Spillovers And Synergies: Geographical Clustering of Eminent Scientists

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In this essay, Conor McGlynn provides a comprehensive overview of the effect of geographical clustering on the research output of leading natural scientists. He outlines why geographical clustering occurs and why it may have a particularly strong impact on eminent scientists. He also discusses some policy implications and motivates future research in this exciting field of economics.

Introduction

This paper investigates the question of geographical clustering, and its impact on the output of eminent natural scientists. It will particularly address three areas. First, it will look at the issue of geographical clustering in general, and why it plays an important part in the production of knowledge. Second, by reviewing the literature published in the last few years on this topic it will show why we might expect geographical clustering to have an impact on the output of natural scientists, and eminent natural scientists in particular. Third and finally, given that it is likely that such clustering did take place, this paper will give a justification for why this research is worth pursuing, and will consider some possible policy implications. By doing so, it will provide theoretical and pragmatic motivation for a full empirical treatment of the subject.

Why Geographical Clustering?

Different parts of economics ask different questions. Focusing on production, the most fundamental questions typically concern what goods shall be produced in an economy. Labour economists will then ask questions about who will produce these goods, and how the production process takes place. Researchers looking at the sociology or philosophy of economics might ask why production occurs in the manner that it does, and whether or not this process is fair. Economic geography is related to these areas, but it asks questions about where production takes place, and what effect location and geography have on the production process. Economic geography focuses on where firms and workers decide to locate, and how geographical factors influence the manner in which production takes place.

One area of economic geography deals with the economic costs and benefits of proximity. These benefits include, for example, economies and diseconomies of scale and spillover effects. By locating together in cities, companies can avail of positive externalities that arise from being near other firms, such as lower transport costs, easy access to other firms in the production chain, and immediate knowledge of new innovations in technology. There are also locational spillovers for companies from locating near universities in terms of access to a high-talent pool of workers.

The benefits of spillover effects are not, however, limited to large corporations. Individual workers too can avail of geographical benefits to increase the quality and quantity of their output. Indeed, the original rationale for universities was to allow researchers to avail of advantages that accrue from close and easy interaction between those working in similar fields. Alfred Marshall, writing in 1890, observed the geographical clustering of creative workers in particular, and posited the synergies and cooperation afforded by such clustering as the reason why creative workers move close together (Marshall, 1930).

There is a growing body of empirical research into the historical impact of geographical clustering on the output of eminent creative workers. Hellmanzik (2009), for example, investigates the migration and clustering of visual artists from the Renaissance until 1900, while Borowiecki (2013) looks at the impact of geographical clustering on the output of prominent composers from 1600-1950. This research has provided support for the hypothesis that geographical clustering positively impacts on the output of creative workers.

However, there has not yet been an econometric study that takes the same line in looking at the effect of geographical clustering in the history of eminent natural scientists. An investigation into this field would be of interest for two reasons. First, it would be of academic interest to find out whether and to what extent the effects of geographical clustering are present amongst natural scientists. Looking at the history of natural scientists would test Marshall's theory outside of the realm of the arts by investigating whether synergies and cooperation have historically played an important role in the progress and development of natural science.

The second reason why this study would be of interest is the implications it could have for government policy, particularly with regard to funding for the sciences. If a significant level of clustering of the leading scientists in history is found, and if this clustering is associated with increased levels of output and discovery, then it would provide a powerful argument in favour of increased spending by universities to attract world-class scientists, and would provide empirical evidence of the benefits of spending on scientific research institutions. These benefits will be discussed in more detail below.

Literature Review

There is a growing body of research into the impact of migration and clustering on the output of creative workers generally, and in particular on the impact on the output of highly eminent workers in creative fields. That eminent workers in a field do tend to migrate and cluster together was formally established by Kelly and O'Hagan (2005). In this paper the group the authors look at is prominent Western visual artists. Their positive results with regard to migration and clustering prompted the additional question of which cities these artist tend to cluster in. This question is addressed in Kelly and O'Hagan (2007). O'Hagan and Hellmanzik (2008) further expand on these questions, and pose some initial hypotheses about the clustering of highly eminent creative workers.

The choice to use eminent scientists rather than "average" workers is based on two factors. First, more historical data is available on the most successful scientists. Second, and more fundamentally, previous research has found that prominent workers in a field are more likely to cluster than less prominent workers (O'Hagan and Borowiecki, 2010).

The previous papers in this field take Charles Murray's Human Accomplishment (2003) as their starting point. In this work, Murray identifies the most eminent workers in a range of fields including the natural sciences: physics, chemistry and biology. His dataset covers 600BC to 1950AD. He identifies and ranks the top workers in each discipline. For this paper the ranking of the scientists is not important; all that is needed is the unranked list of top workers. This list, which incorporates 615 scientists in total, would form the basis of an econometric treatment of the subject.

O'Hagan and Borowiecki (2010) apply the methodology developed in these papers to another group of creative workers. In their dataset they look at prominent Western composers in several different periods. Their findings support the results of the earlier papers in identifying a clear tendency for highly eminent workers to migrate to and cluster in certain cities. They also provide a number of possible explanations and hypotheses which may be tested on the data.

Two studies have looked at migration and clustering amongst eminent philosophers. Collins (1998) looks at networking and clustering amongst a wide range of philosophers, east and west. However, his methodology for analysing and collecting this data is sui generis in the literature. Walsh and McGlynn (2014) look at the migration and clustering of 146 philosophers using a methodology similar to that established in the literature discussed above.

Waldinger (2010, 2012) uses an exogenous shock, namely the expulsion of scientists from Nazi Germany, to isolate and investigate the causal effect of migration and clustering on the output of natural scientists. While his methodology is different from that of these other papers his research informs the study of clustering of scientist in particular. Borjas and Doran (2012) take a similar approach to Waldinger in looking at mathematicians. They chose the exogenous shock of the collapse of the Soviet Union, and the

effect on the output of American mathematicians of the influx from the USSR to the US. Interestingly, the authors in this case find a negative impact of migration on the output of indigenous American workers.

There are two noteworthy econometric analyses in the literature that take Murray's dataset as their starting point. Hellmanzik (2009) empirically examines two questions relating to the migration and clustering of visual artists. The first question is: What determines the degree of mobility amongst artists? The second is: What determines the decision to move to a specific cluster location? The model used includes control variables on biographical information, career indicators, mobility indicators, country of origin, and artistic style.

Borowiecki (2013) looks at the effect of geographical clustering on productivity, taking prominent composers as the dataset. The aim of this study is to estimate the causal relationship between composers' productivity and the incidence of geographical clustering. A two-stage least-squares model is used to avoid possible endogeneity, with variables on age and distance from cluster location included. The results of this model show a significant benefit for composers, in terms of the number of written works produced, from working in a geographical cluster.

Policy Implications

Evidence of a historical link between the clustering of eminent scientists and increases in output could have important implications for policy today relating to, for example, university and institutional funding. As we have seen, there are strong reasons to think that such clustering of scientists did indeed take place. Previous research has confirmed Marshall's hypothesis with regard to artists, composers and philosophers. Marshall posited three types of externality that would lead to the clustering of creative workers: the growth of subsidiary trades, synergies, and creative spillovers. Synergies and creative spillovers certainly do apply to the work of natural scientists, and so it is reasonable to expect that they will cluster. There is also plenty of anecdotal evidence that eminent scientists worked together throughout history, which suggests that clustering did indeed take place (Koestler, 1964).

What is involved in the spillovers and synergies generated by such clustering? This is a question still debated in the literature. One answer to this is given by the idea of tacit knowledge. This is the sort of knowledge that is difficult to transfer from one person to another by means of verbalising it or writing it down. This includes, for example, the knowledge of how to speak a language, tie a bow-tie, or design and use complex technologies. Tacit knowledge is defined by the philosopher Gilbert Ryle as "know-how" as opposed to "know-that" knowledge (Ryle, 1945). This sort of knowledge plays an important part in scientific networks, in transmitting knowledge that consists in tacit rules that we may be unable to formulate in words (Collins, 1974), for example mathematical or

technical methods. Historically, this tacit knowledge could only be transmitted by scientists locating together in a particular location, and hence clustering would be expected to have played a key role in the development of scientific theories and ideas.

Given the likelihood that such clustering took place, and hence that output increased through tacit knowledge transfer, why should policy makers and researchers be interested in investigating it? Investigation of the clustering of eminent natural scientists would obviously be of academic interest, and would inform the study of the history of science. It would also provide support for Marshall's hypothesis outside of the realm of the arts and humanities. However, such an investigation would also have tangible benefits for policy makers. Evidence of a historical link between the incidence of clustering of eminent scientists and an increase in their output would provide strong support for policies aimed at promoting such clustering amongst scientists today. This could be in the form of increased funding for universities and research institutes, so that they could attract the most outstanding practitioners in each scientific field.

An investigation of the link between clustering and output could also make the allocation of funding to research institutions more efficient. For example, does specialisation increase output most, as when biologists working in similar areas cluster, or are there benefits from those working in radically different areas clustering together? An answer to this question would inform policy related to setting up research institutions that are specialised as opposed to universities, where a wide range of practitioners in different areas cluster. This could also be linked to the previous research in the area of geographical clustering of artists, composers and philosophers, and whether spillover benefits manage to cross between the 'two cultures' of science and the humanities.

A final benefit of an investigation into the effects of clustering of natural scientists is the greater understanding it would give us of the creative process within science, particularly amongst highly eminent practitioners. This is an area that has been investigated by the psychologist Dean Simonton (2010). In his research he looks at many different groups, including scientists, artists, writers and politicians, to identify common elements in the lives of extraordinary individuals. These include psychological factors such as the likelihood of mental illness, and environmental factors such as childhood environment. An investigation into the effects of clustering on the process whereby new scientific theories are generated would inform this area of research, and would give us a better understanding of what makes eminent people so outstanding in their field. This research could thus inform policies aimed at fostering greatness and genius in a wide range of creative endeavours.

Conclusion

This paper has provided a theoretical justification for more in-depth research into the geographical clustering of eminent natural scientists, informed by previous empirical work in the field. Such research would be valuable both for its academic interest, as well as informing government policy regarding scientific funding. It would also inform general studies into the creative process and the study of highly eminent individuals. For these reasons, this area of research is worth pursuing.

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