CITR
Center for Innovation and Technology Research

CITR Electronic Working Paper Series

Paper No. 2014/2

Something New: Where do new industries come from?

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March 2014

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1. Introduction

The question of why some places grow and prosper while other similar places do not is a fundamental question in both the academic literature and in policy circles. This is seen most notably for radical innovations that involve a wholesale restructuring of economic and social activity. Ever since Schumpeter (1911), academics have explored the origins of new industries and the relationship of technological breakthroughs and entrepreneurial activities to economic growth. Schumpeter identified long cycles of economic growth attributable to basic inventions that create surges of investment as the economic potential of the new discovery becomes known and complementary activities coalesce in close proximity. Specific places or communities are associated with each of the waves of Freeman's (1974) industrial revolutions: textile production, steam power & railroads, electricity, mass production, and microelectronics. From Manchester, during the industrial revolution to current Silicon Valley, the pronounced clustering of innovation provides great potential for growth at the formative early stages and a means to harness economic growth for a local area that is able to capture that activity.

The argument that new industries can transform regions and enhance economic growth is not new. It dates back at least to Schumpeter's notion of "creative destruction", where he explored the origins of new industries and the impacts of technological discoveries on economic growth (Schumpeter, 1942). Alas, like so many after him Schumpeter focused on the nation and ignored the more local concentration of new industries. Our concern in this chapter is about how industries take root to transform places. Our focus is on a set of activities that did not exist previously in the form that it currently manifests. Our main aim is on understanding the forces required for an industry to form – what the literature says is needed to go from an idea or single product to an industry, defined as an aggregation of a set of related firms devoted to a common productive pursuit. Following Schmookler's scissors we argue that we know a great deal about push factors and the ways in which scientists or user inventors create knowledge and act towards their commercialization. The literature has explored entrepreneurship as a creative force. We know less about what Schmookler would call pull factors that would need to be in place to create a technological change or the realization of a new industry and subsidiary activities.

The focus of this chapter is on the question of how new industries originate in places. There is often confusion between the process of diffusion and the locational factors that give rise to early stage creative discovery. There is a long and distinguished literature that considers the diffusion of ideas, e.g. in hybrid corn (Griliches, 1957). Diffusion is important as it influences the general uptake and implementation of ideas across geography but it is a different process than our focus here. We advance the argument that the creation of new industries is a process that has inherently geographic features. Something new is created out of prior knowledge (Neffke, Henning, & Boschma, 2011) but a more complex process is required to develop an industry and reap the economic benefits.

This chapter is organized as follows. Section 2 argues that new industries are important for economic growth as they have potential to transform old industries and regions. Section 3 elaborates on the main question of this paper, i.e. where new industries come from, by focusing on why some places are able to create new industries while other similar places are not. Section 4 discusses the empirical challenges to study new industries while Section 5 discusses the theoretical challenges for that matter. Finally Section 6 provides some future agenda for research in the topic.

2. The Transformative Potential of New Industries

Adam Smith, in *The Wealth of Nations*, asks the question of why England grew while the rest of Europe stagnated. Smith wrote at the time of the industrial revolution focusing on the division of labor. His famous adage that the degree of specialization was limited by the extent of the market is only one of many lessons. Specialization allows for economies of scale to develop and transferred production to firms as a more efficient production unit. Yet firms also aggregated together to form industries and England was creating industries from skilled trades and craft production. The industrial revolution transformed the production of textiles and firms located along water arteries as their source of power but with a high degree of localization. The tendency for industry to co-locate and become specialized in specific geographic locations persisted as noted by Alfred Marshall (1890). Most interestingly, the 1900 U.S. Census of Manufacturers reports of the localization of industries in cities (Merriam 1902:Table CXXXVIII), noting that "in some cases the causes are apparent, while in others there is a variety and complexity of causes that makes explanation of this phenomenon a very difficult matter."[i]

Geographic investigation fell out of favor with the rise of neoclassical economies only to be revitalized as the *New Economic Geography* in the 1990s. We have a good understanding of the reasons for the geographic clustering of innovation and for factors that promote the clustering of established industries (Audretsch and Feldman, 1996). What is still missing is an understanding of reasons that industries develop in some places and why other places are able to generate innovation but not able to capture industrial development.

Innovation exists along a continuum that is bracketed by the small incremental improvements weighing heavily on one side and major revolutionary discoveries as a rare event on the other. Most innovations are incremental. Some innovations are arguably so radical that are termed revolutionary as in the industrial revolution and involves a wholesale restructuring of economic and social activity. The literature notes the concept of major revolutionary discoveries driving economic growth has persisted over time in a variety of different theoretical conceptualizations. For example, Nelson and Winter (1982, p. 257) use the term technological regime to describe "the frontier of achievable capabilities along a complementary set of research trajectories" as the primary drivers of economic growth. Relatedly, Freeman and Perez (1998) define a "techno-economic paradigm" that has widespread consequences for an economy and define platforms that create opportunity for profitable investment in a large set of related innovation, called "carrier branches". Scholars more recently have expanded on these ideas and focused on the concept of General Purpose Technology (GPT) (Helpman, 1998; Lipsey et al., 2005). According to Lipsey et al. (2005, p.96), a GPT is "a single technology, recognizable as such over its whole lifetime that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects." No matter what the term used the basic idea is that radical breakthroughs have great potential for the economic transformation of place is pervasive and one of the foundations of economic development.

These types of innovations are usually characterized as GPTs (General Purpose Technologies). As Lipsey et al. (2005: 96) defined GPT, it is "a single technology, recognizable as such over its whole lifetime that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects." Therefore GPTs are radical innovations which act as platforms for complementary innovations and hence motivate subsequent incremental innovations, which diffuse in a broad array of established industrial sectors. This eventually leads to transformation of the industry and regions. This way

GPTs triggers the emergence of new industry (Hall and Trajtenberg, 2004; Lipsey et al, 2005; Bresnahan, 2010; Feldman and Yoon, 2012). For instance Feldman and Yoon (2012) showed that how Cohen–Boyer rDNA technique, as a GPT, created substantial new opportunities for systematically searching large protein molecules, triggering the emergence of the biotechnology industry, as a new industry. It is worthy to note that a GPT, in principle, is defined in the same way as a basic innovation or paradigm in the evolutionary tradition (Verspagen, 2005). Moreover three common characteristics of GPTs are identified in the literature: technological complementarity, applicability, and discontinuity (Hall and Trajtenberg, 2004; Lipsey et al, 2005; Feldman and Yoon, 2012). New industries may be composed of: either *de alio* (large, established firm diversified from related industry) or *de novo* (new, independent firms) entrants, or both (Khessina and Carroll, 2008).

Researchers have examined several of GPTs in detail. Some of the studies GPTs are in the original Freeman's waves, while more recent studies went even beyond such categorization. Starting with the former, some valuable work has been done to examine in detail the GPTs which were seen already in Freeman's waves. Prominent examples are on steam power and Electricity (Bresnahan, 2010). Other studies examined more recent GPTs, such as Biotechnology (Zucker et al, 1998; Stephan et al, 2000; Feldman and Rigby, 2013), internet (dot-com firms) (Goldfarb et al, 2007), and Modern Optics (Feldman and Lendel, 2010). It is argued that there is a lag between invention of GPT and its diffusion across application sectors. Moreover, the diffusion rate of GPTs across application sectors has not been the same, because of difference in the nature of GPTs. While some GPTs like internet diffuse quickly, others such as steam diffused very slowly (Bresnahan, 2010). Even further, as Griliches (1957) showed in hybrid corn, the diffusion rate of it differed across various application sectors in which it diffused.

Generally speaking, a major difficulty in studying emerging technology is the limitation of current industrial categories and patent classes. Given the ambiguity in definition, which reflects the evolving nature of the industry, the Standard Industrial Classification (SIC) Codes and North American Classification System (NAICS), which are based on existing industries, are not reliable (Feldman and Lendel, 2010; 2011). We will come back to this issue in Section 3. Nevertheless, researchers have adopted various methods to study the emergence of new industries. For instance, in the study of Modern Optic, Sternberg (1992) used directories or membership listings of industry associations (SPIE) to define the industry. Hassink and Wood

(1998) interviewed with experts at industry associations and universities. Hendry and Brown (2006) relied on the directory of the organization Photonics Spectra to provide a survey frame. Feldman and Lendel (2010) investigate the geography of optical science by relying on companies that self-identify themselves as working on optics on the basis of their voluntary membership in the Optics Society of America (OSA). Forbes and Kirch (2011) emphasize on the value of historical archives and state that they are currently under-exploited resource for the study of emerging industries. Saying so, they pointed to an alternative way of studying the industry emergence within a larger historical context that extends backward to include some period of time prior to industry emergence[ii]. Shearman and Burrell (2007) describe the medical lasers in UK, however, in a more descriptive way without any explicit methodology to define the new industry.

Steven Klepper's works put invaluable insight in understanding the emergence of new industries. In his earlier works, he pointed out on the role of chance on the emergence of new industries (Klepper and Graddy, 1990). In his later works, he specifically pointed out on organizational reproduction and heredity as the primary forces underlying the emergence of clustering in several industries, i.e. automobiles industry in Detroit, integrated circuits in Silicon Valley, tie industry in Akron and cotton garment industry in Bangladesh (Klepper, 2010; 2011). This is what has been coined as "neo-economics", which aims to trace the intellectual and geographic heritage of the (founders of) new firms that entered the new industries (Klepper, 2011). It is found that each of the studied industries had at least one successful diversifier. But *why* those diversifiers happened to be in those regions remained still an open question.

3. Empirical Challenges to Studying New Industries in Real Time

Understanding of new industries is limited by many empirical problems inherent in studying new industries. The most obvious problem is the limitation of *existing classification schemes:* much of our understanding of industrial activity relies on industrial classification schemes that are inherently backward looking and conservative. The standard schemes, either SIC, NAISC or patent classification were designed to describe established activities. Anyone who has ever done time series work appreciates that stability in these categories is desirable but they mask emerging or early stage activity. Moreover, once firms change their focus it is highly unlikely that they would change their classification with government agencies as there is no incentive to update.

Newer activities emerge at the boundaries of several existing categories. Technological breakthrough often stem from combining elements of previously unrelated technologies in what Wietzman (1998) calls *Recombinant Growth*. While combining previously unrelated domains is more likely to fail, however when successful, such innovations are also more likely to lead to whole new applications and functionalities, which span new technological trajectories for their further improvement (Dosi,1982).

For example, opto-electronics, which at least sounds like the combination of two existing categories. But consider other industries like green technology, which can cover an entire range of activities and may attract firms to self-identify with an emerging field if this is warranted or not. Research has used industrial directories or membership organizations to capture new activity. The USPTO also issues change orders to create new categories. Feldman et al. (2014) use the creation of a new patent class for recombinant DNA to study its use and diffusion. Strumsky et al. (2012) provide a review regarding the use of patent technology codes to study technological change, and point to their usefulness in tasks that relate to the identification of technological capabilities, the definition of technology spaces, or as an indicator of the arrival of technological novelty. For empirical work, when a set of USPTO technology codes is revised, all granted patents and reclassifies those meeting the criteria of the new codes. This provides the researcher with a consistent set of all of the patents that use a specific technology.

Another reason emerging industries are difficult to study is the *prediction problem*: it is often hard to identify emerging industries until after they have taken off and matured (MacMillan and Katz, 1992; Forbes and Kirch, 2011). While many pundits announce the "next big thing" they are typically wrong or their time frames are off by decades. Indeed most of the empirical literature focuses on incremental innovation, because most innovations are small, incremental improvements that are easier to observe. Emerging industries are usually the outcome of radical innovation, rather than incremental one. By the time a technology become accepted as radical then it is left to historians to carefully construct the narrative (Murrman 2004).

There is great opportunity for *ex-post bias*: once an emerging industry is successful we are left with after the fact evaluation and analysis of the historical record that can interpret the results as inevitable or ease over the difficulties. For example, solar panels have been emerging for 40 years yet even now problems with reliability may limit the acceptance of the industry. Many potential emerging industries based on technological breakthroughs may failed to grow and become mature, leaving both academic inquiry and the public good worse off. There are many places that were possible venues for the development of a new technology but there is scant literature on these counterfactuals, except in cases where an industry was expected. For example, Leslie on New Jersey and Orsigeno on Northern Italy.

Finally, there is the *system problem* for emerging technology. For example, Kurlansky (2012) writes about Clarence Birdseye, who discovered a method for freezing vegetables. As always, the invention is the easy part to describe and characterize. But consider in this case what was the innovation? To sell, frozen vegetables required changes in the retail and distribution system, culminating with the supermarket concept. The interrelationships are complex. Moreover, the literature tends to focus on consumer products or products that are directly distributed to consumers but the more profound emerging technologies may be systemic.

4. Theoretical Challenges to Studying New Industries

The complexity in the phenomenon of emerging industry requires rare inter-disciplinary cooperation between management, economics, organizational sociologist, and economic historian (Forbes and Kirsch, 2011). To this mix we add economic geographers to add an investigation of the attributes of place.

The academic discussion often centers around product life cycle and industry evolution that posit different locations for different activities in a most deterministic manner. Duranton and Puga (2001) argue that new products are developed in diversified *Nursery* cities, trying processes borrowed from different activities. On finding their ideal process, firms switch to mass production and the product becomes mature. The firm relocates to specialized cities where production costs. Jacobian externality (diversity) has its effect on productivity of plants during early phase of industry life cycle, while Marshallian specialization has its effect in later stages (Neffke et al, 2011). However our problem is more nuanced we would like to understand how characteristics of regions contribute the new industries.

In contrast to the life cycle of stages approach, Boschma and van der Knaap (1999) propose the Theory of Open Windows of Location Opportunity to explain why it is uncertain and unpredictable where new high-technology industries will emerge in space. First, new high-tech industries reflect a high rate of discontinuity because they place new demands on their local production environment. Second, due to such mismatch, new high-tech industries depend on their creative ability to generate or attract their own favorable production environment Third, chance events may have a considerable impact on the place where new industries emerge.

Braunerhjelm and Feldman (2006) describe five stages of industrial cluster genesis. This process begins with the nascent stage where the first signs of a new industry form, either through technological discoveries or another source of opportunity to which entrepreneurs respond. The second stage is the emergent stage when products begin to appear on the market followed by a take-off stage when a dominant design emerges and the rate of growth for the industry starts to attract attention because the potential is well established.

For these first three stages location is critical; firms benefit from location in a cluster. When an industry is new and becoming defined, tacit and sticky knowledge requires geographic proximity and the ability to tap a variety of external sources of technical, market and financial knowledge. During these early stages there is a high rate of new firm market entry and exit as firms experiment with the new opportunity and learn from their collective mistakes. With the low level of market concentration, the market share of individual firms is also volatile. Ironically, the most successful clusters are associated with lower overall survival rates of new firms. The logic is that the cluster is made more vibrant through this evolving process, which suggests that efforts to save marginal firms are not likely to be associated with higher innovativeness and growth of surviving firms.

During the takeoff phase certain places become known as hot or as the place to be for a certain industry. This is a critical juncture, representing the point when the cluster can solidify its lead. This is also the point at which public policy can play the most decisive role in creating conditions conducive to entrepreneurial endeavors and the success of existing small businesses.

The last two stages in the life cycle model are maturity and decline. As industries mature, their knowledge based is codified and oriented toward process innovation and incremental product innovation. The opportunities for growth are low unless there is the start of a new industry along a technological trajectory. Some of those clusters that have averted the final stage through diversification include, turbine manufacturers in Ohio that were able to literally turn their automobile product on its side to innovate to meet demand for wind power. Akron redefined itself as a center for polymer research, based on scientific research from corporate R&D labs working with the University of Akron. Also, the computer industry in Silicon Valley has evolved into Internet companies who seek to define new application and service delivery modalities.

5. The Regional Context of the Creation of New Industries

New technologies and new industries, while offering potential for economic growth, do not emerge fully developed, but begin rather humbly as scientific discoveries, often made in academic laboratories. At the time of discovery the commercial potential is not known and only a few experts may appreciate the significance. Translating the discovery into commercial activity and realizing its economic potential entails a process that has a strong geographic component. Moreover it requires taking the technology out of the lab, into a community and building companies. Increasingly there is recognition that what matters more than resources or initial conditions is the social dynamics that occur within a place and define a community of common interest around a nascent technology or emerging industry (Freeman, 1979). The important analytical issue is how consensus is achieved, the conditions under which social dialogue takes place and the appropriate role of governance in creating conditions conducive to the development of industry (Dawley, 2014). Also important is the issue of who participates in this dialog and the degree to which consensus building processes involve outside academic and entrepreneurial circles.

Geography provides a platform to organize new industries. This is why we believe that only some regions can host the emergence of new industries precisely because they have some regional characteristics that trigger the emergence of new industries, while other regions don't. Yet this conceptualization seems too deterministic.

Jacob Schmookler (1966) demonstrated that demand-pull factors were also important: the more intense the demand, the more creative groups and individuals were drawn to work on an unsolved problem and more patentable inventions they generated. Struggling to reconcile the prevailing knowledge-push hypothesis with the demonstrated importance of demand-pull, Schmookler argued that both could be important, just as it takes two blades of a scissors to cut a paper. Schmookler argues that demand might originate in a quite different industry. The importance of considering demand-pull has been re-confirmed in recent survey (Di Stefano, Gambardella, & Verona, 2012).

Knowledge spillovers have been conceptualized as science-push yet to really be a flow of knowledge there needs to be a recipient to demand or absorb the new knowledge. The idea of Schmookler's scissors argues that innovation (leading to emergence of new industries) requires both market (technology)-pull and science-push. Recently these questions are raised particularly in case of GPTs (Bresnahan, 2010, p.764). Callon et al (1991) showed that both science push and technology pull theories are needed to explain the interaction dynamics of research in the field of polymer chemistry. Peters et al (2012) showed that, in the field of solar photovoltaic modules in 15 OECD countries, while only domestic science-push policies foster innovative output, both domestic and foreign demand-pull policies trigger greater innovative output. Zhao and Guan (2013) used the sample of 20 leading universities active in nanotechnology and showed that nanotechnology is currently a scientific-push rather than the market-pull industry, which has led to limited creation of an industry.

This section examines the regional-specific science-push as well as market-pull factors necessary for the emergence of new industries.

5.1. Regional-specific Push factors

Knowledge spillovers, or the non-pecuniary transfer of knowledge, are a major reason why innovation clusters spatially. Knowledge spillovers are subtle as individuals observe one another, copying ideas, iterating and incrementally building up the stock of knowledge with new ideas, components and design elements. These spillovers are what economists term an externality: they exist because knowledge, once created, is impossible to value and price. Such knowledge spillover usually happens when at least one of the agglomeration economies are at place, such as urbanization, localization, and diversity externalities. The most interesting aspect is that knowledge is subject to increasing returns, meaning that its value increases as more people use it. In addition, knowledge spillovers provide serendipity, which suggests unexpected outcomes. If an innovator knows what information is required they can search for a source. Knowledge spillovers promote and facilitate new and unexpected ideas.

Of course, places are not equal in their ability to benefit from knowledge spillovers. The main reason is that places are not equally endowed when it comes to various specific kinds of agglomeration economies. Urbanization economies are due to the actual size of a place itself and the doubling the size of a city generally creates a productivity increase for firms in the ranging of

3-8% (Sveikauskas, 1975; Segal, 1976, Tabuchi, 1986). Bettencourt et al. (2007) find that large metropolitan areas have more inventors proportional to smaller cities, and generate more patents. This suggests that an increasing return to patenting exists as a function of city size and therefore smaller places need to work harder cultivating inventive activity or find strategies to develop ideas within their local proximity.

Localization economies are attributed to the concentration of a specific industry in a particular place. Three specific benefits are highlighted in this context: the spatial concentration of input-output linkages between buyer and supplier networks, the character of local labor pools with a high degree of specialization, and embodied knowledge spillovers that facilitate the diffusion of technical knowledge (Marshall, 1920). When localization and urbanization economies are investigated together the results point to a stronger impact of the localization, indicating that a spatial concentration of a specific industry within a smaller city can be competitive (Henderson, 2002; Rosenthal and Strange, 2003). However, Marshall (1920, p. 273-4) recognized the inherent risk that industry localization could make a place vulnerable to external shocks in demand.

Jacobs (1969), on the other hand, points to the significance of diversity as a source of external inputs that boost creativity and subsequently spurs economic activity. The main argument is that diversity enhances the cross-fertilization of ideas between industrial sectors, through facilitating the knowledge spillovers. This leads to the differentiation, diversification and transformation of the underlying processes of production, which in turn, directly influences the creation of new industries. The idea of Jacobian externalities is further refined by showing that existence of "related" sectors (not unrelated sectors) within a region, i.e. related variety, leads to growth of regions (Frenken et al, 2007; Boschma and Iammarino, 2009; Boschma et al, 2012). Jacobian externality also shows its positive effect on regional innovation (Feldman and Audretsch, 1999; Ejermo, 2005; Antonietti and Cainelli, 2011).

Diversity and specialization might play very different roles in different industries, especially if one considers the stage of the industry life cycle. Jacobian externality (diversity) has its effect on productivity of plants during early phase of industry life cycle, while Marshallian specialization has its effect in later stages (Neffke et al, 2011). Diversity and specialization might also play very different roles in terms of the types of innovation that result. The potential to generate radical, disruptive innovative output should be higher when very diverse knowledge bases are combined, while incremental innovation favors the specialized knowledge that accompanies industry localization (Schumpeter, 1987; Castaldi et al, 2013).

The relationship between the relative importance of localized specialization and diversity to economic growth is best characterized as a continuum from evolutionary to revolutionary innovation. Lest places become too inward looking, the most successful clusters benefit from what Bathelt, Malmberg, and Maskell (2004) call *local buzz* and *global pipelines. Local buzz* indicates that there is energy and excitement around the activity in the place. However, much depends on the ability of local firms to export and trade globally and to tap the best expertise and knowledge in the world.

5.2. Technology-pull Factors

Market demand or technology-pull factors certainly play a role in the emergence of new industries in a region. The literature has paid less attention to these factors but in this section we highlight three demand side mechanisms: supplier relationships to dominant industries; value chain deepening especially through outsourcing and finally through government procurement. Clusters burgeon through self-organization as resources are attracted and subsequently accumulate (Tavassoli and Tsagdis, 2014). This in turn cultivates a buzz around the potential of opportunities.

Any new industry or new activity requires supplies that provide additional opportunity. The presence of suppliers or their subsequent development may be important to the cost structure of an industry and to its developing advantage. Consider for example, the California gold rush of the 1890s while providing a certain opportunity. But the discovery of gold, just as with any technological discovery also attracted suppliers. In this case, Levi Strauss invented the denim blue jean as the perfect clothing for prospecting. The demand for equipment created an opportunity – indeed it is said that there is more money to be made selling picks and prospecting supplies than in digging for gold. While the gold rush is distant history, Levi is a global brand still headquartered in San Francisco. Indeed, long after the gold rush finished, the company and product has endured to become an icon of American style and enigmatic of the city’s sense of style. This example demonstrates the serendipitous nature of opportunity, the importance of entrepreneurs to recognize and build companies within the dynamic environment of a clustered space.

Market forces should induce suppliers who recognize the opportunity to flock to that location; however, information about opportunities is often not broadly disseminated or available. Intellectual property and business development attorneys, certified public accountants and marketing specialists are often difficult to attract to new locations. Even when this highly skilled human capital exists in an area, the resources to support these specialists are notably scant and take time to develop. The lack of this type of expertise may deter industry growth. Although emerging entrepreneurial firms depend on their expertise and resources, this support network demands considerable compensation at the usual and customary fees.

Technological proximity to the existing industrial structure of the region plays an important role in determining the emergence of new industries (e.g. Klepper 2007; Boschma and Wenting 2007; Buerger and Cantner 2011; Bathelt et al, 2013). The main finding of these studies is that new industries and technologies do not start from scratch but emerge out of regional structures that provide related assets and competences. In addition, there are systematic studies (though still few) that provides empirical evidence for such argument (see Neffke et al, 2011; Boschma et al, 2013). Yet there is no mechanism specified. It seems likely that a discovery or idea that serves the technological needs of existing industries or to adapt new technology to existing uses will potentially result in a new industry.

User based innovation is certainly driven by demand (Von Hipple 1995). Private sector procurement is likely to produce more incremental innovation but there are certain historical examples like Eli Whitney's cotton gin, where a user need revolutionized an industry. The cotton gin is a mechanical device that removes the seeds from cotton, a process that had previously been extremely labor-intensive. Whitney invented the cotton (en)gin(e) while visiting the Green plantation, which was on the brink of insolvency due to the difficulty of harvesting cotton.[1] Whitney did not make money on the cotton gin because the design was easily copied and turned his attention to the invention and manufacture of muskets with more secure and lucrative government contracts.

Another way to create a demand in the region is through public procurement. Public procurement is a demand side innovation policy instrument (Rolfstam 2013). Edquist, Homman and Tsipouri (2000) consider procurement as a special case of user producer interaction.

[1] http://web.mit.edu/invent/iow/whitney.html. The cotton gin not only revolutionized cotton harvesting it unfortunately made slavery profitable.

Procurement of innovation becomes a process where the social and collaborative aspects are stressed as users work with suppliers to tailor innovation to meet the users' specifications. The end result is that a new product has the attributes that customer seek and ready market demand. If the product is not under IP protection by the user but more generally available we might expect that such products would diffuse more quickly due to the understanding of the attributes that users look for in the products.

The role of government procurement has been demonstrated by Mazzucato (2013), who argues that government has also shaped and created markets, paving the way for new technologies and sectors. By reducing risk the private sector is able to venture in to expand demand. From the internet to cell phones, Mazzucato demonstrates the role that government played as a lead user. The adaptation of government procurement to more general use is called dual use and (Alec et, al 1992) and there are a variety of factors that condition to potential for adoption for dual use (Cowan & Foray 1995). Government is an important lead user due to the amount of resources at its command. Most government procurement is for defense, which has led Rutton (2006) to ask the provocative question, *Is War Necessary for Economic Growth?* Ruttan (2006) shows that government's military procurement has been crucial for the emergence of six major GPTs in US, i.e. nuclear power, airplane, production system, space technologies, IT, and Internet (Ruttan, 2006).

As places around the world attempt to capture new industries there is little discussion about governance beyond limiting public sector involvement to create favorable business climate. Of course, new technologies may pose environmental, health and safety risks felt immediately at local levels where facilities are located, creating a need for local regulation and oversight. Thus there is a presupposed tension between creating a favorable business climate and protecting local citizens. However, an alternative view is that participatory democracy and open decision making—that is widening the social dialog— may lead to more socially and economically optimal outcomes (Freeman, 1979). Regulation may limit firm liability by providing standards and expectations, making a location more attractive for an industry than areas that lack regulation (Lowe and Feldman, 2008). Moreover, the process of public discussion and debate about regulating the industry may inform citizens and local officials about the potential of the industry and what it requires to move forward. Thus, process may be more important than simple adoption of a regulation or advocating for a recipe that worked in another location (Lowe and Feldman, 2008).

Few papers consider the role of community formation around an emerging technology. Lowe and Feldman (2008) researched the origins of the concentration of the biotech industry in Cambridge Massachusetts, specifically Kendall Square, arguably the most densely concentrated agglomeration of private firm activity in the world. Their investigation uncovered a contentious early debate that centered on fear of genetic engineering, the early name used for the technology. Indeed, the City of Cambridge passed regulation in 1976 that was more onerous than national standards at the time and engendered great discussion and notoriety. Berkeley California, another jurisdiction where significant academic research offered commercial opportunity enacted identical regulation, yet currently no biotechnology industry took root there. Startups from the University of California have instead dispersed to other East Bay San Francisco Bay communities. Arguably what is different is the process of participation and community building that occurred in Cambridge but was notably lacking elsewhere.

6. Future Agenda

New industries certainly originate in place and are defined by local attributes and prior activity while sparked by fruitful serendipitous collisions. In this paper we offer a series of challenges to study of new industries not to discourage scholars but to lay out a roadmap for future understanding. Theory is best informed by appreciating empirical examples and there are enough interesting case studies to provide a corpus of knowledge.

Trying to predict the future is a perilous exercise yet every time government funds are invested in a new technology this is precisely what is required. Policy analysts need social scientists to begin to examine emerging technologies and to understand the factors that promote or inhibit their realization.

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[i] The authors thank Andrew Reamer for calling our attention to this source.
[ii] An example (in another industry) is the historical analyses of the disk drive industry (Christensen, 1993).