If culture is unique to individuals who live or work within the same community (Marti et al. 2013), then local cultures define and provide meaning to interactions that those individuals value (Castells 1998). Like national culture (e.g., Hofstede 1980), which presumes that all individuals living within a nation have shared values and belief systems, local culture presumes that individuals within the same region have a distinct culture that is not commonly shared by individuals in other regions (Saxenian 1994). A region can be comprised of diverse individuals, each of which brings a set of values based on unique personal characteristics that define the culture he or she follows. Those personal cultural values may differ from those of the dominant collective value (Leung 1989). Therefore, there are often subcultures that exist within a dominant culture. For a cluster to form within a region, it must have a critical mass of individuals who engage in behaviors that formulate a subculture for innovation system within the region.

The work of scholars such as Marshall (1920), Maskell (2001), Romanelli and Khessina 2005, and Tallman et al. (2004) points to some of these important macro-level characteristics, and stresses the importance of knowledge and the functioning of firms and employees in the region. Other work (e.g., Saxenian 1996; Stam 2015) highlights the elements of a supportive community culture for technology entrepreneurship. These include tolerance for risk and failure, a positive impression of entrepreneurship, narratives that celebrate entrepreneurial success stories, and the emergence of networks, especially peer-to-peer networks such as meet-up groups and events with entrepreneurship- and innovation-related themes, that facilitate interaction with entrepreneurial peers (Stam 2015). In other words, there are critical micro-level behavioral factors that create macro-level outcomes in regions. As there is limited research that builds understanding of the micro-level behaviors that contribute to these macro-level outcomes of innovation systems, the sections below contribute to this gap in the literature.

1.1 Micro-level supports of macro-level outcomes for innovation systems

The innovation system that underlies a cluster region is comprised of several subfunctions. Markard and Truffer (2008) highlighted these functions based on Hekkert et al. (2007), Bergek et al. (2008), and Chaminade and Edquist (2005). For parsimony's sake, we accordingly summarize these subfunctions as macro-level outcomes of a knowledge function (including search,

development, and diffusion), an entrepreneurial function (including entrepreneurial activities), and a market making function (including market formation, resource mobilization, and legitimacy). Naturally, these functions require individuals who are capable of executing them. Extant research on existing clusters commonly focuses on regional-level demographic characteristics, and in particular on the presence of scientists, engineers, entrepreneurs, and policy makers who occupy these roles (e.g., Albertini 1999; Appold 1998; Bellandi 1996; Da Silva 1999; Ebbekink and Lagendijk 2013; Fornahl et al. 2015; Kasabov 2010; Sydow et al. 2010). However, in regions where skill levels are limited (Rosenfeld 2003), there is an insufficient number of workers for these careers. Moreover, there is little research that elaborates on the mindset that is needed for individuals to choose such careers. Consequently, it is necessary to consider more elementary foundations for the individual behaviors—that is the micro-level behaviors—that foster knowledge, entrepreneur, and market making outcomes. Accordingly, we review each of these functions and propose several mindsets and behaviors that would contribute to the emergence of these functions within regions.

1.2 Knowledge function

Knowledge development is one of the central aspects of the knowledge function (Markard and Truffer 2008). It is the process through which knowledge is converted into specific insights, and commonly the result of formal research and development where an inventor searches for solutions to existing technical, organizational, or marketplace problems (Katila and Ahuja 2002). At the regional level, the accumulation of R&D around a given technology results in the creation of a regional identity for that technology (Romanelli and Khessina 2005). Knowledge development enables technology firms to identify solutions for marketplace needs and subsequently to enhance the innovations they offer. It ameliorates a firm's ability to offer competitive products to the marketplace (Katila and Ahuja 2002). Therefore, knowledge development is an important aspect of the innovation systems and is foundational to technology clusters.

The knowledge development process commonly involves a firm's internal research and development, but oftentimes also involves knowledge exchange with university scientists (D'Este and Iammarino 2010; Rosenberg 1994), other firms (Guo and Guo 2011; Keeble and Wilkinson 1999; Ramirez and Li 2009), and in some instances the active users for a given activity (Lettl et al. 2005; Shah and Tripsas 2007). Knowledge also commonly flows between producers and users in regions (Marshall 1920; Maskell 2001). In fact, in Silicon Valley, this knowledge is said to flow from laboratories to local bars and community groups (Brown and Duguid 2001). Other studies have acknowledged the importance of knowledge transfer for creating technology communities (Kellerman 2002). These studies emphasize that specific occupations and actors contribute to the development of the knowledge function within regions. However, in developing countries where these actors may not exist, they will either need to develop these characteristics in the residents that are currently there, or attract actors from outside of the region. While attracting firms and talent may be a viable approach in the short term (Finegold et al. 2004), in the long run, regions benefit when their population can fulfill these functions within the region. This necessity requires consideration of how the knowledge function operates at the individual level, if a knowledge function will eventually emerge at the regional level.

At the individual level, the knowledge development process is initiated when an individual becomes dissatisfied with existing offerings and pursues a better solution. These individuals reject available options from a belief that there are better ways of operating. Therefore, knowledge development occurs in individuals with a problem-solving mindset and a willingness to understand the nature of the problem, the options for solving it, and who also have the capabilities to bring new technological solutions to market. Problem solving is a "cognitive process directed at achieving a goal when no solution method is obvious to the problem solver" (Mayer and Wittrock 1996, p. 47). It initiates a quest to identify knowledge to address a known or unknown problem (Greiff et al. 2015). For example, the nation of Israel is surrounded by nations with which it has historically had a volatile relationship. They are argued to have developed their high technology core in part to be able to protect themselves against these neighboring threats. This problem required them to identify advanced technological solutions that help the small nation

achieve its national security objectives (Kellerman 2002). This pursuit of knowledge to solve this pressing challenge has catapulted them into a status as an innovative nation.

A culture must support individuals who willingly reject the current status and search for more viable options. Such individuals are commonly both self-driven to solve a problem, which means they exhibit intellectual autonomy in getting tasks done, while also believing they can affect the problem (Heppner and Petersen 1982). Intellectual autonomy equips individuals with the freedom and flexibility to pursue new directions. The process for thinking creatively and indeed also for building a company is uncertain and time-consuming, and filled with significant challenges, thus requiring individuals who are motivated to achieve and persist in their efforts to accomplish their goals. Therefore, individual motivation to succeed combined with confidence in their ability to complete a task is an established factor for effective problem solving (e.g., Hopp and Stephan 2012).

The knowledge sharing aspects of the knowledge function involves collaborating with others to solve problems, develop new ideas, or implement policies or procedures (Akhavan and Hosseini 2015; Cummings 2004). In the process is the provision or receipt of task information, know-how, and feedback regarding a product or procedure (Hansen 1999), which involves at least two parties, a provider and recipient. From a knowledge provider perspective, the act of knowledge sharing either requires an element of altruism (Hung et al. 2011), which is an act of unconditional kindness without an expectation of a return (Fehr and Gächter 2000), or requires rewards-oriented behavior, which according to economic exchange theory suggests that rational self-interest drives human behavior (Fehr and Gächter 2000). Under altruism, the sharing of knowledge is done purely out of benevolence. People who are altruistic receive intrinsic satisfaction from the act of doing good for others (Kollock 1999). For this reason, altruistic people are motivated to help others learn (Wasko and Faraj 2005).

Under rewards-oriented behavior, knowledge sharing is done with the expectation of a future benefit. In other words, knowledge is shared because people believe there is some personal benefit associated with doing so (Constant et al. 1994). Knowledge sharing has the potential to foster learning and competitiveness (Pouder and John 1996; Romanelli and Khessina 2005; Tallman et al. 2004), which is especially important for advancing new knowledge. Because knowledge sharing benefits from frequent interaction and extensive communication (Eisenhardt and Tabrizi 1995; Hounshell and Smith 1988; Leonard-Barton and Sinha 1993), there is a clear social component associated with the practice. The flow of knowledge between parties—whether inside or outside of a region—lessens the knowledge search process and facilitates more rapid technological advancement and the development of a technology community (Karlsen 2011). These characteristics make knowledge sharing critical for knowledge development to occur within a region (Romanelli and Khessina 2005; Tallman et al. 2004). Therefore, a regional culture must support knowledge sharing as a practice, by individuals who believe in doing good, or who understand the value associated with exchanging information with others. Through these micro-level behaviors in a region, the macro-level knowledge function can be established. Accordingly, we propose that:

Proposition 1a *In regional innovation systems, the knowledge function emerges from knowledge development, knowledge search, and knowledge sharing behaviors.*

Proposition 1b *Knowledge development, knowledge search, and knowledge sharing behaviors are supported by a critical mass of regional individuals with problem-solving skills, intellectual autonomy, achievement orientation, altruism, or rewards-oriented behaviors.*

1.3 Entrepreneurial function

The literature acknowledges the importance of entrepreneurs in regional innovation emergence (Feldman 2001; Henn 2013) and of new firms for promoting industry concentration (Kim 2015; Mossig 2004). This recognition has made the entrepreneurial function an important engine driving emerging regional innovation. The entrepreneurial function is the ecosystem that forms in support of regional startups. New ventures are generally important in local markets because large firms generally do not address well the needs of many customers. Entrepreneurs observe local firm offerings which enables them to recognize the strengths, weaknesses, and corresponding gaps in the marketplace (Cohen and Winn 2007), and to create companies that address those recognized needs. For this reason, new ventures commonly serve underserved markets that large firms have overlooked or ignored (Bathelt 2002). In developing

countries, where many factors could dissuade large companies from establishing a presence, entrepreneurs may be even more important for shaping the emergence of an innovation system.

The venture creation process involves the planning, organizing, and establishing of new organizations to exploit opportunities (Gartner 1985). It is the direct outcome of individuals' intentions and consequent actions and culminates when individuals create products or services and promote them by initiating a new venture (Bird 1992). Venture creation combines entrepreneurial intent, idea generation, and opportunity recognition, followed by the decision to exploit the opportunity and acquire the necessary resources (Bird 1988; Schaper et al. 2010; Shook et al. 2003). It requires individuals with an entrepreneurial orientation, which manifests through innovative, proactive, and risk-taking behaviors (Bolton and Lane 2012), and encourages individuals to pursue self-employment rather than work for existing corporations.

Innovativeness reflects an individual's ability to conceptualize new products, services, or solutions for the marketplace. Innovativeness requires the ability to generate ideas to solve problems, but the individual must also act on those ideas to bring new solutions to the market. For this reason, proactiveness is an important component of entrepreneurial orientation. Proactive individuals pursue opportunities they perceive as beneficial. It requires an individual to recognize when opportunities exist, and to be prepared to garner the resources to exploit the opportunity. In deciding to bring a product to market of unknown quality, unknown value, and correspondingly unknown demand, the individual must be reasonably comfortable accepting the risk that is associated with the uncertainty of entrepreneurship. Therefore, risk-taking, which means acting under the guise of receiving benefits from those actions, even despite substantial evidence that indicates failure is imminent, is a necessary characteristic of individuals that can create new ventures, and trigger the entrepreneurial function within a region. Accordingly, we hypothesize that,

Proposition 2a *In regional innovation systems, the entrepreneurial function emerges from venture creation behaviors.*

Proposition 2b *Venture creation behaviors are supported by a critical mass of regional individuals with innovativeness, proactiveness, and risk-taking behaviors (i.e., entrepreneurial orientation behaviors).*

1.4 Market making function

As a new product or technology must attract customers, suppliers, manufacturers, and other stakeholders that enable an entrepreneur to build and sell new products, an important task of entrepreneurs is acquiring the resources from the environment that she does not already control. Entrepreneurs must identify, gather, and incorporate the resources to establish the firm's positioning in the marketplace (Sirmon et al. 2007). Those resources must come from other people, organizations, and institutions (Venkataraman 1997) that recognize the ventures as legitimate organizations even despite their newness to the marketplace (Lounsbury and Glynn 2001). For many small firms, these resource providers must exist in the local environment (Schoonhoven and Romanelli 2001), even though these needs often change as the venture grows (Sirmon et al. 2011). In developing countries, where the local environment is replete with resources (Lee 2016; Rosenfeld 2003), it may be even more important for entrepreneurs in these contexts to help shape the environment to create the resources that the venture will need. Thus, while venture creation starts with an entrepreneur, it also involves a complex interaction between entrepreneurs and their immediate environment (Venkataraman 1997).

Local geographic communities can be viewed as institutional environments (Marti et al. 2013), with a set of pervasive cultural values and norms of the community that serve as informal institutions (Hopp and Stephan 2012; Stephan and Uhlaner 2010). These institutions and in some cases the broader regional culture need to coevolve in support of new technologies (Feldman 2001). Many stakeholders are aware of the inherent uncertainty of new ventures and are cautious in their interactions with new firms (Stinchcombe and March 1965). Thus, entrepreneurs have the responsibility of influencing others to build the market, social norms, rules, and procedures that support their ventures, while minimizing the uncertainty and risk for stakeholders that are associated with venture creation (Dickson and Weaver 2008).

The community building process requires individuals who are motivated to lead in their life and circumstances, and who have the ability to persuade others to follow their lead. Yukl et al. (2008) defined influence tactics to include rational persuasion, consultation, inspirational appeals, collaboration, apprising, ingratiation, personal appeals, exchange, legitimating

tactics, pressure, and coalition tactics. Through these measures, individuals convince a target to act favorably on their behalf. Those with the motivation to lead and influence others succeed at acquiring the resources and creating the institutions that will enable the emergence of the market making function of a regional innovation system Accordingly, we propose that:

Proposition 3a *In regional innovation systems, the market making function emerges from resource orchestration and institution creation behaviors.*

Proposition 3b *Resource orchestration and institution creation behaviors are supported by a critical mass of regional individuals with strong influence tactics and motivation to lead.*

The six propositions we have posited are illustrated in Fig. 1. It shows that individual micro-level characteristics of problem solving, intellectual autonomy, achievement orientation, and altruism/rewards orientation contribute to micro-level behaviors of knowledge search, development, and sharing. These micro-level behaviors generate the knowledge function outcome, which contributes to the innovation system. Likewise, individual micro-level characteristics of entrepreneurial orientation foster the venture creation behavior, and this behavior initiates the entrepreneurial function outcome within regions, which helps to shape the innovation system. Last, the micro-level characteristics of influence tactics and motivation to lead contribute to the resource orchestration and institution creation behaviors, and these behaviors contribute to the macro-level outcome of the market making function, which helps to establish the innovation system in the region. In summary, this model represents the micro- and macro-level behaviors that we believe create a culture and infrastructure that supports regional innovation systems.

1.5 A culture for regional innovation system emergence

We have presented a set of micro-level behaviors that are required to produce the macro-level knowledge, entrepreneurial, and market making functions of a regional innovation system (Fig. 1). This perspective is offered, with a specific focus on characteristics that contribute to the formation of regional innovation systems in developing countries, as these regions are presently weak in their innovation capacity (Lee 2016), and consequently, under-researched in the literature on innovation systems and technology clusters (Gilbert 2017). We have argued that for regional functions to emerge, a critical mass of individuals must exist who exhibit characteristics that initiate the knowledge

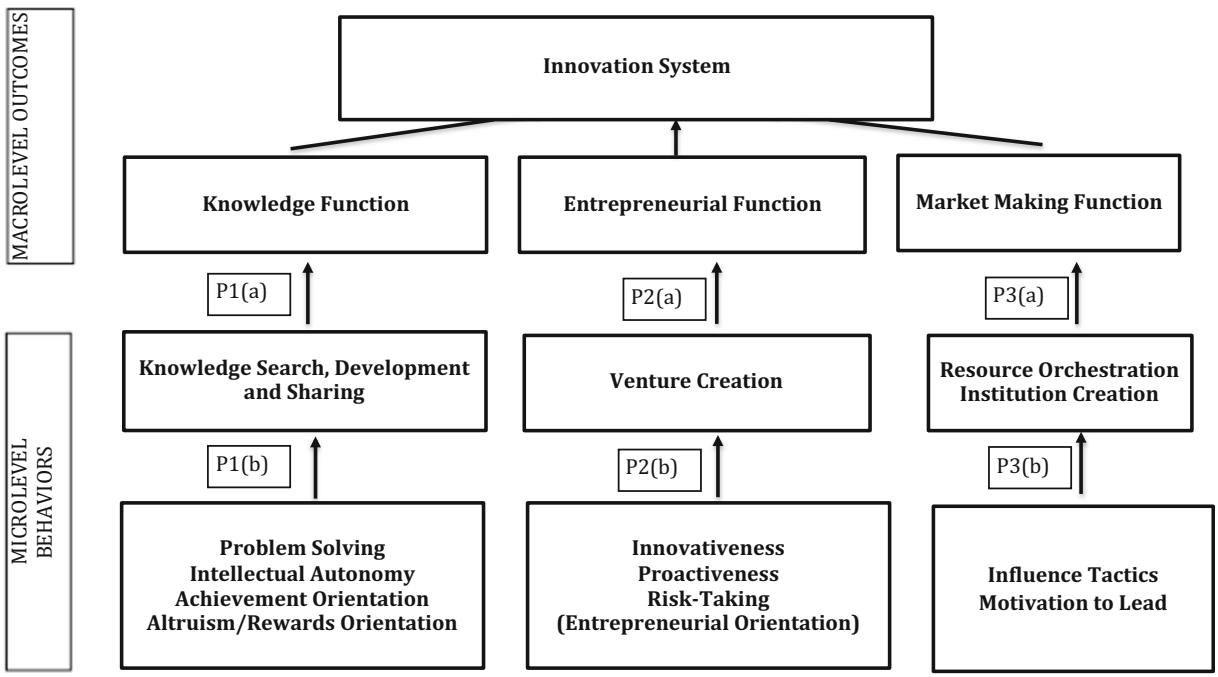

Fig. 1 Multi-level model of behaviors and outcomes that support innovation systems

development, search, and sharing capabilities that underlie the knowledge function.

The culture must also produce the entrepreneurial function, which emerges as ventures are created through innovative, proactive, risk-taking individuals, and the market making function, which is initiated when resources are brought together and institutions are created to support an emerging industry. These regional cultural characteristics emerge from a critical mass of individuals with the ability to influence others to accomplish their goals and objectives, and who are motivated to lead efforts to gather the resources and create the institutions that will support market development within a region. The implication of this framework is that regional officials cannot simply concern themselves with infrastructure components, but also must understand how micro-level factors may be contributing to or detracting from support for regional innovation systems. The perspective on behaviors needed to stimulate industry concentration was underrepresented in the literature, which focuses more on established industry clusters in developed countries, and offers little understanding of how to promote them in developing regions. This brings us to the necessary discussion on how these characteristics can be fostered in regions where they do not currently exist.

1.6 Building culture for emerging technology regions

This model offers several important insights for officials who are planning innovation systems within their regions. First, to see the knowledge, entrepreneurial, and market making functions emerge within a region, human resources must be shaped with the specific skillsets of the emerging business activity. In fact, research has shown that the inability to train human capital slows development of cluster regions (Diez 2003). As knowledge is an essential input for technology firms, officials who aspire to foster technology regions must strengthen the ability of their people and firms to generate knowledge that leads to new technological solutions. To succeed at effectively solving a problem, an individual must "know something (content knowledge), possess intellectual tricks (problem solving strategies), be able to plan and monitor one's progress towards solving the problem (metacognition), and be motivated to perform (effort and self-efficacy)" (Herl et al. 1999, p. 2). This development implies there is a need to strengthen the educational system to focus on problem solving capabilities in the population, which will require the support of regional educational institutions that train and educate future workers in the skills for the emerging industry.

Primary and secondary schooling may require new curricula that shape a non-conformist mindset within the student population. Developing this mindset may be especially challenging in collectivist cultures, or those with difficult historical circumstances (e.g., political tyrants) and certain religious beliefs and traditions where people are sanctioned for going against the norm. Identifying ways to successfully develop such a mindset in the context of historical, religious, sociopolitical, and economic constraints that create a culture that encourages conformity and compliance constitutes a significant research agenda that we hope scholars will add to their research programs.

Second, to create new products or technologies, a culture must foster the autonomy and independent thinking that leads to creative outcomes. This skill requires individuals who think broadmindedly, are curious, and exhibit creativity, which are characteristics associated with intellectual autonomy (Schwartz 1994). Achievement motivation differs across national cultures, but those who are achievement oriented have higher motivation to perform (Sagie et al. 1996), and are expected to be more likely to invest the efforts that technology development and venture creation require. Identifying the individuals within communities who display this orientation may help to accelerate the development of problem solving and new ventures within the community. Once identified, these individuals should be nurtured and supported in their quests to innovate.

Last, it is important for regional officials to understand the culture for knowledge sharing, whether formal or informal, and the channels that support or block transmission. In contexts where formal channels for knowledge transmission are scarce or poorly developed—even public knowledge—informal channels of knowledge exchange and relational ties become comparatively more important. In relational cultures, people organize life in terms of their relations with other people (Fiske 1991). They engage in communal sharing, which implies that a geographically bound group of people will form communities of practice (Brown and Duguid 1991) and operate under consummatory social capital (Willem and Scarbrough 2006). These cultures provide social pressures that expect members to

contribute to a balanced exchange relation. Participants are expected to aid people who have given help to them, or at a minimum to not do harm to those individuals. Failure to share knowledge among relational ties threatens the relationship and status in the community. Therefore, in these contexts, reciprocity that forms from relational ties may function as a precursor to knowledge sharing behaviors. Communicating the benefits to sharing knowledge may encourage this behavior.

However, even when relationships drive reciprocity, extreme levels of resource scarcity such as those found in developing contexts may limit locals' incentive to give, and their actual or perceived scarcity may prevent the sharing of anything of value. Under these conditions, altruism levels may be low and rewards orientation may drive knowledge sharing. In organizational settings, high financial rewards have been found to increase employee's job satisfaction, and willingness to share knowledge within the organization (He and Wei 2009). Therefore, in developing contexts, money or other material-based rewards may similarly seed initial knowledge sharing behaviors (Bartol and Srivastava 2002), and incentivize people so that they recognize the personal benefit that comes from sharing and collaborating with others. Without incentives, convincing individuals of the potential for greater personal gain by sharing with others may be difficult, especially if they live in environments where trust has been eroded by the challenging conditions of the developing context. Extreme corruption that has diminished the locals' belief in the value of doing good for others is a factor that has potential to suppress a knowledge sharing culture within a region. Therefore, regional officials would do well to incentivize the population to engage in knowledge development and venture creation activities.

For many people in developing contexts, there is significant uncertainty around where the next job—and in some cases the next meal—will come from, and the people have had to accept the daily uncertainty that they face. These individuals find creative ways to stretch the resources they have or to obtain new resources simply to survive. For populations that live under these circumstances, the greatest challenge may be changing the mindset from one that reacts to circumstances to one that proactively seizes opportunities. It may also be difficult to motivate individuals to assume the risk to act when their day-to-day existence involves intense uncertainty that may induce fears around committing limited resources towards other uncertain outcomes. To overcome this challenge, it may be increasingly important for regional officials to first and foremost meet the basic needs of the population, and secondly redress the unattractive conditions in the local market. With better conditions, it may be possible to attract individuals with the mindset and personal connections to source resources from other locations. One potential option for accomplishing this objective may be identifying expatriates who relocated to other regions or countries to repatriate and bring their talents and resources back to their home towns. This effort may be especially important in developing contexts where difficult political, social, or economic circumstances have discouraged immigration by foreigners and suppressed native's belief in their ability to control their own destiny.

To sustain a technology cluster, a region must have within it the resources, firms, culture, and institutions that permit an ecosystem to form around the technological identity of firms within the region. The institutional work (Lawrence et al. 2011), which involves the creation (Levy and Scully 2007), modification (Battilana et al. 2009), maintenance, or disruption and then advocacy (Lawrence and Suddaby 2006) of institutions that facilitate development of their firms, is complex and requires leadership that sets the direction for what these institutions should entail as well as people who can influence others to join the endeavor. In a developing context, these factors may not be fully formed, and may require partnerships with organizations in other areas that have strengths where the region has weaknesses. The industry will also require the support of trade associations that provide a voice to regional firms. By considering the activities that foster technology clusters through the individual beliefs and behaviors that contribute to the innovation subfunction, this work enables regional officials to more appropriately assess their region's potential for technology cluster development before they make significant investments into infrastructure for technology firms that their local culture may not yet support.

From the perspective of prospective employees to hopeful entrepreneurs, this framework shows the various roles that must be undertaken if a technology region will emerge. It is imperative that individuals understand what is required, as well as their own capacity to serve in those roles, so that they fully understand the ways in which they can contribute to this process. Then, these individuals should work with others to develop the necessary culture for a regional innovation system.

2 Conclusion

This research was undertaken because the discourse on technology regions (clusters) often points to the infrastructure that is needed in the regions, which has led many regional officials to prioritize investments into infrastructure (Diez 2003; Witte et al. 2003). These investments have been at the expense of considering whether the population can support the needs of a well-functioning technology cluster. To date, many of these regions are not seeing the levels of entrepreneurial activity that are necessary to support cluster development. One plausible reason for this delay is that it is simply too soon to evaluate their progress. After all, even Silicon Valley required several decades to develop into a vibrant state. However, knowledge creation and entrepreneurial activity are necessary catalysts for technology region growth (Feldman 2001; Feldman and Francis 2003), and can be observed. The scarcity or absence in a region, particularly one where officials have already invested into infrastructure, may signal that the region needs to strengthen its micro-level foundation in order for the innovation system to emerge. This theoretical framework was developed to offer insights into the characteristics that must exist in the region's people and local culture as critical factors for technology region emergence.

These factors notwithstanding, it is important to acknowledge that even with the requisite infrastructure and culture to support technology region emergence, it cannot be expected to happen overnight, over a few years, or even a few decades. Still, it is clear that having people in the region who support a regional innovation system is an important start. The framework developed in this paper offers regional officials a multi-level overview of attitudes, values, and beliefs—i.e., the culture—that their region will need to support technology firm emergence. With better understanding of what is required, officials can deploy their limited resources towards identifying and interjecting the mechanisms that allow a supporting culture to emerge. It is only with a supporting micro-level foundation that investments into macro-level infrastructure might be expected to yield productive returns.

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