Does Distributed Innovation fit with current innovation theory and policy?

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1 Introduction

For the last several decades, Globalization has been the hot topic in economic analysis and policy development. Nations have been continually lowering barriers to outside investment and trade, and firms have been expanding both cooperation with other firms around the world and their own operations overseas. This appears to be in sharp contrast to other structured policy such as Clusters and Regional Innovation Systems, but the contrast is only skin deep. This paper aims to provide an overview of the Distributed Innovation model and compare it to other models, finding compatibilities and incompatibilities, as well as predicting effects of the interaction of Distributed Innovation with other models for the foreseeable future. It will show that there are more similarities than differences between the various models, and that Distributed Innovation provides a best fit for the direction of the global information economy.

Not much presented here is completely new, but the context given is somewhat unique. Globalization is a common topic of discussion but I was unable to find anywhere where someone provided a strong model for analyzing the competitiveness of firms or places based on the effects of globalization. If trends continue as they are, some comprehensive model must be developed that takes into account the importance of networks, specialization, clustering of innovation, distributed production, and continually new additions to a global economic market. Without such a model, policy makers will not be able to be very effective in designing their policies to compete in the new economy. What follows is an explanation of the sources and implications of Distributed Innovation and what needs to be taken into consideration to form an effective model for future analysis and policy making.

2 Explaining Distributed Innovation

2.1 What is Distributed Innovation?

There are several ways of describing Distributed Innovation (DI) that each lead to very different consequences and policy implications. Some consider DI to be "the successful implementation of creative ideas, tasks, or procedures by employees in different geographic locations" (which could apply to a firm with several physical locations in a nation) while others consider DI to be cooperation between firms, regardless of their physical location (which can be used to explain parts of cluster theory). (Cummings 2005) This paper suggests that DI can be inter-firm or intra-firm cooperation, but narrows down the definition to be specifically cooperation that is possible as a direct result of globalization and the changing face of the world economy towards a knowledge based economy.

Innovation Networks is an older model with much overlap with DI, and is the best place to begin discussion of DI. Typically in evolutionary economics analysis begins with individual firms, "but the configuration within which the firm is active may be equally if not more important to it's survival." (Gulati, Nohria, and Zaheer 2000) Coombs takes this even further:

> ...[As] an alternative to taking firms as the unit of analysis (which is commonplace in innovation studies and strategic management), research should be conducted

> by the 'bottom-up' examination of individual processes of provision and innovation... and the 'top-down' examination of whole configurations... As innovation processes tend to be embedded within existing (or evolving) configurations, we stress these are complementary rather than alternative approaches. It is unlikely that the distributed nature of each individual innovation can be understood without some understanding of the wider configuration within which it is embedded, but equally the examination of individual innovation processes is likely to enhance our understanding of (the relations of power and dependency within) these wider configurations. (Coombs, Harvey, and Tether 2003)

This paper provides some firm-level analysis but focuses on the interactions between firms and the networks they form.

2.2 The Knowledge Economy

If anything could be singled out as the most important factor in enabling DI, it is the Knowledge Economy: the production, trade, and consumption of research or creativity based products or information instead of those based strictly on manufacturing or production capabilities. Johnson goes as far as to say "The tendency to treat information and knowledge as commodities is ubiquitous" and "Firms are increasingly becoming aware of the possibilities to sell knowledge in different ways." (Johnson and Lundvall 2000, 21) In the Knowledge Economy, firms (or networks of firms) have a base of knowledge that is very important to their livelihood. Some of this knowledge would be harmful if shared because it could enable more effective competitors, but other pieces may be sold, shared, or even purchased from other firms to increase the competitiveness of the firm. Howells explains that being open to external sources of knowledge is important:

> There is a growing recognition that an organization's knowledge base is a valuable company asset and that enlarging that knowledge base and improving its use can contribute to the competitiveness of the firm. ... [In] different ways, recent studies have emphasised the potential openness of the firm to the acquisition of external knowledge and the possibilities that this presents for the firm to increase its potential to create radically new knowledge.(Howells, James, and Malik 2003)

Johnson also points out a potential problem with the ease of sharing critical knowledge: "Elements of collective tacit knowledge are [at] the very core of the competitiveness of the firm. The tacit knowledge embodied in individuals may easily disappear in fluid labour markets while codified knowledge may be more easily copied by outsiders." (Johnson and Lundvall 2000, 15)

2.3 Globalization and Outsourcing

DI is a natural progression from Globalization, Outsourcing, and the ability to get things done in different places. Globalization and Outsourcing have led to firms that are comfortable purchasing parts and products from firms in other nations, as well as firms that are comfortable operating parts of their business overseas as a Multi National Corporation

(MNC). As the global economy has moved towards information, so has this outsourcing, and firms are becoming more comfortable outsourcing knowledge activities (such as reading xrays and transcribing voice into writing). Firms are slowly becoming more willing to outsource low value-added research and technical activities such as materials testing and design implementation. As more firms are willing to utilize knowledge services overseas, an increasing range of options become available which makes it easier to find the right fit for externalizing R&D. This availability of choices then brings in more interest from other firms looking for someone to outsource knowledge activities to. (Kogut and Metiu 2001)

2.4 Communication Technology

Communication technology has been a key enabler of both Globalization and Distributed Innovation. Global high speed communication allows for real-time communication with people anywhere around the world as well as sharing of large amounts of information quickly. (Karlgaard 2004) This means that knowledge can be shared almost instantaneously anywhere on the globe at essentially zero marginal cost. (Kogut and Metiu 2001) A firm with a presence in the United States as well as Eastern Asia can have employees working on a project 24 hours a day with the work being passed off to the next location when the work day in the previous location ends. (Friedman 2006) Additionally, a low delay phone call or video conference can put people in the same virtual space. People working in remote corners of the world can get the same work done as employees sitting in adjoining cubicles. They can work together in ways previously impossible between employees in different cities just a few hours apart.

Our advanced communication technology introduces new issues that have been overlooked by development theory and policy. The role of knowledge and the problems of knowledge transfer have been underestimated and the fact that the "[use of information] by one party does not preclude use by another" is a fact very foreign to most models of development. (Kogut and Metiu 2001; Johnson and Lundvall 2000, 3) Johnson also explains how this effects the speed of innovation and the codification of tacit knowledge:

> The radical development of information and communication technologies has an equivocal impact on the codification of tacit knowledge. On the one hand it gives stronger incentives and more effective procedures for codification. On the other hand the very growth in the amount of information made accessible to economic agents, increases the demand for skills in selecting and using information intelligently. The major impact of the information technology revolution is, however, that it speeds up the process of change in the economy. For this and other reasons, experience based learning tends to be come even more important in 'the new economy' than it was before. (Johnson and Lundvall 2000, 14)

2.5 Transportation Technology

Globalization has also been fueled by cheap airfare and effective distribution and package delivery systems. Where firms used to need to be located in adjacent cities to exchange physical materials quickly, UPS, FedEX, and DHL can typically transport a package anywhere

in the world, more quickly and at a fraction of the cost of sending someone with the package in hand. (Friedman 2006) It is also relatively easy to fly anywhere in the world cheaply and quickly allowing, for example, firms in Silicon Valley to regularly send employees back and forth to manufacturing facilities in eastern Asia.

2.6 Location Is Still Everything

Previous models of innovation have concluded that "location is everything," meaning that the physical location a firm chooses for its physical presence can make or break the future of the firm. However, with Distributed Innovation, location matters in a very different way. Parts of work are done wherever it can be done most effectively and efficiently. This suggests a global network of suppliers with inexpensive labor in several places, access to resources in different places, and strong innovators in different areas in different places can be much more effective than a single firm located in "the right place."

2.7 Network Dependence

Distributed Innovation is defined by network dependence and is made possible by all of the aspects mentioned above. In DI, firms depend on other firms in their network for success. As mentioned above, the openness of a firm to knowledge from others and a firm's position within a network dictates much of the possibility of success for that firm. Coombs describes that it's truly the network that matters, not the individual firms:

> Networks, which serve as sources of opportunity and constraint, are seen to evolve endogenously, and the ties formed or disbanded by any agent influence not only their own behavior in subsequent periods but also the behaviours of others to which it was connected. ... [We] emphasize the interactions and interdependencies between agents, based often on enduring and socially embedded relationships, which have an important role in shaping the processes of provision, competition and innovation. This is certainly not to assert that agents have no scope for strategic decision making in relation to their activities, but these decision-making processes or strategies become part of the explanandum rather than the explanation of firm behavior. (Coombs, Harvey, and Tether 2003)

In addition to being such a solid basis of analysis, networking combined with most unrelated policies can lead to greater firm success: "...Success in terms of innovation is even greater when [a strategy of introduction of new forms of organization] is combined with active networking in relation to customers, suppliers and knowledge institutions." (Johnson and Lundvall 2000, 16)

In DI (and other models of innovation that utilize network dependence), knowledge is shared between suppliers, manufacturers, innovators, and distributors. However, as product complexity grows and industries shift from mechanical to electro-mechanical products, the increasing number of technologies per product requires deep interdisciplinary research which requires a stronger trust between firms and the sharing of even more secretive information. As trust continues to grow, participating firms begin to move away from activities such as

technology licensing and move towards sourcing new technological knowledge from other network participants. (Howells, James, and Malik 2003)

Networks of firms appear to be an excellent idea, however they are not without their own share of problems. The ease of sharing information and willingness of firms to participate leads to firms exposing knowledge assets very close to their core competencies. When a firm's strategic assets and core competencies are knowledge based, the firm needs to be very careful about the balance of knowledge sharing that they participate in. If a firm is not careful and exposes too much, they can loose their competitiveness to other firms, but if they expose too little they will be unable to participate. Additionally, if a firm sources too much knowledge externally they can loose their value to the network as well as their own capacity to innovate. If a firm tries to internalize too much innovation, they will not gain any of the benefits from participating in the network. Acquiring the full benefits of a network without loosing a firms core competencies is a very complex balancing act and something that firms need to be constantly aware of. (Howells, James, and Malik 2003)

2.8 The Driver

Initially, a "driver" is required to get innovation started. Typically this has been a firm with available funding and great ideas in a place with many similar firms. (Silicon Valley firms being common examples.) This firm innovates and grows to a point where it must start reaching out to other firms to keep up its pace of growth. The firm involves suppliers in design decisions to make both supplying the parts and producing the end product more effective, which leads to information sharing and eventually ideas can start to flow from the suppliers to the driver. As this evolves into a network of ideas going in many directions (between suppliers, between consumers of the same components, etc) the initial driver of innovation can become irrelevant. There may still be a specific driver for a very specific technology (ex: an individual firm may be responsible for innovations relating to increasing the power efficiency in LCD backlights for LCDs larger than 12 inches), but in a network of substantial size, no one firm is the driver. Once a network is large enough, any firm can be removed from the network without substantial disruption. Innovation policies sometimes specifically require this redundancy of firm capabilities as is the case with most critical United States military purchases: the Government requires redundant suppliers before it will commit to a specific technology 'just in case' something happens to one of them. (Saxenian 1996)

3 Model And Policy Compatibility

There are many similarities between Distributed Innovation and some of the existing models of innovation. Most models seem somewhat compatible but some are quite incompatible. Each of the following sections examines a specific model and compare this model and the policies created to support it with the DI model and its possible supporting policies.

3.1 Regional and National Innovation Systems

Location based innovation systems are policies set forth by governing bodies to direct innovation in a particular way. Too often these policies are not relevant as markets become global, and:

> In the context of the globalising learning economy the crucial elements and linkages in the innovation systems are those that have an impact on the learning capability of individuals, organizations and regions. So far the studies of national systems of innovation have given too little emphasis to the subsystem related to human resource development. (Johnson and Lundvall 2000)

These systems have evolved slowly over time and often have trouble dealing with the free flow of information in and out of the nations or regions they are concerned with. National and regional boundaries are artificial boundaries for innovation and national and regional policies are usually designed to keep business and innovation locally for (legitimately) selfish reasons. (Coombs, Harvey, and Tether 2003) The best policy "out" of this model to support DI would be policies that open doors to information sharing and encourage firms to participate in DI, especially policies that set incentives for new firms to locate in the nation or region and participate in DI. This would both maintain local economic strength and ensure compatibility with increasing globalization.

3.2 Sectoral Innovation and Technological Systems

A less common model, Sectoral Innovation Systems commonly uses industries defined by SIC or patent classes as unit of analysis. This can be more effective than analysis directed towards a location because different sectors can rise and fall at different times in any region. However, there are several limitations to this model that can lead to ineffectiveness if not properly addressed. First of all, the categorizations are fairly time sensitive and must be updated as the economy changes. With a rapidly changing global economy, the categorizations quickly become out of date and must be updated. Additionally, most innovation draws on multiple sectors and it is too hard to continually regroup industries and patent classes each time a study is performed. (Coombs, Harvey, and Tether 2003) Even working around each of these limitations, it's somewhat difficult to use this model for analysis of DI. Any policy resulting from the use of this model would have little to no effect on DI as policies for industries as defined by SIC or patent classes would be based on performance that could be wholly unrelated to DI. The Sectoral Innovation System model provides no indication as to the cause of innovation.

Technological systems are an even less common model and another step away from location based innovation systems beyond sectoral innovation systems. Introduced by Carlsson et al, a product class is used as the level of analysis: "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilization of technology."(Carlsson, Jacobsson, Holman, and Rickne 2002, 237) This model has the same relevance to DI as Sectoral Innovation Systems; It operates independently of DI and neither conflicts with or supports DI based analysis.

3.3 Clusters

Clusters are groups of firms in a locality including the innovators, suppliers, and supporting services (often, tied to educational institutions). It's fairly straightforward to actually think of Clusters as highly localized Distributed Innovation. There is usually specific policy for a specific cluster in a specific location, but clusters can be as general as "semi-conductor technology" and can form without the specific direction of policy when firms naturally locate in the same area. Cluster policy is similar to DI policy because it encourages networking in the pursuit of innovation, but Cluster policy is typically very specifically targeted to the growth of a particular industry in a particularly place. Cluster policy also encourages localization and specialization which can be key in DI because it allows a place to compete in the global market more effectively. These policies perform well alongside DI policies, and typically policies created to encourage innovation based on either model will work well with the other.

3.4 Open Source

Open Source is a very hot topic in Globalization because of the complete deemphasis of location. Typically the words "Open Source" are followed by "software," but Open Source encompasses much more than just software. From Wikipedia, Open Source "describes practices in production and development that promote access to the end product's source materials". Often this is software, but it can be hardware (Sun Microsystems "open sourced" their recently announced T1000 processor), research results, or any kind of media. (various 2006)

Due to the communication technology and knowledge economy aspects mentioned above, Open Source can fits with all models. Firms participate in Open Source in the same way they would participate in the knowledge economy: when they can do so without negatively affecting their bottom line. Kogut makes two excellent points: "Open source represents the emergence of a production model ideally suited for the properties of information that can be digitally coded and distributed." and "Because open source works in a distributed environment, it presents an opportunity for developing countries to participate in frontier innovation." (Kogut and Metiu 2001) Essentially, Open Source means innovation and product development without any emphasis on physical location which is precisely what Distributed Innovation entails. Supporting Open Source means supporting DI which should create a positive feedback loop between innovation and the growth of Open Source.

4 Implications and Choices

Distributed Innovation has far reaching effects for all players in innovation. As mentioned above, DI seems to be very compatible with many existing models of innovation, and it seems to be good for innovation. However, there are many potential pitfalls reminiscent of problems with Globalization. For everything that DI implies, there are big policy decisions to be made, whether for firms, networks of firms, or nations and regions.

4.1 Firms

The ability to do a particular part of a process anywhere in the world means that a single metric (cost) can determine the fate of an industry. Many firms may make decisions based on other metrics, but often cost is the bottom line. As it has in Globalization, this focus on cost can lead to the loss of lower wage manufacturing jobs in the United States to overseas where wages are even lower.

Competition solely on the basis of cost often leads to brutal competition between suppliers to have the lowest cost. Firms in locations without effective human rights regulation too often choose to compromise labor conditions and wages to improve the firm's bottom line. Once globalization is fully realized and there is a complete leveling of all markets, participating firms may take more notice of all aspects of their networks; consideration of human rights should improve, but this will be a slow evolution. If this is to happen at all, firms (specifically MNCs) need to develop strategies to account for these hidden costs in their networks.

Another potential pitfall of Distributed Innovation is that policy changes directed at encouraging DI and metrics used to gauge their success may lead to superficial changes instead of an actual increase in innovation:

> Industrial policy needs to include an adjustment to each other [sic] of competition policy and policies aiming at developing learning organisations and competence building networks. Intensified competition may stimulate superficial change rather than competence building if not combined with organisational change and new forms of inter-firm collaboration. (Johnson and Lundvall 2000, 19)

Johnson also points out that the lives of employees and the social values that lead to a productive workforce could also be destroyed by the increased rate of change enabled by Distributed Innovation:

> And the final fundamental problem is that the speed-up of the rate of change puts a pressure on social relationships in traditional communities. It contributes to the weakening of traditional family relationships, local communities and stable workplaces. This is important since the production of intellectual capital (learning) is strongly dependent on social capital. To find ways of re-establishing the social capital destroyed by the globalisation process is a major challenge. (Johnson and Lundvall 2000, 23)

The solutions to most of these problems are not obvious. Policy makers have been tackling the issues associated with Globalization for years without a definite solution and Johnson's only suggestion, slowing down the rate of change, is made without any indication of a plan to actually accomplish this. (Johnson and Lundvall 2000) If the growth rate isn't sustainable, it will eventually cap itself or fall backwards, but comprehensive global policy change would be required to slow the speed of innovation by force.

Multinational Corporations (MNCs) are very compatible with DI. Depending on how the corporation is designed, it could either be only DI, completely unrelated, or somewhere in between. MNCs can either vertically or horizontally integrate in either their localized or remote operations, and they may have manufacturing and distribution capacity around the world, or they may have research centers around the world collaborating so that work gets

done 24/7. Any way that MNCs exist and are analyzed, any policy designed based on MNCs or to encourage innovation in MNCs will go very well with Distributed Innovation.

4.2 Networks of Firms

The networks that firms form are one of the most important aspects of Distributed Innovation and should be encouraged by policy at all levels:

> One of the most dramatic changes in the learning economy is the growing importance of networking and inter-firm co-operation in connection with innovation. Competition policy needs further changes in order to respond to the full implications of the new regime. The formation of networks of firms and of firms and knowledge institutions should be stimulated at different levels. At the regional level the formation of knowledge-intensive networks is a key to promote regional development. (Johnson and Lundvall 2000, 26)

Because of the importance of these networks, it is very important for policy to take these networks into consideration. The networks that have already formed and are continuing to develop need policy to guide them because they become strongly locked in by the policy that effects their growth:

> ... [Exchanges] of material, information, learning and divisions of labour amongst agents (i.e. firms and other organizations) in a distributed configuration are not simply mutual adjustments and accommodations made independently. They are set in the context of power and dependency relationships determined by asymmetric past accumulations of resources and (technological, market and organizational) knowledge. (Coombs, Harvey, and Tether 2003)

Additionally, aside from simply effecting the growth of networks, policy changes about the structure of networks (and not the firms themselves) can actually lead to innovation: "Innovations can arise as a consequence of changes in the configuration of provision, just as innovations can lead to changes in the configuration." (Coombs, Harvey, and Tether 2003)

4.3 Nations and Regions

In older models of innovation, nations and regions have played a key role; their policies and resources directly led to their innovative capacity. To be successful in DI, a place must have something to contribute: innovative capacity is the best offer, followed by motivated human capital, then followed by more straightforward forms of capital such as natural resources and financial capital. This means that places that currently aren't hubs of innovation due to some sort of resource constraint can now utilize policy focusing on motivating human capital to start participating in innovation. It would not be odd for a previously unknown nation or region to quickly establish itself as a leader in a specific component of some innovation network. Precisely as DI allows for a place to fill a niche, the current trend in policy direction has been towards specialization, but this may not be a good thing:

> This new context of accelerating change calls for new strategies at the level of the firm, the region, the nation state and the transnational corporation... While knowledge production and policy making through decades have been characterised by growing specialisation and more narrow fields of responsibilities, the learning economy calls for lateral thinking and for a integration of separate perspectives and strategies. (Johnson and Lundvall 2000)

DI encourages areas to specialize (the same as with Globalization in general), but that this may not be good for the overall health of the innovative capacity of a place. As results of later analysis of policy based on Technological Systems and Sectoral Innovation Systems have shown, regions specializing in a particular area become dependent on that one aspect. As with any system that encourages localized specialization, DI can greatly increase the susceptibility of a place to shocks and the economies of these regions can be completely destroyed if that region looses its place as a leader.

The crucial information-sharing aspect of DI can also be a cause of large problems; Opening the doors to free flow of information in an out can lead to vulnerabilities (such as those seen in outsourcing) where entire industries are transfered to other locations almost overnight. Slightly cheaper labor or raw materials can mean the end of competitiveness for the original location. There is not yet a perfect policy solution to this, but places like Silicon Valley show that somehow places can maintain their competitiveness while participating in DI. Networks of firms in Silicon Valley consisting of small firms, as well as MNCs, engage in both localized innovation and collaboration and in globally distributed innovation. Man questions remain as to what policies can guarantee the success of a place.

5 Conclusions

Globalization is here and now, and Globalization means Distributed Innovation. As Friedman so eloquently summed up in the title of his book, "The World is Flat," meaning that location is transparent and collaboration and innovation can occur in any combination of places. (Friedman 2006) Distributed Innovation builds on clusters and the specialization of places as well as localized innovation and the capabilities that places develop as a result of high densities of Florida's "creative class."(Florida 2002) Any place or firm not taking each of these factors into account will be unable to survive in the new global economy and will be unable to compete with places and firms working with policy models based on Distributed Innovation.

Aside from DI, there are many models of innovation used as the basis of policy. Some models are more compatible than others and some policies are better fits than others, but even the most compatible models and the best fitting policies require at least some tweaking to optimize a place's innovative capacity and economic performance while maintaining the health of the places's firms and networks. All players involved need to keep their competitiveness and the global information economy in mind when formulating new policy because in the blink of an eye, the world can become a very different place. Adoption of polices designed around Distributed Innovation should position everyone to adapt to the ongoing changes in world markets.

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