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Dissertation title:

CITIES AS COMPLEX SYSTEMS: SOCIAL INTERACTIONS, AGGLOMERATION, AND ECONOMIC GROWTH

100-word abstract:

This collection of papers begins on the premise that social interactions underlie economic forces, which constitute the ingredients of the complex system that is the urban economy. With such a view, this dissertation attempts to answer a series of key questions regarding the interface between social interactions, agglomeration economies, new firm formation, and economic growth. A model of social network formation within space is built, and empirical analyses regarding the influence of social forces and agglomeration on entrepreneurship and economic growth is conducted. The results may be used to inform decision making that aims to promote entrepreneurship and sustained economic growth.

Major takeaways from research

- Increased social interactions within a spatial setting do not always equate with an equitable distribution of economic resources.
- Social capital at the regional level is significantly correlated with the birth of new establishments, across all industries.
- Among the Marshallian factors of agglomeration, labor market pooling is the most dominant in promoting new firm formation.
- Cities should promote entrepreneurship in either the traded or local industries, depending on their current industrial mix and their spatial location relative to other urban centers.

Executive summary

Traditionally, there has been much debate regarding the exact definition of a city. Urban economists usually define a city as “a geographical area that contains a large number of people in a relatively small area,” while the Economist Intelligence Unit defines cities as “the urban agglomeration or metropolitan area it holds together.” Other more specific definitions of cities exist; for example, the U.S. Census Bureau considers urban areas to be geographical areas with a minimum population of 2,500 people and a minimum density of 500 people per square mile, and a Metropolitan Statistical Area (MSA) to be a core area with a substantial population nucleus and adjacent areas that are economically integrated, with a total population of 50,000 or above.

Whichever definition is used, a city distinguishes itself from non-urban areas in that the population density is high relative to the density of surrounding regions. This emphasis on population density is due to an essential feature of an urban area, namely the frequent contact between different socioeconomic actors, which is feasible only when individuals, firms and households are concentrated in a relatively small area. The natural question to ask then is why do cities exist? Considering that people need land to produce food and other essential resources, living in cities is in a sense counterintuitive for it separates us from the origins where critical commodities are produced. Furthermore, cities are noisy, dirty, and crowded. The presence of cities despite these drawbacks is due to a number of factors, which relate to the benefits of colocation that more than offset the negative effects.

The fundamental benefits of density are due to increased productivity resulting from specialization and agglomeration. Specialization allows each person to be more productive by allowing for 1) allocational efficiency, and 2) technical efficiency. Allocational efficiency is related to making the best use of a particular worker’s skillset by assigning different tasks to

workers who possess different aptitudes. Technical efficiency arises from the reduction of transition times between different tasks. Specialization is benefited by higher density for more workers allow for a better skillset match. In addition to specialization, higher density results in scale economies, or increasing returns to scale in production. Due to various agglomeration externalities, the increase in output is more than proportional to the increase in inputs, resulting in a decline in average costs and thus higher productivity.

Alfred Marshall famously noted the underlying mechanisms of agglomeration economies, or the economic forces that cause firms to locate close to one another. The first is related to the sharing of intermediate inputs, where competing firms locate close to one another to share intermediate inputs of production. Intermediate inputs are goods and services that a firm produces that is used as inputs in the production process of other firms; for example, the classic example is that of dressmaking firms sharing a buttonmaker. Due to economies of scale, the cost per intermediate input decreases as the quantity increases, leading to lower production costs. The second agglomeration economy is related to the sharing of labor pools. A large labor market allows for workers to readily shift across employers, thus reducing labor market uncertainty, and also facilitates better matches between firms and workers. Finally, knowledge spillovers are also a source of agglomeration economies, and entails the sharing of knowledge among firms in an industry. This results in “the mysteries of the trade becoming no mystery; but are as it were in the air.”

One of the key arguments presented in this dissertation is that agglomeration economies exist due to the presence of social interactions. For example, proximity to customers and suppliers may reduce the costs of obtaining inputs or transporting goods to downstream

consumers, but it also may embody stronger social ties between similar firms and customers that increases trust and information exchange. Similarly, labor market pooling shields workers from firm-specific shocks and promotes better worker-firm matches, but it also represents social homophily. Especially with knowledge spillovers, the spillover of ideas is possible because individuals collocate and gain information through social linkages, which allow the knowledge “in the air” to be shared with one another.

The overarching theme of the papers included in this dissertation is that the economies of cities comprise a “complex system,” which is defined as a system that exhibits adaptive, nontrivial, emergent, and self-organizing behaviors stemming from agents with rules of operation and no central control. The reasoning behind this view stems from the fact that economic agents are faced with fundamental uncertainty; they do not know what they face, and thus in any economic situation, forecasts, strategies, and actions are being “tested” for survival within a situation those beliefs, strategies and actions create. Within an urban economy, people, firms, and governments react to the aggregate outcome these agents together create, without a mechanism for central control. Furthermore, at the regional level, regional economies evolve by adapting to their current circumstances and through competition and collaboration with neighboring areas. Thus in this sense, urban economies are the perfect example of a complex system.

Another key aspect of a complex system is that the individual agents interact with one another to bring about emergent outcomes. Considering the agglomeration mechanisms discussed above, these types of externalities that occur due to physical proximity directly embody interactions within space; otherwise, there simply would be no benefit due to spatial

proximity. Furthermore, the social interactions that underlie agglomeration mechanisms are also manifested due to social networks and the interaction of social actors within an area. In order to best represent the urban economy as a complex system, I will thus forward stress the importance of representing various aspects of the economy as networks of firms, organizations, people, and even ideas. Networks, by definition, are the joint set of nodes and their linkages, which makes them a perfect vehicle onto which the interactions that occur within a spatial economy can be depicted and analyzed.

Utilizing this theoretical framework, this dissertation attempts to answer a series of key questions regarding the interface between social interactions, agglomeration economies, new firm formation, and economic growth. The first paper focuses on the question of how the dynamics of social interactions that take place within a spatial setting affect the inequality in socioeconomic resources among social actors. Utilizing an agent-based model of social network formation that explicitly considers space, one of the main contributions of the paper is the addition of the spatial dimension to social network analysis. Traditional models of networks such as the preferential attachment model of Barabási and Albert, the random graph model of Erdos and Rényi, or the small-world model of Watts and Strogatz all assume that geographic space has little to no relevance. Casual empiricism however suggests that space matters in important ways. Urban dwellers for example rely much more for mutual support on local neighbors than on acquaintances in other cities. By situating social actors within space and varying the dynamics of social interactions, the paper attempts to answer the policy relevant question of how to minimize inequalities in socioeconomic resources, given a model of social network formation that benefits actors with more connections and underlying human capital.

Results suggest that the concentration of social resources is closely related to network density, with the relationship evolving in three distinct phases. Sparse networks exhibit a decrease in social capital inequality as network density increases, moderately dense networks exhibit increases in inequality with higher density, and very dense networks exhibit a decrease in inequality as the network reaches full saturation. In a complete (i.e. fully connected) network no inequality would exist and the level of aggregate social capital would be maximal. However, such networks are extremely rare in real life. The model suggests that due consideration for the relative strength of tie formation and dissolution are warranted when aiming to mitigate disparities over control of network resources. For example, when considering the spread of tacit information, encouraging more networking activity in an ethnic enclave where ties are relatively permanent and dense would have very different results than encouraging such activity among trade association members where ties are weaker and more transient. This relationship between network density and inequality among agents is further complicated when considering the spatial aspects of inequality. I find that spatial inequality is greater – in the form of higher social capital agents being distributed near the core – when inequality among agents overall is low. The results suggest that we should acknowledge the potential tradeoff between spatial inequality and individual inequality with respect to social resources.

The poor in particular – due to resource deprivation – are more likely to utilize membership in community networks that exchange help in crises than to resort to individual coping mechanisms. The results highlight counterintuitively that simply encouraging more networking activity among individuals may not result in the disadvantaged benefiting from the increased intensity of social interactions.

The second paper moves on to address the question of how social interactions and agglomeration economies jointly determine new firm formation within cities. The key argument in this paper is that social interactions, and more broadly social capital within the community or region, aids entrepreneurs in the early stages of forming new firms. Social aspects of the region have been viewed to be a crucial element of regional competitiveness, where the social characteristics of a region are not simple aggregations of firms or individuals. Michael Porter suggests that a key component of cluster formation and success is the degree of social embeddedness, the existence of facilitative social networks, social capital, and institutional structures. Similarly, Michael Storper stresses the importance of “untraded interdependencies” such as networks of trust and cooperation as well as local norms and conventions when considering the success of regions. Thus, the natural question to ask is whether there is a role that regional social capital plays in promoting entrepreneurship, over and above the effect of social interactions at the micro-level. This paper attempts to unify the treatment of regional social capital and agglomeration economies as being part of the broader “entrepreneurial ecosystem” of a region, where the ecosystem takes its form in various types of networks and their linkages. The aim is to present findings regarding the relative strengths of these mechanisms that may aid planners and policy makers in promoting entrepreneurship and economic growth within cities.

Overall, the results provide strong support for the role of different types of social interactions in promoting entrepreneurship. I find evidence consistent with social network and social capital theory, which suggests the importance of both strong bonding ties of repeated interactions within communities and weak bridging ties of long range connections between different groups. This is a key contribution in that previous studies of social interactions within the economic geography literature have not distinguished between these different types of

interactions. The results taken together suggest that these social forces exert a non-trivial impact on the number of new firm births in a region-industry pair, over and above the Marshallian forces. Considering that the Marshallian forces themselves also represent to some degree social factors – such as homophilous interactions and trust gained through repeated interactions – the fact that the measures of bonding and bridging social capital continue to have a strong effect on entrepreneurship suggests that as a whole, social factors may be just as important as economic factors when examining the forces that drive entrepreneurship in regions. I hope that further research will clarify whether one is more dominant over the other in promoting entrepreneurship, and whether this relationship changes for different industries.

The broad results are consistent across a range of industry categories. The basic conclusion is that both Marshallian economies – with the exception of customer supplier linkages – and social capital are important in promoting entrepreneurship regardless of the industry. This result is also non-trivial considering that most previous studies have focused on a narrow subset of industries in testing the effects of agglomerative forces on entrepreneurship. Customer supplier linkages only seem to be significant for the traded, high-tech, and manufacturing industries, while across the board, the effect of labor market pooling seems to be the strongest and most robust across industry classes. I also find that the effects of bonding and bridging social capital are stronger for the traded, high-tech, and manufacturing industries compared to their counterparts. This is consistent with previous studies, considering that social interactions are closely linked to theories of knowledge spillovers. Traded industries – which comprise all of the high-tech industry classifications as well as the bulk of the manufacturing sector – are more dependent on agglomeration economies, and thus the effects of both strong repeated homophilous interactions and weak heterophilous interactions should be expected to be

stronger for these industries compared to local industries which benefit less from knowledge spillovers and more from local demand.

The relative effects of the Marshallian micro-foundations and social capital are consistent when I consider not only the birth of new firms, but also all establishment births including new establishments of existing firms. While further research is needed, this suggests that the mechanisms that promote entrepreneurship for small firms are similar to those that are important for multi-locational firms. Future research should further study whether the effect of the key forces described in this study are consistent across a wide variety of firm sizes – including multi-national conglomerates – and how the relative importance of these factors varies with firm size.

The final paper attempts to answer the critical question of how urban economies should grow. Many theories exist as to why economic growth takes place. Adam Smith emphasized capital deepening, or the increase in physical capital per worker, while more recent models of endogenous growth focus on human capital, technological change, and knowledge economies. Of course, the regional science and urban economics literature has focused on agglomeration effects to play a critical role on growth at the urban level. The main contribution of this paper is to bridge the gap between the many theories that explain the causes of growth with the relative paucity of theories that elucidate how growth should take place, given the theoretical background. Integrating new insights from complexity science and development economics with more traditional theories of economic development that exist in the urban planning and urban economics literatures, the paper studies optimal patterns of economic growth, defined as structural change that takes place through a shift in the underlying industrial structure of cities caused by new firm formation. Such pathways for economic growth through new firm formation

should prove to be a useful tool for planners and policy makers alike in promoting job creation and growth within communities and regions.

Overall, the results provide support for structural change theory at the urban level. I find consistent evidence that the position of cities within a network of industry relatedness has a significant relationship to growth. Considering fixed effects, the results also suggest that the optimal growth paths for cities depend on the current position of these cities within the industry network. Cities that harbor establishment birth patterns that are more geared towards high-spillover industries such as manufacturing should continue on this path towards the network core in order to achieve further growth. On the other hand, cities that show birth patterns focused on local demand oriented industries nearer the periphery of the network should continue on their paths toward the network periphery. While this relationship is strong when considering GDP and GDP per capita, it does not seem to apply when considering the relationship between structural change and employment. Such results suggest that structural change, while benefiting the overall growth in production of a city, may not have a significant effect on job creation. This may be due to other factors, such as the fact that job creation is a gradual process that takes longer to manifest than direct increases in output. Due to the limitation in panel length of this current study, this lagged effect cannot be studied, and thus further investigation to the causes of employment growth is warranted. Furthermore, this result may also be due to the fact that structural change and growth do not directly correlate with increased jobs. It very well may be the case that output growth does not lead to job creation, but rather increases in productivity of current workers, leading to higher wages. It could even be the case that output growth is the result of specialization and automation, which would also dampen the employment gain effects of structural change.

When considering the spatial location of cities together with their position within the industry space, the basic conclusion is consistent with that of central place theory and the argument of Jacobs. Cities that are spatially clustered within a larger urban system generally possess industrial structures that are more focused on local amenities and local demand. Examples of such industries are department stores, specialty food stores, or amusement parks and arcades. According to central place theory, such industries for which per-capita demand is low locate in large cities because they require a threshold amount of demand in order to exist. Large cities, or cities that are part of a larger urban system have the luxury of being able to harbor such industries, and the results suggest that focusing on such industries (near the periphery of the industry space) may be more beneficial than promoting growth in high-spillover industries nearer the core of the industry space. However, cities that are small and isolated do not have this luxury, and must concentrate on the high-spillover industries near the core in order to maintain maximal economic growth. Such results contradict the linear stages of growth models within the development economics literature and imply that national growth and subnational growth follow different trajectories.

Categories and keywords

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