A New Role for Land Grant Universities in the Rural Innovation Ecosystem?

Thomas S. Lyons
Michigan State University

Steven R. Miller
Michigan State University

John T. Mann
Michigan State University

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Abstract

In this article, we examine the issue of economic inequality in the rural United States and its connection to limited opportunities to create wealth through innovation-driven entrepreneurship. Reasons as to why this situation exists are investigated. We then explore the current role played by land grant universities in fostering rural innovation and its limitations. A new vision for effective land grant university participation in this arena of economic development is offered. We conclude by suggesting some actions that might jump-start this new role.

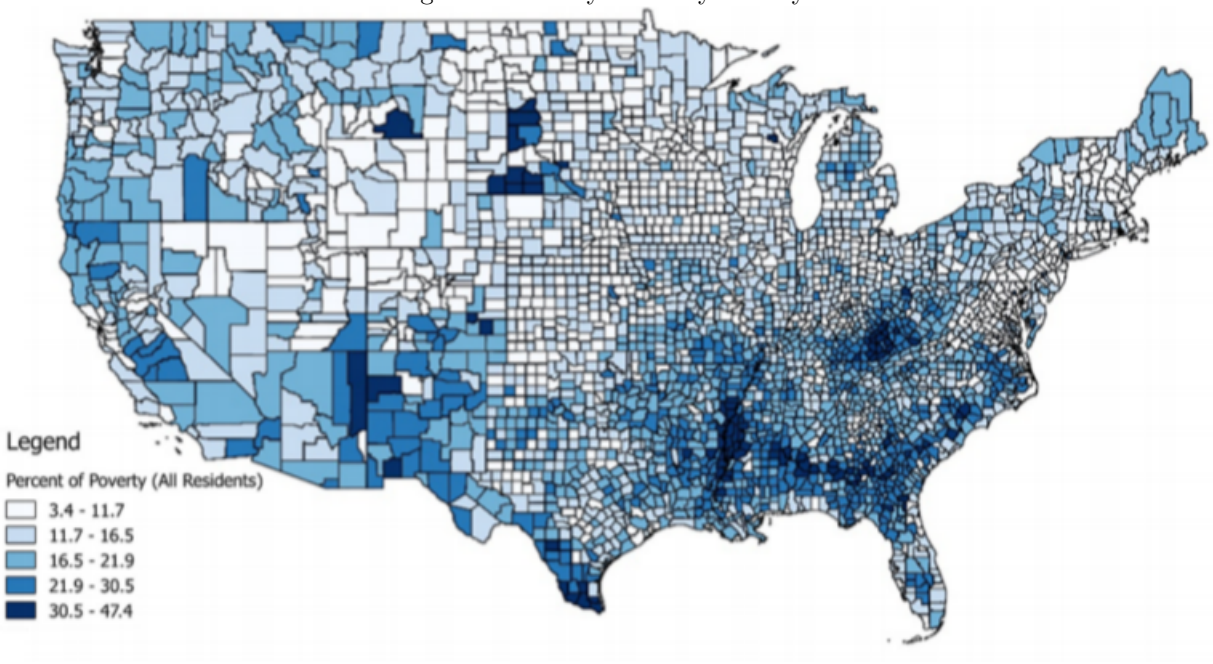
1 Introduction

In this paper, we examine the potential role for land grant universities to foster rural innovation and, thereby, create wealth as a means of mitigating rural economic inequality. We begin by documenting rural poverty, examining its causes and its effects. We then look at attempts to address this issue through entrepreneurship/innovation and their limitations. The gap between rural and urban innovation is explored, and the past, relative ineffectiveness of land grant universities in addressing this gap is discussed. We conclude with recommendations for a new model of land grant university involvement that encourages and supports effective rural innovation.

2 Background

Rural poverty is another manifestation of pervasive economic inequality in the U.S. Many rural communities are stuck in a cycle characterized by low-paying jobs, seasonal work, marginal self-employment, and a lack of spendable income to support local retail and service businesses. As farms and rural companies increasingly invest in physical capital (e.g. mechanization) at the expense of labor, jobs are lost. Persistent poverty is most common in isolated rural areas (Miller and Weber, 2003), and deep poverty – which is defined as income that is less than half of the poverty threshold – is higher among rural populations than urban and highest among rural children. The rate of deep poverty in rural America has been largely increasing since

Figure 1: Poverty Rates by County



Source: U.S. Department of Agriculture (2017), Economic Research Service, Rural Classifications

2008 (Farrigan, 2014). Though high rates of poverty are not unique to rural areas (Figure 1), poverty rates in non-metro counties are about two percent higher than their metro counterparts (Census, 2017).

While much attention has been paid to income disparity as a source of this problem, the real issue is wealth disparity (Oliver and Shapiro, 2006; Lyons, 2015). As Sherraden and Gilbert (1991) have pointed out, the building blocks of wealth are assets (e.g. a house, a stock and bond portfolio, a business, etc.). These can be transferred intergenerationally, creating long-term family wealth, which is accumulated from current and past investment of surplus income. This cannot happen when there is insufficient surplus, when surplus is not saved, or when wage earners are unable to effectively invest. Public policy tends to focus on the first two. We concern ourselves with the latter challenge to wealth creation as it relates to a specific type of asset – a business.

Starting a business can be a way to build wealth. However, there are two important caveats to this (Kutzhanova et al., 2009):

- The business must be built around an innovation - a completely new product or service; reaching a new, previously unserved, market with an existing product or service; or creating a new and improved process for producing an existing product or service (Schumpeter, 1934). If this criterion is not met, the business will likely not be able to generate the profit necessary to sustain itself and to generate wealth; and
- The entrepreneur(s) starting the business must have a goal of growth for her or his business. That is, they must "think bigger" and be intentional about pursuing expansion of the business. Otherwise, they are merely self-employed, and research has shown that self-employment can exacerbate economic inequality because it fails to create wealth, instead acting as a form of job and income substitution (Silver and Bures, 1997).

Innovation is the implementation of invention (Baldacchino, 2009; Mann and Shideler, 2015); therefore, entrepreneurs are, by definition innovators. However, they may not necessarily be inventors. Thus, entrepreneurship alone is not the answer, but when coupled with creativity/invention leading to growth, it can be.

The challenge to rural communities lies in the fact that they are generally not hotbeds of creativity and its implementation. Relative to urban areas, rural regions are less likely to create innovations or adopt them. This is due to various limitations: a lack of economic critical mass, a lack of population density that yields constructive conflict and serendipitous interactions, over-reliance on a single industry, social capital that consists of an abundance of strong ties and a paucity of weak ties, and a lack of funding for R&D, among others (Liechtenstein and Lyons, 1996; Lyons et al., 2012). This is where universities and colleges can play an important role as part of a regional innovation support ecosystem. Through strategies that improve workforce development, knowledge generation and dissemination, creative activity, coordinated entrepreneurship support, and the filling of R&D funding gaps, these institutions can help to foster rural wealth building.

Among these institutions of higher education, land-grant universities are uniquely positioned to play a leading role in the effort to create and sustain rural wealth through innovation, but are they playing that role as fully and effectively as they could be? Traditional land grant activities, such as extension services and experiment stations, have played an important part over the years in supporting *sustaining innovation*, but not necessarily in supporting the development of *disruptive innovation* (Christensen and Raynor, 2003). Through their outreach efforts, they have brought incremental improvements in solutions to challenges in agricultural production and rural community development, for example, to traditional stakeholders. However, with cutbacks in spending and "siloization," they have not positioned themselves to accomplish transformational work for their constituencies through the creation and implementation of solutions that address emerging challenges and serve new stakeholders faster and more affordably. This is Christensen's concept of *catalytic innovation* (Christensen et al., 2006). In order to accomplish this, land grant universities need to move away from the bureaucratic models currently favored and toward thinking and acting like social entrepreneurs operating mission-based social enterprises. This requires being customer-focused – being visionary and global in thinking about their stakeholders' needs and how to meet these in a timely, effective and affordable way. It also requires greater collaboration with community colleges/vocational education institutions and state and local entrepreneurship support services to build hubs and networks for local innovation.

3 The Current Approach to Addressing Economic Inequality through Innovation

Most efforts to address economic inequality via innovation take place in urban areas. Too often, these are entrepreneurship support activities that are not geared to fostering business growth, but rather to supporting economically disadvantaged people to start businesses but not necessarily expand them. In many cases, the entrepreneurship support organizations (ESOs) involved do not have, and thus do not build, the capacity to assist these entrepreneurs to develop their skills and truly grow their companies (Lichtenstein and Lyons, 2010). Because entrepreneurs often cannot afford private consultants and/or do not qualify for growth capital, their businesses languish and, in some cases, die. The result is that no wealth is created; therefore, economic inequality is effectively unaddressed.

There are exceptions to this. For example, the Westside Xcelerator in Chicago, operated by a faith-based organization called Bethel New Life, is designed to work with minority entrepreneurs who have built their skills and taken their businesses to the growth stage (commonly referred to as Stage 2) where innovation thrives. This collaborative model of entrepreneurship support delivery engages other ESOs to address entrepreneurs' technical and organizational needs. These entrepreneurs are on the cusp of building wealth for themselves and their families, but are in need of capital and connections to markets outside their neighborhoods. The Westside Xcelerator provides these, giving the entrepreneurs the boost they need to turn their businesses into wealth-building assets (Lyons, 2016).

Overall, a similar pattern exists in rural areas – very limited innovation fostering efforts for reversing economic inequality, with some exceptions. The work of the Center for Rural Entrepreneurship (CRE) does aim to address wealth creation through entrepreneurship in a very holistic way. It builds community capacity to support entrepreneurship and thereby create community prosperity (Markley et al., 2015). Economic Gardening is another program that has attempted to address rural economic development through successful

entrepreneurship. It helps to build wealth by focusing on companies in their growth stage, providing them with essential marketing data and information.

These programs are helpful in facilitating rural startups and in helping Stage 2 companies to continue to grow. Certainly, business development assistance, technical assistance, and growth capital are essential to ensuring that entrepreneurial efforts yield wealth creation. However, all of this activity assumes that these entrepreneurs have an idea, an invention, with which to work that can be the heart of a wealth-creating business.

4 The Rural-Urban Innovation Gap

In the above sections, a number of key points are identified that describe what is meant by an "innovation gap" between rural and urban areas and why it persists. In this section, we provide a more detailed discussion about these and other points in an attempt to better understand the problem of an innovation gap. In general, the obstacles faced by rural firms can be categorized in one of three ways: firm/owner characteristics, historic policy/perception, and agglomeration effects. It remains unclear, at least to an extent, how these three categories interact with one another; for example, does one cause or compound, or get caused or compounded, by one or more of the others?

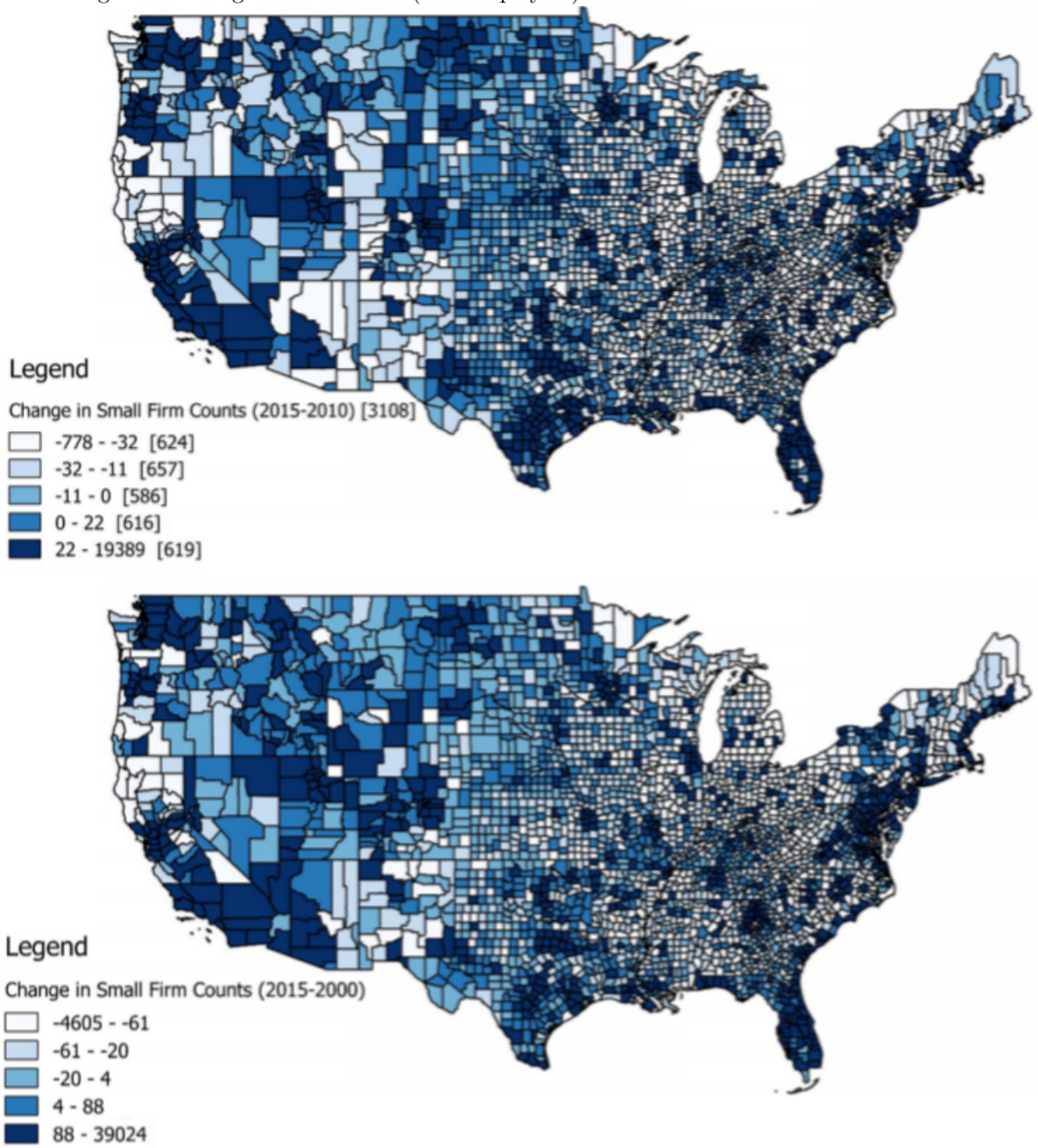
In framing the challenges leading to gaps between rural and urban rates of innovation, geography is an important consideration. The growth, or lack of growth, in business formation is not uniformly distributed across all counties. As is evident in Figure 2, most Midwestern counties experienced contractions in the number of small firms (less than 50 employees) between the years 2010 and 2015 (first map) as well as between 2000 and 2015 (second map). Plains and Rocky Mountain counties appear to have experienced expansions over the 15-year period, but Mountain counties appeared to contract in the last five years. While it is difficult to ascertain a pattern in the maps, comparing the rates of firm growth between USDA-designated metro and non-metro counties indicates that metro counties increased small firm counts by 1.2 percent between 2010 and 2015 compared to a decrease of 1.2 percent for non-metro counties. The disparity is even greater when comparing rates since 2000, where metro counties grew by 9.1 percent compared to a 3.0 percent decline for non-metro counties.

Two types of entrepreneurship dominate rural areas; specifically "necessity" and "lifestyle" entrepreneurship (Acs, 2006; Figueroa-Armijos and Johnson, 2012). Necessity entrepreneurship involves individuals who operate their own businesses because they see no economic alternatives for themselves. By its nature, necessity entrepreneurship is not innovative and this group of business owners typically abandon their ventures when better opportunities arise. Enterprises established by lifestyle entrepreneurs are frequently viewed by this group as a means to subsistence with no intent or ability to grow (Fortunato, 2014). Lifestyle entrepreneurship is entered into based on one's desire to pursue self-employment in the presence of alternative opportunities, but it does not necessarily involve innovation or a desire to see the firm grow.

The motivating factors that underlie starting a business and continued ownership by some rural entrepreneurs may also explain why these rural firms are not growth-oriented. In particular, a number of rural business owners start, or are part of, multi-generational business-ownership models, where parents intend to pass along the family-owned and operated enterprise to their children (Markley et al., 2015). This generational ownership model may have several growth-limiting effects that are linked to owner perceptions about risk. First, this model likely reduces firm exit strategies which makes the business less appealing to private equity and venture capital managers (Markley et al., 2015; Renski and Wallace, 2012; Rubin, 2010). Second, factors influencing these business owners' choice of ownership model may also impact the timing and types of new innovations adopted (or created), and rural firms have historically been laggards in adopting technology (Knickel et al., 2009; Markley et al., 2015; Renski and Wallace, 2012). Third, a desire by business owners to seek profits early in the life of the firm may also further restrict the kinds of industries entered into by rural entrepreneurs (Renski, 2008; Renski and Wallace, 2012). Finally, family-owned and operated businesses are difficult to sustain because later generations often do not have the same level of motivation and entrepreneurship skill as the founder (Lichtenstein and Lyons, 2010). Only about 30 percent of family businesses survive into the second generation (Family Business Institute, 2017).

Legacy issues may also work against rural innovation. In terms of U.S. policy, rural economies have

Figure 2: Change in Small Firm (<50 employees) Counts 2010 - 2015 and 2000 - 2015



Source: County Business Patterns.

historically been framed as primarily agriculture-based and this likely led to missed economic opportunities (Stauber, 2001). Starting with the industrial revolution; however, U.S. dependence on agriculture as a primary driver of the economy dramatically declined. As new production-based innovations were created, the agriculture sector was able to generate more output with the same or fewer inputs (Fuglie and Heisey, 2007). This also meant that more capital and labor could be directed to industries that were emerging in mostly urban areas. By the mid-twentieth century, the agriculture sector accounted for less than 5% of total US GDP and farm related income and wages accounted for about one-fifth of total income and wages in Rural America (Bureau of Economic Analysis, 2017). At the same time, Rural America was often thought of as being synonymous with agriculture, and rural policies continued to primarily focus on farm-related concerns (Browne, 2001; Cochrane, 1979). By the end of the twentieth century, the agriculture sector's contribution to total US GDP and farm income and wages share of total rural income and wages were even smaller; yet, much of rural policy maintained the outdated premise: that rural was synonymous with agriculture (Markley et al., 2015; Stauber, 2001). These same policies may also have negatively impacted the competitiveness of other rural industries (Stauber, 2001). For example, the limited public resources directed to rural areas were highly focused on agriculture, and most agriculture-related innovations were cost saving technologies applied to the agriculture production process (Mowery et al., 2010; Stauber, 2001). While these innovations were important to farmers and other agriculture-related producers, the policies driving these innovations overlooked the diversity and potential of other industries in rural areas (Stauber, 2001).

Rural economies also tend to be plagued by relatively low levels of human capital. The financial returns to education, in the form of wages, tends to be higher in urban economies than in rural ones encouraging more educated and capable workers to migrate from rural communities to urban communities. Rural economies also suffer from a dearth of opportunities for job changes and the associated transfer of knowledge across firms. One of the tenets of urban economies is that knowledge flows across firms, increasing the urban economy's aggregate level of productivity. As such, urban firms are able to afford higher wages and engender higher rates of innovation. The relative dearth of human capital in rural markets also lowers levels of management and technical skills (Henderson, 2002; Rubin, 2010) necessary to spark innovation and may reduce the capacity for entrepreneurs to develop innovative ideas and follow through with them to market.

Legacy issues around public and private infrastructure and human capital set the stage for the rural-urban innovation divide. Dynamic factors also apply. Building on endogenous growth theory (Lucas Jr, 1988; Romer, 1986), innovation and associated knowledge spillovers are important determinants of economic performance, and regional economists have spent considerable effort to understand the observed geographic concentration in innovation and industry growth (Maggioni et al., 2007). Sparse populations and remote locations limit rural firms' abilities to capitalize on economies of scale, acquire needed human capital, establish local markets for goods and services, obtain production inputs and export goods outside the region due to inadequate transportation infrastructure, and access new information and benefit from knowledge spillovers (Acs and Varga, 2005; Andersson et al., 2007; Audretsch and Keilbach, 2008; Henderson, 2002; Porter et al., 2004; Renski, 2008). The lack of agglomerative economies also increases the transaction costs of business services, and service provisions may not benefit from the economies of scale exhibited in urban markets. In rural settings, these shortcomings can be at least partially mitigated with sufficiently functioning regional networks that expand the reach of existing service providers and allow them to reach economic thresholds with reduced transactions costs. However, economies of scale in public services like waste remediation and EMS services are more grounded in space. These factors not only restrict potential opportunities for firm formation and growth, but they have compounding effects by further limiting opportunities for human capital formation.

4.1 Knowledge Transfer

Under the umbrella of agglomeration effects, the innovation gap can be characterized by differentials in the rate of knowledge and skills formation between urban and rural economies (Lucas, 2004). This type of knowledge has real implications for its impact on industry and transferability (Polanyi, 2015). Codified knowledge entails well-established processes or methods and is easy to transfer over great distances. Tacit knowledge, however, is difficult to communicate and is best realized through observation and "learning by doing." It is therefore difficult to transplant outside of the developing organization. As codified and

tacit knowledge are complements (Frenken, 2007), those geographic regions near contributing universities or innovation centers have an advantage in promoting growth through innovation. One take away is that rural areas without strong linkages to research centers should develop strategies for gaining labor force experiences to build up tacit knowledge that expedites the application of codified knowledge that can be purposefully acquired.

Economists largely see knowledge as a public good that is "non-rivalrous" and "non-excludable," in that once learned by one, it eventually becomes learned by all (Romer, 1994). Urban centers, with high population densities, facilitate the exchange of information and knowledge (Carlino et al., 2007; Fujita and Ogawa, 1982; Glaeser and Mare, 1994). The efficient exchange of information, especially tacit knowledge, declines substantially with distance from knowledge centers. In what has been termed "knowledge decay," central business districts generate clusters of knowledge and innovation that reinforce the cluster of innovation in the urban core as exemplified in patent filings (Lobo and Strumsky, 2008). While Audretsch and Feldman (1996) showed that firms that are most productive in generating innovation tend to co-locate with similar firms pursuing innovation, other research recognizes different forms of knowledge transfer that transcend the bounds of knowledge decay. Hagerstrand (1966) proposed that knowledge spillovers follow either a contagious channel of diffusion that relies on proximal exchanges of information or a hierarchical channel from universities and centers of innovation to be broadly applied in diffused locations through purposeful exchanges of information (Maggioni et al., 2007). Florax and Folmer (1992) found evidence that while proximal exchanges of information near universities facilitate firm adoption of university research, a more impactful uptake is found at greater distances. In other words, there are potential opportunities to purposefully import knowledge into rural areas from knowledge generating centers.

Much of the literature considers the barriers to spatial distribution of innovations. Reviewing patent citations, Jaffe et al. (1993) found that patent filings more commonly cite the patents of other nearby inventors, and that patent citations decline rapidly with distances as short as three to five miles. Fujita and Krugman (2004) suggested that the geographic spans of innovation clusters could be expanded through efficient transportation networks. The same may be true for extending the base of professional networks, within the context of knowledge value chains (Melcher and Miller, 2017). In considering a knowledge value chain, we can think of the knowledge production function (Griliches, 1979) as entailing the interrelated transactions of knowledge inputs across many sources or suppliers. Because knowledge, especially tacit knowledge, declines in space, the knowledge value chain degrades with distance.

As regions within a state exhibit unique strengths and weaknesses, efforts to ameliorate the innovation gap should recognize such differences. Kolko (1999) shows that cities tend to specialize and that the largest cities benefit from specializing in those sectors that are most likely to benefit from person to person contacts. Smaller cities and rural areas tend to specialize in manufacturing sectors that rely less on person to person contacts but seek innovation nonetheless (Audretsch and Feldman, 2004). Here exists a policy option for improving the innovation production of rural areas. Using a natural experiment of decentralizing university research in Sweden, Andersson et al. (2009) show that geographic diffusion of university funding promotes regional development of local innovations with a net increase of national productivity. The authors attribute this partially to the ability of individual regions to capitalize on targeting research and industries by which there exist a localized comparative advantage. Sonka and Chicoine (2004) reach a similar conclusion, noting the importance of regions specializing and innovating in areas where they exhibit comparative advantage. A potential downside effect of such regional specialization is that localized knowledge spillovers, especially across industries may be reduced, giving rise to concerns over long-term growth in innovation. However, with properly developed knowledge networks, regional specialization may not preclude knowledge spillovers within industries and across regions.

Combined, these categories of factors (firm/owner characteristics, policy, and agglomeration effects) lead to observations that rural firms have much lower rates, compared to urban firms, of investment in and the creation and adoption of new innovations (Knickel et al., 2009; Renski, 2008; Renski and Wallace, 2012). The long-term consequence of limited firm innovation is restricted wealth creation. Innovation-based (or growth-based) entrepreneurship is essential for economies to achieve sustainable growth (Mann and Shideler, 2015; Schumpeter, 1934). This type of entrepreneurship allows for other forms such as gap-filling entrepreneurship and, more important, it encourages other innovation-based entrepreneurship which continues to propel the cycle of growth (Goetz et al., 2010; Mann and Shideler, 2015) and builds a culture of entrepreneurship

(Hustedde, 2007; Loveridge et al., 2012). Moving forward, new polices and efforts intended to improve the vitality and resilience of rural economies must address the obstacles impeding rural firms from innovating.

5 The Role of Land Grants

In the late 19th Century, the Morrill Act established the land grant system and allocated resources to states to establish colleges tasked with educating the industrial class and, thus, promote economic growth. As the peoples' colleges, land-grant institutions focused research on the typical challenges that people faced and were the primary conduit of agricultural research to community, developing technologies around agricultural production (Campbell, 1995; U.S. Department of Agriculture, 2015). Research supporting agricultural and engineering activities, such as through experiment stations and the establishment of an extension service to disseminate new knowledge, are part of the historic land grant mission. In some instances, land grant universities played a pivotal role in developing disruptive technologies. The advent of mechanical harvesters for tomatoes in California and pickles in Michigan are good examples where industry, financiers, scientists and the respective state's cooperative extension worked together to break down silos and capitalize on the regional comparative advantage in agriculture (Cargill et al., 1975; Schmitz and Seckler, 1970; Zahara and Sims, 1966). California and Michigan are now the top producing states for tomatoes and pickles, respectively, and Cooperative Extension was pivotal in bringing together the right people and institutions to advance these disruptive efforts. However, as the economic role of agriculture dwindles, so does the public return to such traditional economic development roles of Cooperative Extension.

The relationship between the University of California at Davis (UC Davis) and the wine industry, specifically Napa Valley, illustrates a 21st Century university-public partnership for rural economic development. Rather than focus exclusively on enhancing agricultural production, UC Davis provided training and new innovations throughout the value chain of the Napa Valley wine industry (Kenney and Mowery, 2014). Though initially launched after the repeal of prohibition, US Davis brought food science research to help address the region's wine making industry needs for building a viable industry around the region's comparative advantage in agricultural wine production. Today, Napa Valley winemaking accounts for about 20% of California's multi-billion dollar wine industry, and UC Davis continues to receive large financial contributions from producers (Kenney and Mowery, 2014).

Despite today's evolving rural landscape, land grant universities maintain strong linkages to the historic rural-agriculture framework, which may also restrict their purview of potential influence (Drabenstott, 2008). This may be especially true where agricultural innovations are limited to cost saving production practices. The passage of Bayh-Dole Act in 1980 placed new emphasis on the academy to develop innovations with commercial appeal and to commercialize those innovations. In response, universities have taken steps to advance the commercialization of university research, for example, developing technology parks and business incubators, and establishing technology transfer offices that manage university developed intellectual property (IP) (Drabenstott, 2008; Sonka and Chicoine, 2004). However, a systematic role for Extension is largely absent from these strategies and opportunities for advancing rural economic development are likely being missed.

In today's environment of shrinking university funding and greater private investment in innovation, is sparking such efforts outside the scope of possibilities? Part of the challenge is that land grant universities adjusted priorities in response to reductions in local, state and federal funding (Friedman and Silberman, 2003; Just and Huffman, 2009; Rausser et al., 2008). Coupled with the provisions of the Bayh-Dole Act that allows universities to generate revenue streams from university-developed innovations, it makes sense that decision makers would focus more attention on the most promising revenue generating innovations for the university, rather than promising large social returns to the state's residents and industries. These same innovations are more likely to be licensed or adopted by firms in urban areas. Further, financial forces driving university decision makers may also put new pressure on extension services to shift from operating under the status quo. As described in the next section, this pressure may also present an opportunity for Extension services, experiment stations, and more broadly land grant universities. Thus, new tasks for cooperative extension may include building the networks and knowledge infrastructure to advance workforce development, knowledge generation and dissemination, creative activity, coordinated entrepreneurship support, and filling

of R&D funding gaps for the 21st century.

5.1 A New Role?

Universities play an integral role in regional innovation ecosystems, for example, connecting firms with new innovation through knowledge transfers and spillovers. Such opportunities may arise through university-firm collaborations, licensing of university-developed technologies, placement of students or through faculty-entrepreneurs launching a startup (Acs and Varga, 2005; Audretsch and Keilbach, 2008; Howells, 2005). In other words, universities help fill private sector R&D funding gaps through different means of formal and informal technology transfer (Festel, 2013). For urban firms, this phenomenon is well documented and can generate significant returns (Audretsch and Keilbach, 2008), where agglomeration effects facilitate spillovers that lead to further innovations. In rural areas, with less fluid flows of information, R&D funding gaps are more pervasive and contribute to lower innovation creation relative to urban areas (Knickel et al., 2009; Renski and Wallace, 2012; Rubin, 2010). Thus, university spillovers in the context of rural firms may be especially relevant regarding land grant universities as they have a historic relationship with rural communities, and much of the research, information, and network infrastructure already exists (e.g., extension services, experiment stations, and networks). However, the current mechanisms for knowledge, information and technology transfer to rural firms must evolve in a way that works for rural firms and regions. Additional support is likely necessary to help facilitate and nurture the process. As an example, Pennsylvania State University found that industry was less likely to engage in industry-sponsored university research because the university insisted upon maintaining IP rights to all innovations in which they were involved. As a result, the university has changed its policy to allow industry to hold those IP rights, except in cases of research involving federal funding (Foley, 2012).

There may also be university technology transfer opportunities for rural and agricultural regions that can capitalize on recent agricultural innovations. Identifying and facilitating these opportunities could occur simultaneously as the university technology transfer systems is improved in ways relevant to rural firms. For example, universities have catalogs of innovations intended to combat some of the challenges of climate variability or help meet the demands of the growing global population (Dutia, 2014; Figueroa-Armijos and Johnson, 2012; Weber and Rohracher, 2012). While some these innovations may appear better suited for large or urban firms to take advantage of them in terms of creating firm growth, they could be attractive to small, rural firms as the scale of growth needed for positive results is much smaller. There has also been a significant uptick in venture capital investment into agricultural innovations over the past 10 years – $3.2 billion in 2016 – and this may provide new avenues for some rural firms to obtain early stage and seed capital for new, innovative startups (AgFunder, 2016; Pitchbook, 2015). However, informational flows that facilitate matching capital with innovating firms is largely absent in rural areas. The land grant university and its networks can be the nexus for matching funding with opportunity. This, in itself, requires untethered funding to build networks of relationships with industry, ESOs and other community development NGOs, sources of capital and regulators. While these may have existed in the past, they have given way to new mandates for accountability and documented returns on public investment in state universities.

Encouragingly, recent literature suggest that young educated workers are finding new opportunities in the rural landscape compared to past generations and exhibiting a greater willingness to locate based on amenities rather than employment opportunities, especially for those in service sectors where location is less constrained by the need for a physical presence (Henderson et al., 2007). Thus, the process of expanding university technology transfer to encompass rural development opportunities could begin by engaging extension services and research stations in contributing to efforts that match university-developed innovations sitting on the shelf with rural firms or entrepreneurs interested in new innovative launches, and in bringing together potential investors and services for bringing such innovations to market. That is, institute the network building that makes rural areas attractive to an innovative workforce. In this, we envision the land grant university being well networked with other educational institutions, including community colleges and NGOs, with a more direct mandate for local economic development through facilitating knowledge and technology transfers. Such a call is not intended to eclipse existing state and regional ESOs, but rather to build in state-wide resources for meeting rural growth objectives largely overlooked by existing business development efforts.

As a practical example, the North Central Regional Center for Rural Development (NCRCRD) at MSU developed a program, titled "Innovations in Agriculture and Rural Development", to help disseminate university innovations to rural stakeholder across the region. One of the featured innovations addresses antibiotic resistance in poultry. It was developed by the University of Wisconsin, but was of interest to a group in Virginia. Another innovation developed at South Dakota State University provided solutions for a small aquaculture firm in Oregon. It was through the NCRCRD's broader national network that these exchanges were able to occur. In these examples, it is also important to point out that this effort by the NCRCRD augments other marketing efforts by university technology transfer offices, as the networks of each are different and complementary. Additionally, many of the relationships between the rural firms and the NCRCRD were established through extension activities. This group of entrepreneurs may not have otherwise engaged with innovation developers through the usual university technology transfer channels. However, beginning with existing agriculture-related networks is just the first step. Such networks can further evolve by placing stronger emphasis on strategies that direct agricultural and, more broadly, biophysical innovations to rural areas and firms, through networks of partners that may transcend state boundaries. Eventually, the type of innovations that flow through an improvised technology transfer system would be more reflective of the diversity of industries in Rural America.

Working through its network of partners, the land grant university can strive to correct the urban-rural gap in innovation. Many of the benefits of agglomeration can be addressed with the fluid transfer of knowledge and by matching resources with needs through its network of partners. Public- and private-sponsored knowledge infrastructure is a key conduit to innovation (Maggioni et al., 2007) and colleges and universities make up the backbone of public knowledge infrastructure and of the leadership and direction for the successful development and deployment of a public knowledge infrastructure that spans urban and rural space. A program that has received a great deal of attention is the LivingLabs concept developed by William Mitchell at the MIT MediaLab and School of Architecture and City Planning (MIT Smart Customization Group, 2017). LivingLabs are described as "...a R&D methodology where innovations, such as services, products and application enhancements, are created and validated in collaborative, multi-contextual empirical real-world settings." That is, developers and customers co-develop and review developed innovations in a collaborative effort to meet market needs (Schaffers et al., 2007). This is in keeping with the principles of lean startup from the entrepreneurship world, wherein entrepreneurs repeatedly test their market hypotheses with their customers in order to refine them and bring them into true alignment with customer needs, or what is referred to as "continuous innovation" (Ries, 2011). It is also consistent with the 'democratization of innovation' where parties have equitable input to the process and priorities of local innovation (Von Hippel, 2009). Such two-way collaboration advances the innovative process to market in ways similar to the benefits urban innovators have and improve the footing of both the opportunity and the relevance of rural innovation with urban centers.

The call framed in this paper goes well beyond traditional and incremental support of agricultural producers such as communicating with and educating rural firms and agricultural producers about best management practices. Through an expanded effort, land grant universities can offset some of the diseconomies of rural regions. New efforts by land grant universities, including partnerships with other universities and community colleges, can improve the quality and access to human capital while, at the same time, provide new innovative startup ideas attractive to emerging entrepreneurs. Such partnerships may be led by a faculty-entrepreneurs or by industry. These same activities may also provide the necessary support to sustain new firms through their infancy, such as additional education, training, coaching. They may also facilitate and encourage networking for obtaining private equity, venture capital, and government R&D directed to innovation commercialization, e.g., the small business innovation research (SBIR) program. Once a firm is established, extension network partners would provide relevant education, training and coaching as firms mature. At the same time, improved extension networks that include venture and private equity investors, financial institutions, and other resources could link more mature firms to new financial capital, including grant-writing for public funding through programs like the SBIR. This process will also mean that land grant institutions become more innovative in the types of assistance they provide, continually seeking new opportunities in respond to stakeholder feedback. Such an approach requires new incentives for universities and new ways of measuring outcomes that do not contribute directly to university budgets. This also requires partner institutions, like community colleges, to develop new mandates around supporting local economic

development objectives. We envision the land grant university, with state funding and mandates for rural economic development, to be the glue and leadership that makes this system work. We see nodes in the networks, including community colleges, NGOs, and vested business interests to be partners in providing support and opportunities to leverage rural innovation and business formation.

In addition to supporting human capital for labor and connecting new firms to financial capital, universities can connect rural firms and industries to their vast global networks and provide marketing tools and activities to aid rural firms in reaching new customers. Many land grant universities already have in place economic and business research bureaus engaged in such efforts. This calls for expanding their roles within a broader system. These same networks can also facilitate peer-contacts and entrepreneur networks that facilitate the exchange of ideas and build collaboration among similar rural firms. In this way, it becomes the system of peer networks for rural entrepreneurs, which are invaluable to urban entrepreneurs but geographically challenging for rural entrepreneurs to establish. In urban settings, peer networks are often impacted by influencers and can aid in technology adoption by other firms or in identifying and obtaining financial capital (Bruton et al., 2015; Hienerth and Lettl, 2011). As broadband continues to extend into remote rural areas, use of information and communication technologies (ICTs) can help facilitate and sustain these relationships. Through such virtual networks, a small group of rural entrepreneurs may connect with each other to present and discuss some of the obstacles and solutions that they face which are unique to rural areas. In the process, more experienced rural entrepreneurs may identify resources that can help others navigate some of the pitfalls. Such networks would also provide a mechanism for rural firms to connect to new suppliers or exchange other types of resources or ideas across different geographies that otherwise would not have occurred due to the physical distance between participants. To achieve this, however, land-grant institutions must be willing to cross geographic boundaries – thinking more regionally and nationally in reach and impact – and be willing to work more collaboratively with each other and other institutions. In some ways, this is already occurring. Consider the example of the Innovation in Agriculture and Rural Development program at the NCRCRD discussed above. To be effective, partnering institutions may need to allow untethered funding to support an office and staff for building such networks, much in the same way that they have funded offices for technology transfer. However, unlike those offices, the metrics of outcomes must not be tied to university revenues generated, but instead recognize that benefits will mostly accrue to the businesses and individuals that make up the tax base.

This also suggests a new vision for Cooperative Extension. The land grant university system was built on a system of Cooperative Extension networks that channeled innovation and best practices from university researchers to agricultural producers. This system relied on in-person communications and demonstrations with agricultural producers as the key target. The last 30 years has seen an explosion of information technologies from the personal computer and personal printer to cell phones and the internet. Extension no longer holds a near monopoly on relevant information; instead, private-sector agricultural support services maintain as much or more communications with growers. A recent evaluation of the Michigan State University IPM program found that growers largely turn to chemical and seed representatives and to third-party scouts for guidance on pest management, and that do-it-yourself pest management is largely outside the skill set for the typical grower without advanced entomology training (Miller and Fournier, 2016). In reality, growers turn to their consultants, and those consultants turn to Cooperative Extension to manage the network of specialists and researchers on upcoming threats, technologies and policies. That is, the locus of information needs have shifted from broad dissemination to narrow dissemination to experts in the fields, and Cooperative Extension's failure to adapt to this changing landscape may be one factor contributing to its diminishing footprint of influence. Both the channels and the stakeholders may need shifting for the new landscape. We call for Cooperative Extension to channel influence where its influence has the most potential. This channel appears to be with experts and industry who then will disseminate the relevant information. Under this approach, the key nodes of the informational network become the nodes of the partnership networks, like community colleges.

Within the economic development realm, Cooperative Extension works with local civic leaders, business owners and entrepreneurs with the goal of spurring local economic development. In this role, Cooperative Extension is often bound by policies and a dearth of relevant tools for growth. That is, Extension Educators cannot run the marketing or capital campaigns that growth oriented entrepreneurs seek. However, they can maintain the networks of those that can. We see Extensions' primary role as building the networks

with centers of innovation, industry stakeholders and business service providers to facilitate the exchange of services and knowledge that place rural areas on more equitable footing with urban areas. This calls for land grant universities to take on leadership roles in building networks and linking businesses, technologies, skills and ideas that rival the benefits firms in urban centers receive through economies of agglomeration. As they do so, they will be engaged in the types of activities that scholars have found to foster innovation: spreading tacit knowledge, diffusing university funding, encouraging regional specialization and serving as the backbone of the public knowledge infrastructure. In this way, land grant universities can more effectively provide an environment/ecosystem that is conducive to successful entrepreneurship. These pursuits have the transformational capability to change rural economies and create the individual, family and community wealth necessary for addressing economic inequality.

6 Conclusion

Numerous factors contribute to the economic problems faced by many rural areas. Geographic isolation and its effect on knowledge spillovers, policy making that has failed to recognize the economic diversity of rural regions, the predominance of entrepreneurship that is necessity-based as opposed to opportunity focused, among others.

Land grant universities are well placed to address many of these problems by supporting rural innovation and entrepreneurship. This effort must be intentional and strategic in its approach, however. We offer the following suggestions as a starting point for further discussion:

1. Geographically diffuse university spending to reach isolated rural areas;
2. Encourage economic specialization in rural regions (e.g. forestry products in forested areas);
3. Move beyond agriculture to encourage innovation in a diversity of industries;
4. Think in terms of entire industry value chains and the possibilities for innovation at every stage of the chain and of opportunities for the university to play the role of coordinator of those value chains (Lyons, 2015);
5. Utilize the connections of Extension to import knowledge created by the university into rural areas, with a focus on utilizing experts and industry to spread that knowledge, as well as to build urban-rural knowledge linkages;
6. Acknowledge that, today, industry rivals the public sector in its support of agricultural research (Amanor-Boadu and Zereyesus, 2007) and work with industry to meet its needs;
7. Work with community colleges to create labor force experiences that facilitate the development of tacit and codified knowledge;
8. Utilize Extension and experiment stations for technology transfer and rural entrepreneurship support, including assistance with opportunity recognition/creation, marketing and creative financing;
9. Build rural regional networks of industry, educational institutions, entrepreneurship support organizations, economic development organizations and others to recreate the agglomeration effects enjoyed by urban areas;
10. Utilize the latest communications technology in support of these networks; and
11. Network with land grant universities across state boundaries to foster innovation and entrepreneurship on a larger scale.

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