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13. Informal Relations and the Innovation Problem in Hungarian Healthcare: A Discussion about Data Collection and Initial Findings Using LinkedIn and USPTO Data

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Monitors of innovation performance from all of the major sources: Eurostat, the World Bank and the World Economic Forum continue to show the failure of European transformed societies (post-communist) to make significant progress in innovation (the market application of recombined knowledge) relative to non-transformed societies.

The purpose of this paper[1] *is to identify the obstacles to the invention, adoption and diffusion of cutting-edge health-related inventions (new knowledge, medical devices, medications, and therapies) and firm performance that are due to the structure, composition, magnitude and significance of informal networks in the healthcare industry (from bench to bedside) in Hungary. To achieve a higher level of understanding about the composition (the ratio of personal contacts to arms length contacts) of firm-firm informal (non- contract-based) networks and their effect on innovation and firm performance, three basic questions must be addressed: What is the relationship between informal ties and firm performance in healthcare-related innovation networks in Hungary? What is the magnitude and significance (if there is any) of the effect? What are the implications of the findings from one and two for innovation policy in the transformed societies?*

1. Introduction

Several factors drive today's trends in global drug research and healthcare: changing population demographics; the availability of big data; the growing interest in self-diagnosis; the economic recession; and growing levels of access to the internet and mobile technology. These trends make a deeper understanding of the optimal advancement of life sciences and its translation to marketable products and services for the sick and the aging a necessary course of action. A timely study of the healthcare industry in so called "emerging" economies" is all the more important given the aim of the European Union to maximize social cohesion among and within the EU-27 through a decline in health-related inequalities and because it is expected that innovation will become more globally distributed in the future.

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How will innovation become more globally distributed; and most importantly, where? Monitors of innovation performance from all major sources: Eurostat, the World Bank and the World Economic Forum continue to show the failure of European transformed societies (post-communist) to make significant progress in innovation (the market application of recombined knowledge) (Schumpeter 1943) relative to non transformed societies. Decades after transition, Hungarian performance is still low, appearing as a "moderate innovator" in the 2011 EU Scoreboard. According to the "innovation network" metrics (international, co-publications, public-private partnerships), Hungarian performance is still notably poor; however all the transformed societies perform orders of magnitude lower than the Scandinavians (especially Sweden) on this measure.

Hungary does extremely well however in the "innovation cooperation" measure of the Community Innovation Survey (waves 2006, 2008, 2010). Indeed, there appears to be no significant difference in the mean percent levels of cooperation between the transformed and non transformed countries in the 2006 and 2008 waves (Crosby-Nagy). In terms of global drug research, Hungary placed well in the region according to the numbers of papers funded by Big Pharma with at least one CEE author; where, Hungary was second in CEE only to Poland in number of papers funded from 1989 to 2010 (Crosby-Nagy 2011).

Hungarian performance in public health outcomes such as peri-natal health has improved but still need work; especially with regards to infant mortality and birth weight.[2] In international comparison, there is great cause for concern according to maternal death and preterm birth indicators[3]. The purpose of the dissertation is to identify the obstacles to the invention, adoption and diffusion (Coleman et al. 1957, Hagerstrand 1967, Halila 2007, Loof − Brostrom 2008, Valente 1996, Wejnert 2002, Griliches 1957) of cutting-edge health-related inventions (new knowledge, medical devices, medications, and therapies) and firm performance that are due to the structure, composition, magnitude and significance of informal networks in the healthcare industry (from bench to bedside) in Hungary. Where, "composition" is defined as the ratio of personal contacts to arm's length contacts (Granovetter 2008, Uzzi 1997) of firm-firm informal (non contract-based) networks. As a result, three basic questions are of interest here: What is the relationship between informal ties and firm performance in healthcare-related innovation

[2]http://www.tarki.hu/en/research/childpoverty/tarki_chwb_mainreport_online.pdf; p. 82.
[3]http://www.europeristat.com/images/doc/EPHR/european-perinatal-health-report.pdf; p. 99, 132.

networks in Hungary? What is the magnitude and significance (if there is any) of the effect? What are the implications of the findings from one and two for innovation policy in the transformed societies?

2. Background

The "innovation problem" in CEE is attributed to a variety of institutional and macro-level factors. "Laggard" and "catching-up" status has specifically been attributed to the failure of policies both industrial and innovation-wise, a lack of significant investment in innovation inputs by firms and governments, historical heritage, measurement error, cultural values, business climate, the shadow economy and poor quality scientific personnel (Graham et al. 1992, Taylor − Wilson 2012, Zelizer − Rotman 2010, Lippenyi 2007, Griliches 1957, Andreff 2001, Brouthers et al. 2001, Glovackas 2005, Radosevic 1999, Radosevic 2002, Sporer 2004). Some scholars from the network perspective also attribute the problem to a severe disconnect among the system of innovation (government-university and industry) including the so called "invisible college" (Price 1971) i.e. overall poor connectivity within the system domestically and poorly formed connections external to the system internationally (Chaminade − Edquist 2006, Evangelista et al. 2002, Feinson 2003, Niosi − Saviotti 1993, Katz − Shapiro 1994, Leydesdorff 2009, Nelson 1993, Lundvall − Tomlinson 2000, Lundvall 2011, Inzelt 2008, 2004, 2003, Rosenberg 1976, Klein − Solem 2008, Kreiner − Schultz 1993, Leydesdorff − Wagner 2008).

The role of networking, also known as "innovation cooperation" has become of increasing importance to policy makers, due to the discovery of its function as a driver in product innovation (the creation of new products and services). Intra-industry linkages play a major role in firm strategic behavior, which affects productivity. And, government- university- industry relationships play an increasing role as knowledge becomes the primary source of power in an economy (Etzkowitz 2002). Other networks such as research networks are appearing more often in EU policy such that they now serve as an important piece of "socio-economic infrastructure" (Cassi et al. 2008).

"Innovation networks", often measured by formalized relations such as co-publications, strategic alliances between firms, funded research at universities etc., have been called the *sine quo non* of innovation (Agapitova 2003, Caniglia 2001, Cassi et al. 2008, Coe − Bunnell 2003,

Gossart − Özman 2008, Saxenian 2002, König et al. 2011, Ciarli 2010, Kreiner − Schultz 1993, Lombardi 2010, Schilling − Phelps 2007, Hagedoorn − Vonortas 2003, Okamura − Vonortas 2006, Feldman − Link 2001). The formulation of innovation networks are also at the heart of innovation policy in the European Union. Cluster policy, the creation of science parks, and incentives for cooperation are just some of the ways governments have tried to intervene in the innovation process in the EU using the idea of relationship building. Clusters are based on the idea that bringing businesses closer together physically will result in better research translation (Kamath et al. 2012, Melnik et al. 2011, Phlippen − der Knaap 2007)

"Designed networks" as opposed to "emergent networks" rarely produce desired results in biotechnology for example. This is perhaps due to a misconception about how tacit knowledge is transferred. A study of transfer of know-how in the manufacturing industry (Eric 1987) showed that conferences acted as an important medium for partner search and selection. Individuals would attend conferences, meet people, create a short-list of people who might be important and then contact those people when in need of advice to solve a problem. Survey data of 71 polish enterprises in 1998 explored the idea of tie-formation as a result of strategic interdependencies where social capital is describe in terms of "relational assets" and that those have opportunity costs, which can give rise to lock-in. They noted that a large number of links among peers means power and influence such that a partner can exert this power by not cooperating.

Formal and informal ties are used differently by different sectors— where, the more knowledge intensive sectors such as the chemicals sector tend to create both research partnerships and inter-firm alliances as opposed to the manufacturing sector which tends to create ties with its supply chain and customers. Additionally, informal ties are mostly used in the chemicals sector for gaining new information and formal ties are used for maintaining relationships. Firms also create ties in order to access information with varying intensity and as the result of firm size. Small firms in the chemicals sector may partner more because they simply don't have the capability to perform in-house R&D. In addition they may have more informal partnerships since small firms are likely to be younger firms and therefore have a need to achieve more immediate results with new information from informal ties.

The literature linking networking and innovation performance as well as business activity is sparse, but contains a few classics. Ruef (2002) tries to understand network structure and cultural factors and their relationship to organizational innovation using survey-based probit

analysis of 700 company start-ups (Ruef 2002). Most of the hypotheses (out of 9) were not significant when the dependent variable was patent applications; however, when teams were asked their impression of innovation activity, the hypotheses were significant. Thus, effects were seen in magnitude, but did not necessarily rule out the possibility that they were due to chance. Uzzi's 1997 Paradox of Embeddedness found networks can improve efficiency, but can also impede progress (Uzzi 1997). Granovetter's Strength of Weak Ties (1973, 1995), befitting the chemicals sector, showed that weak ties are useful for obtaining new information, strong ties (of friends and family) are ties that require continual maintenance (Granovetter 1973, Granovetter 1985). Contributing to the so called "paradox" of embeddedness, Burt in 1992 found strong ties can be sources of redundant information (Burt 1995).

It is important to note that all the above studies treat the firm as the unit of analysis. This idea was challenged by Saxenian (1996), where she suggests that regional networks should not be thought of as networks of firms, but rather networks of people (Saxenian 1996). Such an approach is largely reflected in the all aspects of the dissertation, from hypotheses to operationalization of variables.

3. Hypotheses

When innovation networks are thought of as teams, which are assembled based on certain rules of attachment (Powell et al. 2005), these rules of assembly appear unhealthy for optimal invention, adoption and diffusion of innovations and finally firm profit in Hungary. Specifically, it is supposed that they contain a suboptimal mix of personal and "arm's length" (Uzzi 1997, Granovetter 1985, Granovetter 1973, Granovetter 1995, Granovetter 2005, Granovetter 2008) exchanges. A similar hypothesis was tested in (Ruef 2002) using patent applications as a dependent variable and strong/weak ties as the explanatory variables . It is suspected that LinkedIn as a data source is more accurate at delineating between friends (people of former places of work and study) and „arms-length" contacts (everyone else) and will yield better results.

H1: Actors in Hungarian healthcare have a suboptimal mix of personal and arm's length connections according to their online professional network in LinkedIn.

H2: Actors with suboptimal mixes have companies that perform worse patent-wise than Actors with more optimal mixes (not too much of one kind).

Further, when innovation networks are thought of as teams, which are assembled based on certain rules of attachment (Powell et al. 2005), these rules of assembly in transformed societies are unhealthy for invention, optimal innovation adoption and diffusion and finally firm profit. Rules that govern these attachments might include: party competition (Vedres − Stark 2010, Vaan et al. 2011, Gernot − Stark 1996, Stark 1996, Vedres − Stark 2008). Where, the party affiliation can be identified by the year the company was founded and its correspondence with the majority party.

H3: Poor innovation performance is also due to: party competition; namely, Actors whose party flags align with the majority perform better patent-wise than those who align with the minority.

Finally, it is suspected that the current attachment rules in innovation networks will begin to matter less and less over time because they are a function of the society's market evolution ("catching-up"). As long as the market continues to progress, the composition of innovation networks will evolve towards a better mix of personal and arms-length contacts that will result in better innovation outcomes. The same hypothesis was tested in Uzzi 1997.

H4: "the weaker the ability of prices to distill information, the more organizations will form embedded ties".

4. Discussion: exploring innovation networks using LinkedIn

What is LinkedIn? LinkedIn is a publically traded for profit corporation founded in 2003, which, according to Wikipedia, had over 200 million users as of January 2013 in more than 200 countries and territories. Claiming to be a social networking site for professionals, LinkedIn is free for creating an online profile, and for connecting with others, but offers upgrades for a fee; primarily targeting sales professionals, job seekers and employers. The US population is the highest represented, followed by India, then the UK; with the fastest rate of growth in the Netherlands.

Making Connections: You are technically able to try to connect with anyone, including people who are not members of LinkedIn, however, the user agreement advises that you don't try to connect with people you do not know, nor accept requests from users you do not know. Nonetheless, you are able to connect to people you wish to connect with by tagging them as a

personal or professional contact. LinkedIn will call up your former places of work or study when you wish to connect with someone. Or, you can provide the email address of the person. Or you can simply select "friend" and wait for them to accept your invitation. Should you build up a record of too many instances where the other party told the system you invitations were spam, or that they did not personally know you then your account could be closed.

Once someone becomes a 1st degree connection to you, your 2nd degree connections become much larger; that is, you are able to see all the people who are one connection away from you such that, should you try connect, the other party will see you have one person in common, a shared connection.

Code of Conduct: This brings up two issues with regard to using LinkedIn for data collection and analysis.

1. It not crystal clear whether "friending" someone, that is, trying to connect with them as a stranger, is “breaking the rules of the site”. Assuming that when one selects friend, they mean "let's be friends" since if that were your friend, you would most likely have their email address to provide, or have some outside connection such as former place of work or study; except in the very rare cases that your network consisted primarily of your high school friends or friendships that naturally emerged from childhood and you also had no common place of work or study later on); and
2. When someone accepts your friend request, in most cases you are able to see their entire network. (They can however restrict you from seeing their own network should they wish to.) You are then limited to seeing only certain information about their 2nd degree connections - something similar to a business card that contains current and former places of work/study. And most of the time full name and location. When someone gives you full access to their information and their own connections as well as when they join and actively participate on the site, are they consciously agreeing to your analysis of their connections?

LinkedIn as Ego-Centered Networks: The code of conduct/ethics discussion is relevant when discussing the use of LinkedIn as a vessel for ego-centered network analysis. Traditional ego-centered network analysis uses surveys of live people that provide alters through name generation. Such surveying techniques are costly and have various effects such as order-effects,

fatigue, satisficing, non-redundancy, as well as interviewer effects. The advantage of using online networks for personal network research where there is usually a disadvantage when using surveys are in terms of: cost, interrelation, and accuracy. However one is still faced with other common problems of personal network research: the bounds of the network (where does it end?), assessment of negative ties (who is the Ego not connecting with?) and in the most crucial of ways, how to interpret the tie itself when no name generation question was given.

Why do people join LinkedIn/What does a connection represent? Interpreting the tie, is then perhaps one of the most difficult challenges presented by network analysis of online social networks. In order to answer this question, we begin by asking: why do people use LinkedIn?

Seeking Jobs: Many people think of LinkedIn as a site where one can look for jobs and be seen by employers looking for talent. But especially today, how much activity does this really explain?

Keeping up with industry trend: LinkedIn advertises that one can "keep up with industry trends" using LinkedIn. It is safe to say, this is not likely the first order reason people use the site, but is still important.

Keeping an online rolodex: Another share of activity might be explained by individuals who use LinkedIn to keep an online rolodex. Someone they met at a party, a networking event, at a meeting, wishing to create a weak tie with that person, to share his/her resume in order to build credibility, but do not necessary have the intention of seeking a job from that connection's firm. LinkedIn might serve as an avenue to keep a business door open, as opposed to trying to connect on the more personal social networking site Facebook.

Connecting with the West: Given the skewed distribution of users from the United States, it might be the case that entrepreneurs who are interested in growing their network of "Western" contacts join LinkedIn. So for example, Chinese CEOs who want to find business opportunities outside China, would network on LinkedIn, but not those who are primarily interested in doing business in China. Those who are primarily interested in doing business in China might be using a Chinese version of LinkedIn. This highlights another aspect of the site, that should be taken into consideration, which is, that LinkedIn operates in as many languages as it does countries. So, people who are using the English language LinkedIn site, are most definitely looking to connect outwards more so than inwards.

Connections as informal networks: So long as tacit knowledge is still transferred through people, as the LinkedIn slogan goes, *Relationships Matter*. The connection between two people on LinkedIn would not likely be considered a formalized relationship, since there is no legal contractual arrangement between the two parties nor their company or institutional affiliations. There might indeed be something of an implicit mutual acceptance, but we can safely assume that there is no legally binding agreement between an Ego and its Alter and thus, can interpret LinkedIn networks as "informal".

Connections as "innovation networks": It is speculated that informal networks give rise to formal networks, especially in the case of a firm's desire to access external sources of knowledge—its innovation network. One could interpret an online professional networking site containing a virtual "rolodex", as an Ego's informal network, standing by as a resource to be called upon when needed. Further, when Ego is a proxy for the firm itself, one can view Ego's alters as a firm's potential sources of external knowledge - the building blocks for future, formalized, contract-based partnerships and arrangements whether they be potential partners for sharing risk when entering a new market, or candidates for co-publication.

Data Collection Method: The above conceptualization of LinkedIn - that is, LinkedIn as informal innovation networks, highly influenced how we chose to grab data from LinkedIn. We first used the company search feature to identify small and medium sized companies, then isolated them by industry (biotech and pharma) and then by country (V4, Russia, China and Germany) using the filters provided. (We did not upgrade our LinkedIn account in order to access these companies, just the regular free version.) Then we clicked on each company and "friended" those with the title of CEO, Director, Founder, or Co-Founder, which appears to right of the company profile. We then used a systematic random sampling method to explore the composition of each Ego's (CEO) network of alters. We collected data on 10% of each Ego's network as well as information about each Ego. (Indeed it was difficult to select a sampling method. And there may very well be a periodic bias to the systematic random method we chose since we do not know the algorithm used to display the list of alters when one views an Ego's network.)

From the beginning we knew that the populations we would be dealing with would be small, made smaller by the companies that have employees that are using LinkedIn and then made smaller still by those who chose to accept the friend request. In the early days we tried to track our

"acceptance rate", but then quickly found that the population was growing by day and in some cases exponentially. Obviously the latter has implications about the representability of the Ego set, in addition to the problem of the nonrandom nature of acceptance of the "friend" request.

The acceptance of a "friend" request is interesting as an Ego-centered network study in itself. We found that CEOs from developing countries quickly accepted friend invites. The German acceptances were much slower such that we had to use a different strategy for those CEOs. For Germany we tried to leverage first degree connections by calling up all these in the pharma and biotech industries in Germany and then viewed my 2nd degree connection. Then we sent a friend request to those CEOs, with whom we had one contact in common. This strategy was effective. Next we filtered those contacts by employee size.

Finding Hungarian inventors using the USPTO Database: The trial data grab of USPTO patents contained all Hungarian inventors from all industries in 2007. After isolating inventors in the healthcare industry using the title, international class, field and place of first ranked author, very few of these inventors were identified on LinkedIn (about 4 out of about 15). For example the entire medical probe team is missing from LinkedIn. Incidentally, this team also lacked international partners. (Where there was a US member of the team, these Hungarian inventors did tend to have a LinkedIn account.) A problem the arose with identifying the inventors on the LinkedIn site when there were several people with the same name, and one could not be sure which industry that person now works in.

5. Initial observations

The above data collection strategy allowed us to feign embeddedness in the biotechnology and pharmaceuticals industries; where, each friend request increased the likelihood that the next CEO would accept the invitation exponentially. This suggests further support for Barabasi's scale-free network concept (the larger my network becomes the larger my network will become). Those who do not yet have a connection to me will see that I have connections to their connections and decide to connect based on this mechanism - i.e preferential attachment. However, we must not rule out the idea that there could be other possible attachment mechanisms.

Next we noticed that CEOs in the V4, Russia and Germany tended to be of that country's majority ethnicity. However, a lot of variation was found in the ethnicity of the leadership of the

Chinese companies. In the Chinese case, leadership tended not to be of Chinese origin (as determined by last name) and in some cases, companies that appear in the initial firm search with a China filter, did not match the same location when the leadership was then identified (there was an India-located CEO whose company appeared in the Chinese search).

Initial findings show that the Hungarian CEO networks vs. the Hungarian Inventor networks vary by size of their LinkedIn networks. Of the four inventors who accepted the friend request, only one had more than 50 connections, and that person had over 500 connections.

Finally, on composition, initially it appears that former place of study explains variation in many of the Hungarian CEO network-ties; with the University of Szeged being a hub. One important observation is that some Ego's alters have over 500 ties and some have fewer than 50. This might mean that there should in fact be a ranking of Egos based not on the number of ties, but the impact of those ties, as weighted by their alter's number of connections (a kind of impact factor). Where Ego has ties with alters that have several 500+ connections, that Ego's network is of higher value than another's, even if they have a fewer total number of ties.

6. Conclusion

The dissertation is interested in investigating the relationship between informal networks and firm performance in healthcare. It remains to be seen whether online professional networking sites such as LinkedIn, can provide a clue about variation in country-level innovation performance; namely, the contribution of the composition of informal networks themselves. Thus far it appears that, in light of the hypotheses, that LinkedIn is a severely "western" oriented information and communications technology, such that one might not be able to say, which came first, the international linkages or the invention. It does appear, at least initially, that there may be an overrepresentation of "friends" from former places of study, rather than arm's length contacts in the Hungarian case. This is indeed very interesting given that Hungarian users of LinkedIn must be very outward looking, but still their networks contain mostly Hungarian "friends". However, further data is needed as well as country comparison in order to both confirm this speculation and try to more deeply probe informal network composition as a determinant of firm performance in Hungary.

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