

Reverse Innovation Networks: Connecting Emerging Economies to the Developed World

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Abstract

Reverse innovation (RI) is a relatively recent and understudied phenomenon. It is a product development strategy where an innovation is designed and adopted first in emerging economies before transferring to the West. Research has not comprehensively explained what induces RI. Since RI results in international network building, this research engages network theory to shed light on the network mechanisms likely to position new emerging market SMEs for RI. Illustrations from the sustainable transportation sector provide some applicable clarifying context. Cities around the world are similarly growing rapidly such that firms' transportation technologies can be interchanged across them, but the technologies may also require some local customization. Overall, the theoretical development suggests that: 1) network centrality in terms of prominence, 2) connectedness to powerful others as defined by eigenvector centrality, and 3) brokerage in accordance with betweenness centrality could be indicative of potential RI in local and international value system networks. This research adds to the literature on the dynamics of globalization.

JEL Classifications: F13, F21, F43, O10, O19, O33

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1. Introduction

Reverse innovation (RI) is a new product development strategy where an innovation is designed and adopted first (and modified) in emerging economies before transferring it to the West. For example, India's Mahindra constructs automotive vehicles with intentions to make them green (environmentally friendly) and to stand out as a unique global brand. They have sold vehicles around the world including Australia and Europe. An alternative view of RI is that it is initiated by large North corporations partnering with small South firms, reinventing products in the South that were originally from the North, and bringing them back to their industrialized home countries (Govindarajan & Ramamurti, 2011). However, this research is focused on the underexplored view of RI first introduced and the local networks in the South economies that generate it from within. In what types of positions in local networks are firms such that they will tend to engage in RI? This research theoretically studies this question with illustrations from the sustainable transportation sector.

In emerging and developing economies, a surprising phenomenon is found of entrepreneurial firms in some very disadvantageous contexts overcoming many barriers so as to advance onto the world stage as economically and technologically advanced players. Most modern day international business at significant levels has occurred within the triad regions (within the European Union (EU), North America, or Asia) rather than across regions (Rugman, 2003). Moreover, much of the international business literature has discussed upgrading or the ‘catching up’ of firms in emerging markets, rather than their capabilities to generate new innovations of interest to developed markets (McDermott & Corredoira, 2010; Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012; Lorenzen & Mudambi, 2013). These emerging market SMEs (small and medium sized firms) build their own recognition and generate local industrial benefits such as new manufacturing and export opportunities for other local firms. Previous literature has not comprehensively delved into this phenomenon and thus, this theoretical work aims to make a contribution to the exploration of it. Because a growing firm cannot thrive in a vacuum and its industry networks are presumed to support its actions (Porter, 2000), the aim here is to take a network view and to theoretically propose some network indicators that might suggest when firms could be likely to engage in RI. RI strategies have received very limited attention in the context of small entrepreneurial firms benefiting their countries through the development of new emerging market industries.

Previous literature has considered demand related reasons for the occurrence of RI. Govindarajan and Ramamurti (2011) have suggested five reasons: 1) low-end markets in developed countries may accept what are otherwise emerging economy offerings; 2) aspects of lower cost designs could be incorporated into offerings for developed countries that ultimately allow for price breaks; 3) some functional innovations could also be attractive to developed country markets; 4) low cost products may also improve over time to become acceptable to developed markets; and 5) occasionally, some frontier technologies may overtake any legacy technology anywhere. Additionally, foreign direct investment (FDI) from emerging markets to developed economies may be a strategic driver of RI, as explored from industry-based, resource based, and institution-based perspectives (Yamakawa, Peng, & Deeds, 2008). However, prior research has not explored the more specific firm-level positional network mechanisms enabling or prompting RI in an emerging market. Firm networks offer a more relational view compared to other theories that have been used as lenses for RI (Zaheer, Gözübüyük, & Milanov, 2010). International entrepreneurship studies have considered a relational view very relevant (Ahlstrom & Bruton, 2006; Ansari, Munir, & Gregg, 2012; Coviello, 2006; Ellis, 2011; Hite, 2005; Turcan, 2011; Webb, Kistruck, Ireland, & Ketchen Jr., 2010). Even Johanson and Vahlne (2009) have updated their Uppsala internationalization process model to take a network view. Such an approach recognizes the embeddedness of firms in their networks and the resultant inter-organizational influences that could affect the motivation for reverse innovation which is a relational strategy, by its very nature.

Previous research has examined the internationalization of innovation from a network view (Coviello & Munro, 1997; Lorenzen & Mudambi, 2013). Coviello and Munro (1997) found, in a general way, that network processes influence choice of market and entry mode for small software firms. They tested the well-known Uppsala internationalization model in the context of Swedish firms (Johanson & Vahlne, 2009). However, specific network positions were not considered, as in this research. Also, rarely has internationalization been tested from the point of view of innovation that originates in EMs and penetrates developed countries (Govindarajan & Ramamurti, 2011). Previous research has examined EM firm internationalization through a set of Indian manufacturing firms that have not previously engaged in international competition and that lack experience in building international distribution channels (Elango & Pattnaik, 2007). They have competed on price, not differentiation or leading technologies (Elango & Pattnaik, 2007). That research

considered parental firm network scope, related to Indian business groups, as advantageous for firms because they could draw on the parental resources. It also considered foreign firm ownership, usually by MNCs. However, network positions were not considered in that research and the measures and concepts were fundamentally different from those in this research. That previous research tested the advantages that different types of large owners offer, whether national (parental) or international (foreign MNC). Research has not examined innovation internationalization originating from emerging markets so as to investigate how partnership links between developed and emerging markets may be motivated through the network positions of SMEs in EMs. Thus, a gap in the theory of firm internationalization strategy is addressed in this research. This theoretical contribution to international business and entrepreneurship theories investigates the research question: What network positions and mechanisms are likely to motivate new emerging market firms to engage in RI? Investigating this question supplies underlying explanations for the movement of the semi-periphery closer to core (de Lange, 2013).

2. Reverse Innovation: Sustainable Transportation for Growing Cities

Examining the impetus for RI is a significant question as large urban centers in emerging economies such as the BRICS (Brazil, Russia, India, China, and South Africa) evolve to become centers of power, resulting in an alteration of the distribution of wealth and the geopolitical power balance such that the semi-periphery moves closer to the core. The influx of rural populations into dense urban centers and the rise of a lower-middle class results in the need for technology innovation and diffusion with a focus on new local industries relating to transportation systems, energy and water services, and other critical infrastructure shifts (Gazibara, Goodman, & Madden, 2010). Particular emphasis is placed on sustainable multi-modal transportation to create efficiencies in existing infrastructure systems, enabled by information technology (Gazibara *et al.*, 2010). In the West, a shift in equity and corporate investment momentum is taking place where new business models are being developed to accelerate multi-modal transportation to include electric vehicles, public transport, electric bikes, car-sharing platforms, fleet tracking software, vehicle-to-grid systems integration in the smart grid, and smart city designs. The result of the combination of these strategic drivers is that opportunities are arising whereby lessons learned from emerging economies may be repackaged for applications in the West. Thus, as the theory is developed in this paper, examples from this international and innovative industry context are used as illustrations.

3. Previous Theory and Research

Hence, the current RI dynamics, in sustainable transportation or otherwise, can be viewed as network building that connects the semi-periphery to the core. Previous work has examined diaspora influence, where it alters the geopolitical landscape, by using its position in a core host nation to benefit a homeland nation such that a semi-periphery nation (South nation) moves closer to or into the core (North nations) (de Lange, 2013). A diaspora's influence occurs through social, political and economic means, including intercultural channels through which pools of sophisticated technical labour may travel bi-directionally, among other influential flows (de Lange, 2013; Saxenian, 2005). Historically, world powers have led through innovation and influenced the rest of the world through the diffusion of their innovations (Vernon, 1966, 1979; Porter, 1990). Moreover, firms in the South were often protected from international competition through national policies and this ultimately disadvantaged them for building internationalization capabilities (Porter, 1990; Elango & Patnaik, 2007). However, partly due to the combination of decades of outsourcing from

the developed world outwards (which resulted in appropriation of manufacturing efficiencies) and indigenous innovation (driven by the need to overcome infrastructure deficiencies), we are beginning to see reverse flows of innovation (James, 2001; Pisano & Shih, 2012; Smith, 1993). Recent work, coincidentally aligned with the concept of RI, argues that centers of technology innovation are not only in the core (Saxenian, 2005). Thus, building on the mechanisms of RI helps to explain how semi-periphery countries may move closer to core nations.

In the context of firm strategy, Govindarajan and Ramamurti (2011, p.197) commented that, “Reverse innovation, thus, provides an opportunity to update Vernon’s (1966, 1979) product life-cycle theory to explain such things as ultralow cost innovations in emerging markets and the trickling up of innovations.” Vernon explicated on the direction of innovation flow from North to South countries. In this view, the North has wealthy markets to develop in and distribute into and innovations must drop in price before they can enter poorer South nations. It is reasonable to believe that differing conditions in emerging economies’ such as lack of infrastructure, wealth gaps, and pollution conditions may lead to transportation innovations, as evidenced by Tata’s (India) efforts to deliver the Tata Nano, the cheapest car, and the MiniCat, the cleanest car, using cheap, compressed air. Although not a wealthy market, India is a populous market and the ability to tap into the large numbers at the bottom of the pyramid could lead to reverse flows in opposition or as an extension to Vernon’s original theorizing.

Although academic management research on RI is scarce, market research reports indicate its likelihood to increase in the future. For example, a recent report and value system analysis by the Clean Energy Group concluded that developing countries will be a new source of technology innovation, such that climate solutions will not only depend on North-to-South technology transfer (Morey, Milford, Madeira, & Stori, 2011). A World Bank report mentions that nine emerging economies (Argentina, Brazil, China, Hungary, India, Malaysia, Mexico, the Russian Federation and South Africa) are standing out for their green-tech innovation capacity, accounting for almost 80 percent of all US green patent grants attributed to developing countries between 2006 and 2010 (Dutz & Sharma, 2012). The developing world context can be more conducive to the invention and scaling of disruptive new climate technologies than developed economies, based on previous learning in economic sectors such as agriculture, mobile communications, and pharmaceuticals. The rationale is that frugal innovations, in the absence of existing infrastructure, result in more rapid adoption at scale, the development of an entrepreneurial ecosystem that sustains it, and strategic corporate investment aimed at reinventing the product for markets of the North (Eyring, Johnson, & Nair, 2011; Govindarajan & Ramamurti, 2011). This does not necessarily mean that frugal innovations are of low quality, rather, these products are designed to different price-performance characteristics or the manufacturing process has been redesigned to drive down cost. Therefore, technology transfer occurs South-North and South-South, such that South nations have become leading exporters (Brewer, 2008), and this phenomenon is related to RI.

Recent literature in internationalization of new ventures (INVs) discusses how small firms internationalize (Coviello, 2006; Turcan, 2011). Coviello (2006) noted that as the INV network evolves, it spreads out, thus decreasing in density. The parts of the network that grow are those that are non-redundant, but actors increase their centrality over time, thus increasing their social capital (Coleman, 1988). In further efforts to understand how firm networks evolve, simulations show that innovation networks become chains where innovators are connected to the mass market through imitators (Chang & Harrington Jr., 2007). Also, contrary to some research, INV networks do not increase or maintain their closure (closure is created by a network of highly interconnected nodes) (Burt, 2005; Coviello, 2006; Greve, 1995; Larson & Starr, 1993). Further, Coviello (2006) considers the value chain benefits for INVs as their networks widen, including increased access to financing, markets, referrals and contacts, and distribution channels. It should be noted that the

INVs studied are in niche information technology (IT) markets, allowing them to move fast, widening networks and decreasing density rapidly when internationalizing (Coviello, 2006). However, in other industry contexts, such as sustainable transportation, different network dynamics and configurations are likely due differing industry characteristics such as long term project infrastructure and the related high upfront capital costs that IT does not tend to have. The infrastructure tends to bind long term partnerships so firm networks may evolve differently, remaining more clustered.

The same previous research in IT INVs suggests that structural holes open up in what becomes a more loosely constrained network, and a freer environment of consultation may flourish since INVs have more distant potential contacts, thus minimizing unwanted knowledge spillovers to rivals (Burt, 1992; Coviello, 2006). One can take from this that perhaps when cooperation arises in denser transportation industry networks, some firms may seek relief from local competitive threats by expanding their networks more externally. Prior research considers how these networks evolve without any external coordination. RI could be viewed as a particular instance of Coviello's (2006) research, whereby firms from emerging economies internationalize to sell into developed markets. However, as mentioned earlier, other industry contexts differ from IT and examples from sustainable transportation offer variations on previous research expectations. If hierarchy develops in these more clustered networks, an indicator of it may be a combination of clustering and high centrality of particular member(s) in local networks, possibly reflected by a measure known as network constraint¹ (Burt, 2004). Previous research has found that central firms – hub firms – orchestrate innovation networks and actively take advantage of their position (Burt, 1992; Dhanasai & Parkhe, 2006).

Research has examined “transnational technical communities” (TTCs) as affecting venture capital (VC) flows from the US to overseas countries (Madhavan & Iriyama, 2009). The argument is that immigrant networks of particular technical competence are involved in VC social networks. These individual level networks build trust and reduce the psychic distance that would otherwise accompany investments in distant locations (Hite, 2005; Madhavan & Iriyama, 2009). Other research has found that relational networks are facilitative of foreign direct investment (FDI) in less developed markets where there are more uncertainties than in core nations (Ahlstrom & Bruton, 2006; Chen & Chen, 1998; Yamakawa *et al.*, 2008). Although not explicitly stated in the previous research, it does imply that South countries are obtaining expertise through returnees, emigrants who gain expertise while away and return home, and attracting capital to support indigenous innovation, which may seed future RI opportunities (Nanda & Khanna, 2010).

4. Theoretical Development

4.1. Local and International Value System Network Positions Influencing RI

This section develops propositions (See Figure 1) within the contexts of local and international value systems, considering the centrality of firms within them such that positional differences may represent indicators that RI is likely. In general, value systems include operational components such as material supply chains, information, and communication infrastructure. Investors represent the external financing of the firms and they are also part of the value system.

¹ Constraint in a network measures the extent to which a node links to other nodes that are not linked to each other (Burt, 2004). For example, low network constraint means that a node has links to others that are not already linked to each other.

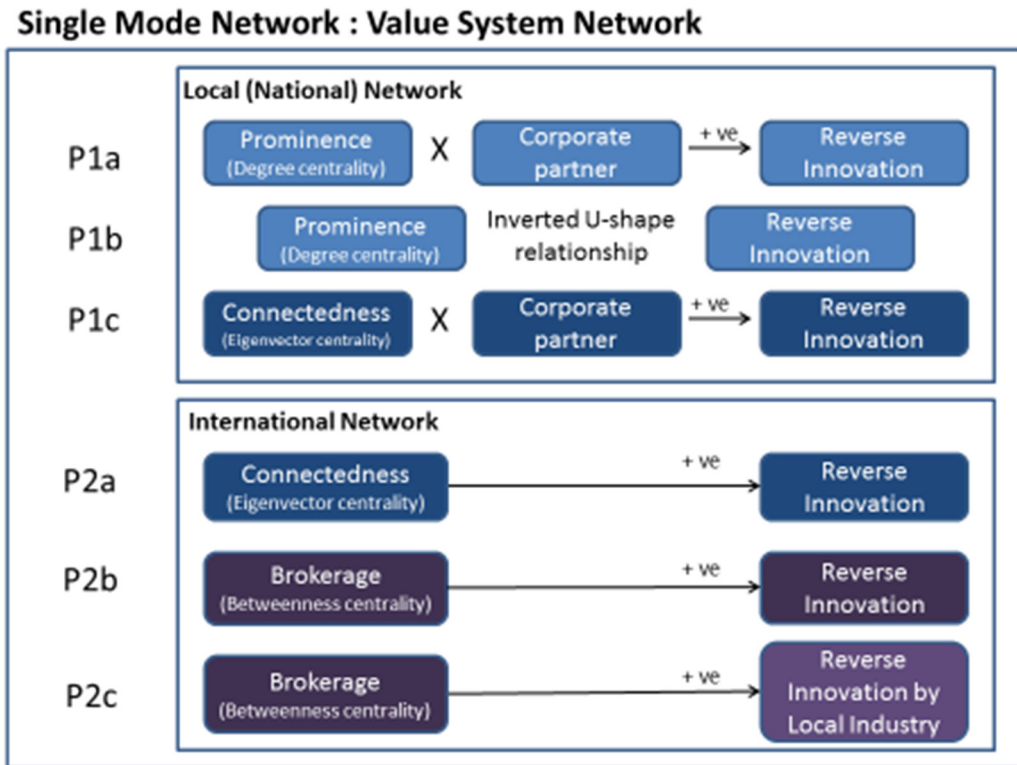


Figure 1. Conceptual diagram of RI propositions

4.1.1. Local Value System

Three types of centrality, to be introduced here with some network theory background, in the local value system are considered for their potential implications for RI. Network theory works at three levels of analysis: interpersonal, inter-unit, and inter-organizational (inter-firm) (Brass, Galaskiewicz, Greve, & Tsai, 2004). This research focuses on the inter-firm level because it builds on existing RI research that has been at that level. Considerable research in networks has focused on the characteristics of the relation (ties) between a pair of firms (the nodes of the network) (Wasserman & Faust, 1994). Weak ties tend to be valuable for exploration and discovery (Granovetter, 1973; Burt, 1992). They are best used for discovering new information that is not complicated or tacit (Hansen, 1999). In contrast, strong ties allow for the transfer of more complex and tacit information (Uzzi, 1996; Hansen, 1999). Strong ties enable firms to convey fine-grained information and facilitate joint problem solving (Uzzi, 1996). They also have a greater requirement for reciprocity (Hansen, 1999).

Organizations gain benefits from each other - from their interconnectedness - and from their positions with respect to each other in the network. The network is both a conduit and a form of social capital (Burt, 1992; Gulati & Gargiulo, 1999). The network offers information (e.g., access, timing and referrals) and control benefits (Burt, 1992). Control benefits may arise, for example, from a position between other actors. A *tertius gaudens* is one who attempts to stay between others to gain negotiation advantages whereas a *tertius iungens*, having a similar network position between others, attempts to join others together rather than taking advantage of control benefits (Obstfeld, 2005; Vernet, 2012). Also, a structural hole exists when groups of interconnected nodes are not joined and there is an opportunity to be a bridge between the groups so as to act like a broker (Burt, 1992). Brokerage is considered in this RI research and measured by betweenness centrality.

“Centrality, the extent to which a given individual is connected to others in a network, is the structural property most often associated with instrumental out-comes, including power (Brass, 1984), influence in decision making (Friedkin, 1993), and innovation (Ibarra, 1993).” (Sparrowe, Liden, Wayne, & Kraimer, 2001, p.316).

Centrality, when measured in different ways, has diverging interpretations, but it essentially means that the most connected actors are most central in the network (Hanneman, 2001). Degree centrality, eigenvector centrality, and betweenness centrality are the three main types of centrality of interest in this research. Degree centrality is measured simply by the number of connections to others that a node has, and it thus is an indication of power because of the independence many connections brings (Wasserman & Faust, 1994; Hanneman, 2001). An actor with high degree centrality is prestigious and prominent. Another way to look at it is that the prominent node has choices in regards to its customers, suppliers, and/or partners if it has many, for example, in a value systems network (Park, Han, Rojas, Son, & Jung, 2011). Many inward directed ties are often interpreted more specifically as in-degree centrality (Hanneman, 2001). However, ties are not directional in this value system network because partners’ relationships, between firms sharing technology, for example, are bidirectional.

Eigenvector centrality measures “the distance of an actor to all others in the network by focusing on the geodesic distance from each actor to all others.” (Hanneman, 2001, p.65). An actor is more central if it is closer to more other actors in the network. Eigenvector centrality measures the importance of a node in a network based on its connectedness to other well-connected nodes. Connections to lesser-connected others do not contribute as much to this centrality value. Lastly, high betweenness centrality suggests that an actor sits on the geodesic (shortest) paths between many other actors (Freeman, 1979); this gives it the power to connect others or keep them apart and negotiate favorably (Hanneman, 2001).

In an emerging market, firms in the same industry are often connected to each other, either transactionally or by information exchange, thus building a small world cluster in that local economy (Hu, Lin, & Chang, 2005; McDermott & Rocha, 2010; Zhang & Li, 2010). A small world network is a form of social organization that is made up of many clusters of tightly interconnected firms having sparse connections between the clusters (Uzzi & Spiro, 2005). Within the clusters, the same information is shared and circulated through strong ties, whereas new information is obtained through weaker bridging ties to other clusters (Granovetter, 1973; Moody & White, 2003; Burt, 2004). When a cluster is determined geographically, it is termed an industrial cluster (Bresnahan & Gambardella, 2004). Research has investigated the relationships between location bound industrial clusters and network connected clusters, in consideration of their combined effects on innovation (Whittington, Owen-Smith, & Powell, 2009). It was found that network effects act both interdependently and independently with geographic proximity in positively motivating innovation. Moreover, the global centrality of a firm was a factor in the aforementioned interactions along with other contingent factors. Thus, a connected cluster of firms is different and may or may not reside in a geographically delineated industrial cluster, however, this coincidence is common in the mobility sector because transportation is inherently location bound (Hu *et al.*, 2005; Zhang & Li, 2010). For example, the Capetown New Mobility Alliance, comprised of a value system of over 150 local partners and motivated by World Cup 2010, builds on current efforts by connecting the multi-modal transportation opportunities between upgraded public transport, innovative public-private partnerships between corporations and local government, and encouragement of taxi, minibus and bike entrepreneurs (Urbansprout, 2012). Also, the new mobility hub in Chennai, India, was catalyzed by the need to develop transportation infrastructure in support of their Information Technology corridor (Chennai City Connect, 2012). To date, close to thirty mobility hubs across the globe are piloting and phasing in locally-optimized approaches to increase transportation efficiency for public and commercial benefit. They are being established in places such as Chennai (India), Johannesburg (South Africa), Hong Kong, and Bremen (Germany). In the US, Portland (Oregon),

San Francisco (California), and Denver (Colorado) are among the leaders where smart mobility clusters and multi-modal models have been deployed or piloted. The focus is on hubs developing in emerging economies although innovation could be connected internationally with hubs located in the North, thus building a small world network and through that network, enabling RI.

A firm having high degree centrality could experience more activity and prominence in its industry, giving it more power to choose any partner. The result of being able to make choices could be a higher quality set of partners that may offer greater promise for a stable and thriving business (Park *et al.*, 2011). “It can be assumed that a node with a higher degree enjoys a greater capacity of resource mobilization and plays a more decisive role in information transaction than other lesser-degree nodes in a network.” (Park *et al.*, 2011) Does a locally prominent firm tend to look outwards to external markets or will it tend to be too distracted by its local activity? High centrality does not necessarily indicate dominance in the market, nor whether the firm has an internationalization strategy.

In contrast, a more peripheral firm, one with lower centrality, may be motivated to attempt external market entry, experiencing constraints exercised by the local control of other more prominent entities that have also possibly captured dominant market positions. However, a more peripheral entity is not a core player in the emerging economy market. If the firm is not recognized in its own home market, then it is doubtful that it can attract attention in sophisticated developed markets, especially when additional investment is required to engage in those markets. Some previous research argues that new ventures not dominant in highly competitive emerging market industries will find that FDI risk is lower in developed compared to emerging economies, and that developed economies offer learning opportunities and greater market potential (Yamakawa *et al.*, 2008). Thus, this previous literature would argue that less prominent firms may explore RI opportunities. Also, research on corporate venturing finds that high local competitiveness motivates new venture internationalization (Yiu, Lau, & Bruton, 2007). However, that research focused on large firms, unlike many of the SMEs of this research that lack resources.

It is proposed that a firm, prominent in its emerging market, may attract external attention in case there are investors or corporations seeking strategic emerging market investments and/or partners (Ahlstrom & Bruton, 2006; Luo, 1997). Multinationals could also already be present in the local network. As mentioned earlier, large foreign firms need to search for local, knowledgeable partners who can navigate the local landscape for them (Luo, 1997; Meyer, Estrin, Bhaumik, & Peng, 2009). Also many cities have started to encourage public private partnerships (PPPs) to develop urban infrastructure projects. Establishing such partnerships requires a financing partner who is also an industry expert to understand project developers’ needs and to help identify and procure the best equipment/technology. This industry expert partner is often a global firm (Kumaraswamy *et al.*, 2012). In transportation, it might be Ford or Siemens. This situation not to be confused with the one where a large firm brings an innovation into an emerging market context to reverse innovate it. As explained earlier, this research is focused on the RI of smaller local firms. However, the smaller firms may be able to internationalize their products through larger international partners’ resources and/or their international locations (Kumaraswamy *et al.*, 2012). Moreover, external investors may be attracted to high centrality firms since the growth opportunities are attractive (Ahlstrom & Bruton, 2006).

Following the success of implementing rapid bus transport systems and interactive operations control systems that allow optimal deployment planning and efficient networking of public transportation in Seoul (Korea), others have followed in less developed nations. From Johannesburg (South Africa), which opened the first phase of a USD 2.2 billion system to transport fans to World Cup matches in 2010, to other cities, including Lagos (Nigeria), and Dar es Salaam (Tanzania), rapid bus lines and e-mobility solutions are being considered or planned to serve growing populations and promote economic growth. The implementation of these solutions will have a local

character, reflecting culture, behavior, and availability of physical and communications infrastructure, resulting in a new product or service. Whereas South Korea, due to its distinction as a manufacturing and innovation hub, has firms well-positioned for technology exporting, much potential RI by firms in these other countries will only become an opportunity if they are partnered with a global industry expert. Therefore, although prominence is not expected to lead to RI directly, it may mean that a SME gains some attention, so RI has some higher likelihood.

In the context of sustainable transportation in emerging markets, high local competitive intensity cannot be assumed. However, in recognition of past arguments that high local competitive intensity motivates new ventures to internationalize into developed nations, in combination with counter arguments that firms having low centrality are unlikely candidates for internationalization, a proposition can be formed. First, when firms are very peripheral, it is unlikely that they can reverse innovate. In contrast, medium levels of relative prominence suggest that firms may satisfy external markets through their potential for resource mobilization while very prominent firms are barriers to greater local market capture for them. As mentioned, highly prominent firms are busy in the local market and do not feel pressure to actively pursue developed ones. Therefore, firms of medium centrality are posited as actively seeking to reverse innovate and an inverted U-shape relationship is proposed.

Proposition 1a: *The higher is the local prominence of a firm, the higher its likelihood of reverse innovation when motivated by a global industry expert partner.*

Proposition 1b: *The relationship between local prominence and reverse innovation, motivated by the focal firm rather than by an external partner, is an inverted U-shape curve.*

Local eigenvector centrality may be more consequential than degree centrality. A higher relative centrality value compared to other firms in the local value system suggests that the firm is connected to others that also have many connections and this is related to more information or power (Bonacich, 1987). Larger firms with global connections and access to diverse markets will tend to have more connections because they have the resources to manage them (Walker, Kogut, & Shan, 1997). A focal firm with more stable and larger partners may improve its life chances (Stuart, 2000), but there is not necessarily a direct link with its own motivation for RI. However, higher eigenvector centrality may be an improved indicator compared to degree centrality for prominence because this type of prominence is supported by stronger partners, a better position than that suggested in the first proposition, indicated by degree centrality. The firm may have a higher likelihood of gaining notice by more powerful external parties and/or local multi-nationals.

Proposition 1c: *The greater the connectedness of a firm to more powerful others, the higher its likelihood of a reverse innovation partnership motivated by a global industry expert partner.*

4.1.2. International Value System

Centrality measurements are next considered in an international network context that is inclusive of the domestic network. An example mentioned earlier, the Chennai, India new mobility hub pilot project involves large US organizations such as Ford Motor company, the University of Michigan, and Cisco. Through this project, Indian firms such as Ashok Leyland (a commercial vehicle manufacturer that is part of the Hinduja Group), TI Cycles of India (a firm that offers personal mobility solutions like bicycles and is part of the Murugappa Group), Suvidha Parklift (a firm that designs parking systems and is part of Poddar Group), and TVS Electronics (a firm that offers computer and electronic tracking products and is part of the TVS Group) are becoming networked with the US organizations.

Many emerging market firms may not have international connections, but those that do likely have a greater impetus for RI than firms having only local connections. Some resource based view research has theorized that new emerging market ventures may internationalize to developed nations if venture capitalists from the North are involved with them or if South firms form strategic

alliances with North firms (Yamakawa *et al.*, 2008). The rationale is that North firms help South firms overcome deficiencies in capabilities. From a network point of view, a firm that is prominent by degree centrality in a value system network could have international connections of any type. Therefore, eigenvector centrality, for reasons discussed earlier, may be more indicative of the power that the firm has and that its connections may have for promoting offerings far afield. Also, a firm with very high eigenvector centrality in the international network may not have appeared as having as high a centrality value in the local network because the international connections were excluded. It is therefore posited that a higher eigenvector centrality in the international network suggests that the firm has greater reach than a local firm. In this case, the firm is not passively waiting for an international partner to identify and attempt to connect with it. In fact, some of the international connections could already be customers. If they are partners, this type of collaboration could be a two-way intercultural channel working in either direction, into the emerging economy and/or into the developed country (de Lange, 2013). Any kind of international partnership could become a conduit for RI and the firm may not need an additional partner to initiate this business strategy since it is already externally engaged and actively using its international network position (Burt, 1992; Dhanasai & Parkhe, 2006).

Proposition 2a: *The greater the international connectedness of a firm to more powerful others, the higher the likelihood that it will actively seek to engage in reverse innovation through its international contacts.*

Secondly, an emerging market firm having high betweenness centrality in an international network may bridge across international clusters, for example, if the network has a small world configuration, discussed earlier. Thus, the firm may be in a negotiating position between its local industry and international parties. If it has this brokerage position, it may do deals on behalf of itself and its local industry, playing the *tertius gaudens* role (Obstfeld, 2005; Vernet, 2012). It may also garner more resources from local players that hope to gain access to international contacts through the focal firm. Alternatively, the focal firm may introduce firms in local and international networks to each other, playing the *tertius iungens* role. However, under circumstances that the firm prefers to promote itself, it may maintain a *tertius gaudens* role, becoming a channel for its own offerings and even possibly two-way interchange between international and local partners. Of course, the high betweenness centrality measurement does not indicate that the brokerage is international or purely local and investigation of who the partners are in a focal firm's network is required, but not difficult to do after a high centrality player has been identified. An international brokerage position suggests many benefits in an international industry network that is likely to lead to RI should the firm actively take advantage of it (Burt, 1992; Dhanasai & Parkhe, 2006; Lorenzen & Mudambi, 2013).

Proposition 2b: *The higher the international brokerage potential of a firm, the higher the likelihood of it actively seeking to engage in reverse innovation.*

Proposition 2c: *The higher the international brokerage potential of a firm, the higher the likelihood of it bridging reverse innovation between its local industry and international markets.*

5. Conclusions and Future Research

This work has considered network mechanisms, focusing on positions and mechanisms in local and international value system networks that could indicate a likelihood of RI. RI is a phenomenon of globalization suggesting the world's movement toward a multi-polar world. As power and wealth become more globally distributed, centers of innovation will arise in the new centers of power. Initially, new centers of technological development in emerging economies of the South may produce frugal innovations designed for the more difficult or unique conditions of their origins. However, these conditions may result in product and service innovations of interest to wealthier

developed (North) economies that offer expanded market opportunities. Entry and wider international exposure possibilities open up for the emerging economy firms and this could lead to investment into what could become leapfrog or frontier technologies such that these economies move up the ladder of development faster. Moreover, North nations are able to bargain with the South on a more even playing field such that demands for foreign aid and special treatment are replaced with valuable and more equal working partnerships. Ultimately, this is a story about building an inter-cultural channel for bidirectional innovation flows, where the reverse flow barely existed in recent history. The fact that a source for the reverse flow has developed suggests a geopolitical power shift.

In this work, a different kind and direction of international flow is considered, that of innovation from South to North. Moreover, this international network theory contemplates whether firm-level network positions of centrality may be indicators of these flows or future flows. Single mode value systems were examined and the centrality of emerging market SMEs within them. The theoretical analysis suggests that, although high degree centrality could mean that a firm is noticeable, eigenvector centrality provides a stronger signal of RI due to the firm's more powerful set of potential international partners. In addition, very prominent local firms may be identified as potential partners for RI, but they could be too busy in their own home markets to actively pursue it. However, when SMEs are at medium levels of local degree centrality, the local market structure may put pressure on them to actively pursue international markets. While these firms are reasonably capable, the most prominent local firms are market blockages. Furthermore, in international value system networks, betweenness centrality indicates an extremely valuable position that likely spurs the innovative firm to also become an international broker or bridge.

This research has presented conceptual propositions that future research may test as hypotheses when the applicable and large network datasets become available. To aid in conceptual understanding, international examples from the sustainable transportation sector were used here because technological developments in this industry are so consequential to all large growing cities around the world, whatever the stage of development. While many general issues are common across cities, the local solutions will often need more customization to local conditions. Thus, this is an excellent context for RI and for future work that could test the connections made in this theoretical research. At the same time, this theory has been written to be generalizable across many industries, but a limitation is that it is not likely generalizable to all of them. As suggested earlier, characteristics of the industry are likely relevant. Some industries, like IT (computer software innovations) are not as location-bound and may not conform to the theory developed here. Determining the boundaries of the theory is also an opportunity for additional future research.

Overall, RI is an exciting new strategic perspective in international business arising as globalization takes hold. In this research, network theory has been extended to an international business context where firms internationalize across locations at different stages of development. The hope is that the kind of RI discussed in this research, where it originates in the less developed nation, spurs local industrial development such that the RI activities create local opportunities and move the locale up the development ladder. Ultimately, this research adds to other previous international network research that considers the dynamics of globalization.

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