Network structure and economic prosperity in municipalities: A large-scale test of social capital theory using social media data

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ABSTRACT

In this study, we analyze the relationship between network structure and economic prosperity in 438 Dutch municipalities. We focus on the structural aspects of social capital theory and test how three forms of social capital – network density, fragmentation (bonding), diversity and geographical distance of ties (bridging) – are associated with economic prosperity at the municipality level. We use data from a Dutch online social network that consists of more than 10 million users to test the hypotheses. We find that communities that have high network diversity are also more prosperous economically, while high network fragmentation is associated with lower prosperity. Contrary to previous literature, we find some support that network density at the community level is negatively associated with economic prosperity.

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1. Introduction

In the scientific literature, social capital has been associated with various benefits, one of the most important being the ability to improve economic prosperity of individuals and collective entities (Burt, 2001; Coleman, 1988). The role of social capital in explaining economic outcomes on the individual level, such as finding a job or moving up the organizational ladder, has been a useful addition to the utilitarian tradition, including neoclassical economics (Granovetter, 1985; Lin, 1999a; Lin, 2001). Social trust, norms of reciprocity and networks of social interaction, the main constituents of social capital, have also been used to explain the variance in economic prosperity of entire nations (Westlund and Adam, 2010). The concept has crossed the borders of academia to agendas of policy implementation. Investments in social capital have been stressed as crucial and relatively inexpensive additions to costly financial instruments for achieving sustainable development in poverty struck neighborhoods and national economies (Malecki, 2012; Huber, 2009; World Bank, 2014).

Although social capital has been identified as critical for societies to prosper economically, empirical research has been relatively unsuccessful in finding the positive relation (Westlund and Adam, 2010). While theories have often focused on positive effects of social capital on economic development, researchers have also found negative or no effects of different dimensions of social capital, such as trust and participation in civic organizations, thus casting doubt on the usefulness of the concept (Fishman, 2009). One of the possible reasons identified behind these ambiguous results is inconsistent measurement of the concept (Westlund and Adam, 2010). Due to diverse theoretical definitions of social capital, researchers have tended to put emphasis on different dimensions of the concept, mostly using trust and membership in civic associations as measures for macro level social capital (e.g. Ahlerup et al., 2009; Hauser et al., 2007). More consistency in terms of operationalization of different types of social capital is therefore lacking in the current empirical literature.

One dimension that is included in virtually every definition of micro- and macro- level social capital is the structural or network social capital (Adler and Kwon, 2002). Since the first definitions of the concept, differences in how individuals are interconnected with each other have been central to social capital theory. Coleman (1988, 1990) argued that closure, a type of structure of a social network in which everyone is connected and no one can escape the notice of others, can be beneficial economically, because it facilitates sanctioning of deviant individuals and makes trusting each other less risky. Putnam (2000, 2007), building on Coleman's theory and Granovetter's (1973) concept of weak ties, proposed the distinction between bonding and bridging social capital – a distinction, which is also founded on structural differences between networks with tightly knit cliques of individuals and, on the other hand, well interconnected networks with bridging connections between these cliques.

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While many empirical studies rely on these theories, differences in network structures on the macro level (e.g. regional or national social networks) have rarely been measured directly. In order to test these structural effects on economic prosperity, network data on the community level are necessary. The core idea of the communitarian approach to social capital that is common in the works of Coleman and Putnam is that social capital is a community-level phenomenon and a public good (Lin, 1999b). A community member might benefit from a highly connected community network even if he or she is only connected to few individuals, because of the high overall trust in the community. Such a member does not need to be well connected personally (e.g. have high out-degree) to benefit from community's high network density. As put forward by Putnam (2007), one can be safe about security of his or her home in a cohesive neighborhood, even if this person never attends barbecues and cocktail parties. Ego-network data consisting of a random sample of individuals and their network neighbors cannot reflect how the structure of a broader community network (i.e. people that are not directly connected to ego) affects economic prosperity of any given person (Westlund and Adam, 2010). Accordingly, a simple aggregation of individual network properties cannot accurately inform us on community-level social capital. To adequately capture the structure of social relations in a community, the data should therefore ideally include connections between all individuals in a network instead of a random set of individuals and their network neighbors. Social capital should therefore also be measured as a network-level property.

Attempts to use such complete-network approach to study social capital on the macro level have been limited due to scarcity of large-scale datasets. To our knowledge, only one study used complete network data to study economic prosperity, among other outcomes, on the regional level (Eagle et al., 2010). Other studies that included social networks as a dimension of social capital mostly used civic participation as a proxy for bridging social capital or, more recently, ego-network ties and relative importance of relationship with family members, acquaintances and friends (e.g. Hauser et al., 2007; Sabatini, 2008). It could be argued that these measures cannot adequately reflect network structure, since they only account for a small fraction of all relationships (Westlund and Adam, 2010).

Emphasizing the structural side of social capital on the macro level could potentially help to overcome the problem of inconsistency of measures in the empirical studies on economic prosperity at the macro level. Network analysis has been widely used to study economic outcomes of social capital at the individual level. These studies have developed consistent and comparable measures of social capital (Burt, 1992; Borgatti et al., 1998; Lin, 1999a; Growiec and Growiec, 2009). Similarly, a network-based approach could also benefit research on social capital of macro-level entities by employing consistent network-level structural measures that reflect the communitarian approach by focusing on the entire network and not individual resources or network positions (e.g. network density or fragmentation).

To that end, this study aims to answer *what is the relationship between network social capital and economic prosperity on the macro level?* We will focus on the structure of online friendship networks and use several network-level structural properties as a measure of social capital. Specifically, we will test the association between various structural properties of networks of more than 400 municipalities in the Netherlands and their economic performance. We will use a large-scale complete network dataset from a Dutch online social network "Hyves". The dataset contains network ties of more than 10 million users from different age groups and geographical locations in the Netherlands.

We chose social network at the municipality level as our unit of analysis. The choice of community boundaries is crucial when studying network structure, especially in large-scale networks with no pre-defined groups of actors. Given the limitations of self-reported location data by Hyves users, municipality level is the smallest geographical unit that can be used in the analyses. While smaller geographical units (e.g. towns and cities or neighborhoods) might arguably be preferable to analyze social capital at the community level, towns and neighborhoods in different parts of the country often have identical names, which make reliable geocoding of online social network users impossible. On the other hand, municipalities in the Netherlands are small in area size, on average 76.48 km^2, and usually consist of a single city and several surrounding towns and villages. It is therefore reasonable to expect that most of individuals' social and economic activities take place within such area and that the structure of social networks at this level can have an impact on individuals' everyday lives. Additionally, many aspects related to economic prosperity – infrastructure, urban development, education, employment and other social affairs – are regulated on the municipal level, making the distinction at this level even more important.

Online social network data can be particularly useful to study social capital. Previous studies have shown that online social networking is used mainly for (re)connecting with offline contacts, thus providing a good proxy for overall structure of offline relationships (Dunbar et al., 2015; Dunbar, 2016; Subrahmanyam et al., 2008; Brandtzæg, 2012). Empirical evidence shows that around 80% of adolescents' online friends are also their offline contacts (Subrahmanyam et al., 2008; Reich et al., 2012; Van Zalk et al., 2014). This phenomenon is also evident among adults, with the majority of their Facebook contacts consisting of family, friends, colleagues and neighbors (Duggan et al., 2015).

Due to the limited level of detail in our data set, we cannot assess the impact of tie strength or pre-select those ties that are actively used. We also have no information on the content of ties (e.g. friends, acquaintances or family members). As a result, in this study we measure the potential amount of social capital in communities, but not the actual flow of resources. Online social network data also inevitably leave out individuals who do not use such platforms and could potentially lead to missing important sources of social capital for each individual. It could be argued, however, that it is a general problem for most existing network data. No data set of offline networks, to our knowledge, captures complete ego networks, which leads to the possibility of omitting important sources of social resources. The scope of online social networks and their resemblance to offline networks can therefore be considered advantageous.

Additionally, although we interpret online social network data as a proxy for offline networks, it has been argued in recent research that the ties formed in online environments provide a similar quantity and quality of social capital to relationships formed offline (Sajuria et al., 2015). In other words, online social ties can be a source of social capital regardless of whether individuals also know each other offline. Finally, the availability of internet access in the Netherlands is one of the highest in the world along with widespread use of online social networks – around 80% of people aged 16–35 in the Netherlands use social networks monthly and around 45% uses them daily (van Deursen and van Dijk, 2010). This makes "Hyves" a particularly interesting case.

This study contributes to the field in several ways. First, we analyze the structure of social networks at the macro level instead of using survey proxy measures of social capital (e.g. participation in voluntary organizations). Due to data limitations, we cannot make inferences about the association between social capital and economic prosperity on the individual level or make any causal inferences. However, we are able to test the aggregate-level associations with economic prosperity predicted by the social capital theory on a large-scale, using country-wide network data, not lim-