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Knowledge Spillovers and Employment Growth in Great Britain

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Abstract:
The importance of knowledge spillovers for achieving innovation and economic growth is widely recognized. It is not straightforward which type of spillovers is most effective: *intra*-sectoral spillovers or *inter*-sectoral spillovers. We investigate this controversy using a model of regional growth. The model also deals with the impact of local competition on innovation and growth. The model is estimated using sectoral data for 60 British regions. A positive effect of local competition on economic growth is found for several sectors of economy, while a positive effect of diversity (a proxy for *inter*-sectoral spillovers) is found only for the production sector. We find no effect for specialization (a proxy for *intra*-sectoral spillovers).

Keywords: knowledge spillovers, innovation, economic growth, industry structure

JEL-classification: O0, R0

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1. Introduction

Spillovers occur when an innovation implemented by a certain enterprise increases the performance of another enterprise without the latter benefiting enterprise having to pay (full) compensation. In the past decades there has been increasing recognition that spillovers contribute substantially to economic growth. According to the new growth theory (Lucas, 1988; Romer, 1986), spillovers are the engine of growth. Mackun and MacPherson (1997), p666, conclude that the relative importance of firms’ in-house R&D compared to external technical activity may be declining. They suggest that external inputs (for example in the form of spillovers) can increase the productivity of in-house initiatives of firms.

There are various types of spillovers (transfers), such as knowledge spillovers, market spillovers and network spillovers. The new growth theory primarily focuses on knowledge spillovers (Aghion and Howitt, 1992; Romer, 1986). Knowledge accumulates, and this generates innovations in enterprises. Since enterprises benefit from each other’s innovations and ideas, an economy may grow even in the event of maximum input of labour and capital. In other words, spillovers explain part of the phenomenon that economies grow faster than might be expected on the basis of labour and capital input growth. The increasing role of knowledge and small firms in the modern economy (Audretsch and Thurik, 2001) motivates the investigation of the effect of knowledge spillovers, as small firms usually are more dependent upon knowledge spillovers than large firms are.

Knowledge spillovers appear to be a local phenomenon (Audretsch and Feldman, 1996). Interaction between people and enterprises located in each other’s proximity produce the highest likelihood of spillover effects. This seems surprising, considering the current state of information technology, where information can be diffused throughout the world at practically zero cost. Audretsch and Thurik (1999), p.5, refer to a paradox, which they explain by distinguishing between information and knowledge. Information may be diffused simply and free of charge, with examples being the gold price in Tokyo, or the weather in New York. Knowledge, contrastingly, may not simply be coded. Knowledge diffusion primarily emerges by means of social contacts, for example during meetings or sales transactions.

The importance of knowledge spillovers for achieving innovation and economic growth is widely recognized. There are, however, various conflicting theories as regards the exact mechanisms of spillovers, with debates focusing on two questions. First, do spillovers primarily emerge within one sector or, alternatively, do spillovers emerge between different sectors? Second, does local competition have a negative impact on the amount of innovative activity because potential innovators consider externalities (spillovers) too large, or alternatively, does local competition have a positive impact on the amount of innovative activity because firms are ‘forced’ to innovate to beat their competitors?

The present paper focuses on these questions, by estimating a model of regional growth based on Glaeser et al. (1992). The model examines three possible determinants of regional sectoral growth, viz. specialization, diversity and competition. We use a data set with information at six-sector level and at the spatial level of 60 British regions, covering entire Great Britain. Regional data are used because geographical proximity is considered important in the spillover mechanisms. The data cover the period 1981-1998.

The organization of this paper is as follows. In section 2 we will discuss different theories concerning knowledge spillovers and competition. In section 3 we discuss the model, the variable operationalizations, and the data set. The estimation results will be given in section 4. In section 5 finally, we present a discussion and give some recommendations for future research.
2. Theory

The model of Glaeser et al. (1992) departs from the assumption that knowledge spillovers at the regional level are of major significance as regards innovation and economic growth. More precisely formulated, Glaeser et al. (1992), assume that sectors in different regions may have different growth rates because knowledge spillovers work out more effectively in one region than in another. This is because different types of knowledge spillovers may emerge in different regions, viz. intra-sectoral spillovers versus inter-sectoral spillovers. Furthermore, the intensity of local competition may differ between regions. With the model three theories on the impact of knowledge spillovers and local competition on regional growth can be tested. In this section these theories are discussed.

The first theory is developed by Marshall (1890), Arrow (1962), and Romer (1986), abbreviated as MAR. They assume that knowledge spillovers are most effective between homogeneous enterprises. So, spillovers primarily emerge within one sector. For a given region, this would imply that specialization in a limited number of activities may contribute to spillovers and growth. The MAR economists further assume that the situation of a local monopoly is beneficial to economic growth, since in that case, the vast share of the yields generated by innovation benefits the innovator itself. That is, the externalities associated with innovation are internalized by the innovator. This would produce an additional incentive to innovate.

The second theory is that of Porter (1990), who agrees with MAR that knowledge spillovers between firms in specialized sectors stimulate economic growth. In contrast to MAR, however, Porter assumes that local competition has a positive impact on growth. In his view, competition accelerates imitation and upgrades innovation. Although competition decreases the relative benefits for the innovator (due to larger spillovers flowing to competitors), the amount of innovative activity will increase, because enterprises are ‘forced’ to innovate: enterprises that fail to improve products and production processes in due time will lose ground to their competitors and will ultimately go bankrupt. So, while MAR emphasize the negative effect of competition on the amount of innovative activity, Porter assumes that the positive effect is dominating.

The third theory elaborating on the significance of local knowledge spillovers was developed by Jacobs (1969). Jacobs' theory departs from the assumption that knowledge spillovers work out most effectively among enterprises that practise different activities. Primarily inter-sectoral knowledge transfers would thus be of significance. In her view, sectors will grow in regions where, besides the sector itself, various other sectors are important. In this philosophy, regions marked by a high degree of variety (diversity) will thrive. As regards competition, Jacobs agrees with Porter, i.e. Jacobs assumes that local competition accelerates the adoption of new technologies and, consequently, stimulates economic growth.

3. Model, operationalizations of variables, and data

Model

We use a simple model to test the three theories described above. The model assumes that each individual firm in a certain sector and region has a production function of output which depends on labour input and the overall level of technology. Each firm takes technology, prices and wages as given and sets labour input such that profits are maximized. Furthermore, the overall level of technology is assumed to have both national components and local components. Growth of local technology captures technological externalities present in the sector in the region. These externalities can be measured by variables such as specialization, local competition and diversity. Using these assumptions one can derive that employment growth in a sector in a region depends on wage growth, growth of national technology, and these measures of (local) technological externalities. For a formal derivation we refer to Glaeser et al. (1992), pp. 1132-1134.
The above framework leads us to an equation that we can test empirically by means of regression analysis. The dependent variable is employment growth in a sector in a region. The explanatory variables are specialization, local competition and diversity and a constant term. The constant term captures both growth of national technology and wage growth (note that we thus assume a national labour market instead of a local one). By including these variables in the regression equation, the empirical validity of the various theories from section 2 can be tested. Specialization is hypothesized to facilitate spillovers between firms from the same sector (intra-sectoral spillovers) while diversity is hypothesized to facilitate spillovers between firms from different sectors (inter-sectoral spillovers). The third variable, local competition, may have both positive and negative effects on the amount of innovative activity and hence on economic growth. As we saw earlier, this involves a trade-off between internalization of innovation externalities and the necessity to innovate to remain competitive in the market.

**Operationalizations of variables**

Specialization is defined as the employment share of the sector in the region, relative to the share of that sector in the whole country (in our case Great Britain). If a sector is overrepresented in a region (relative to the national employment share of that sector), then there are larger-than-average opportunities for within-sector spillovers to emerge, and according to MAR and Porter, this would stimulate growth of that sector in that region. The expression of specialization \( S \) in sector \( i \) and region \( r \) reads

\[
S_{i,r} = \frac{\text{Empl}_{i,r}}{\text{Empl}_{i,GB}} / \frac{\text{Empl}_{r,GB}}{\text{Empl}_{tot,GB}},
\]

where \( \text{Empl}, \text{tot}, \) and \( GB \) stand for employment, total, and Great Britain, respectively.

Local competition is defined as the number of businesses in a sector in a region relative to the number of businesses in that sector in the whole country, adjusted for the size of the region. The (economic) size of a region is measured as total employment in that region. The variable assesses whether local competition is higher or lower than national competition. As we saw earlier, MAR expects competition to have a negative impact on growth whereas Porter and Jacobs expect a positive impact. The expression of local competition \( C \) reads

\[
C_{i,r} = \frac{B_{i,r}}{\text{Empl}_{tot,GB}} / \frac{B_{i,GB}}{\text{Empl}_{tot,GB}},
\]

where \( B \) stands for the number of businesses.

For a given sector in a given region, diversity is defined as the regional employment share of the three smallest sectors other than the sector under study. A larger share of the smallest sectors implies a more diverse sector structure (sectors are more evenly distributed). According to Jacobs, higher degrees of diversity generate higher growth rates. The expression of diversity \( D \) reads

\[
D_{i,r} = \sum_{k=1}^{3} \frac{\text{Empl}_{-i[k],r}}{\text{Empl}_{tot,r}},
\]

where \( \text{Empl}_{-i[k],r} \) stands for employment of \( k^{th} \) smallest sector in region \( r \) (sector \( i \) excluded).
There are several other ways to specify the concepts of specialization, local competition and diversity. A variety of alternative measures, including those used by Glaeser et al. (1992), are discussed in Nieuwenhuijsen and Van Stel (2000) and Van Stel et al. (2001).

**Data**

In the present paper we use a data base with sector information at a relatively disaggregated spatial level, in which Great Britain is divided in 60 regions. This involves the county level in England and Wales, and the local authority region level in Scotland (NUTS3 spatial aggregation level). The sectors of the regional economy considered are agriculture, production, construction, trade&catering, transport&communication, and other services. The data cover the period 1981-1998. As we can see from the definitions of specialization, competition, and diversity, all variables are calculated from two basic variables: businesses and employment. These variables are obtained from Small Business Service and Nomis respectively. For the exact regional and sectoral aggregation levels and classification schemes employed in our data set, we refer to Van Stel et al. (2001).

4. Estimation results

Because we expect different results for different sectors of economy, the regression model is estimated for each sector separately, using OLS. Agriculture is excluded from the analyses because this sector is too different from the rest of the economy. We measure the impact of the various explanatory variables at the start of the study period (1981) on employment growth in the subsequent period. We analyse growth over five different time periods, varying from 3 years (1981-1984) to 17 years (1981-1998). We do this because effects on growth may not be perceptible immediately, and the time needed for spillovers to affect growth may differ per sector. In our regressions, we correct for heteroskedasticity and spatial autocorrelation using Newey-West standard errors. We also checked correlations between the explanatory variables. These correlations were low so we do not suffer from multicollinearity problems (especially specialization and competition might have been expected to correlate significantly, see formulas 1 and 2). Barring outliers (at most two, in our applications), 60 observations were used for each regression (one for each region). Table 1 presents the common pattern of the statistical significance and signs of the estimated parameters over the five time periods. More detailed results can be found in Van Stel et al. (2001).

<table>
<thead>
<tr>
<th>Table 1: Sign and significance of sectoral parameters for the variables specialization, competition and diversity</th>
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<td>Production</td>
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<td>Specialization</td>
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<td>Competition</td>
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<td>Diversity</td>
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* + sign > 0 for all five time periods considered and absolute t-value > 1.96 for at least three out of the five regressions
* − sign < 0 for all five time periods considered and absolute t-value > 1.96 for at least three out of the five regressions
* 0 not + and not − (+ and − as defined above)

**Specialization**

According to Table 1, the effect of specialization is either zero or negative for all five sectors in our data set. We thus find no empirical support for the importance of *intra*-sectoral spillovers. The finding that specialization does not have a positive impact on regional sector growth seems to contradict the
experience that many regions are marked by high levels of concentration of homogeneous enterprises. But it may well be the case that specialization emerges because of the static efficiency thus achieved. For example, Marshall (1890) mentions the possibility to jointly utilize production factors (e.g. highly skilled staff). The present study, however, investigates dynamic efficiency (i.e. growth). We find no evidence that this is achieved by specialization as well.

Local competition
We think that the different effects per sector of local competition on growth can be explained by means of two distinct characteristics of a sector.

The first sector characteristic is the possibility to protect innovations. In industries where innovations can be easily protected (and the returns ‘appropriated’), there is no impediment for firms to undertake R&D activities, and hence, the MAR argument is not valid in such industries. This sector characteristic is consistent with the positive effect of competition in the sectors production (innovations can be protected by means of patents, because often very specific products are invented), transport&communication (most important features of output is stored in computer software, think for example of routing schemes for transport firms) and other services (tacit knowledge is important here, think for example of ways of giving an advice by a firm of consultants). It is also consistent with the zero effect for construction (innovations are hard to protect as the building place is simple to approach for outsiders) and trade&catering (a store or a restaurant is also simple to approach for outsiders).

The second sector characteristic that may influence the effect of competition on growth is the maturity of the sector. In industries at the beginning of the life cycle, there are more things yet to be learned by firms, and hence more growth yet to be achieved. Therefore, one might argue that particularly in young industries, local competition stimulates a process of innovations, rapid adoption of these innovations, new innovations, etcetera, which process in turn leads to growth (consistent with Porter). This sector characteristic is consistent with the positive effect of competition in the sectors production (there are many young high-tech industries within the production sector), transport&communication (considering the fast rising impact of ICT in the last 25 years on the production process in this sector, one might argue that it has become a ‘new’ industry) and other services (many young industries within the services sector due to the rise of ICT). It is also consistent with the zero effect for construction (few young industries).

Diversity
Looking at Table 1, we see that diversity, our proxy for inter-sectoral spillovers, has a positive effect for the production sector, and no effect for the other sectors. We think that this may be due to the fact that the production sector takes a very central position in the economy. Many production firms act as supplier for firms in the other four sectors. These production firms can get ideas for new innovative products from their customers, based on specific product wishes of these customers. Of course, there are also transactions where firms from the other sectors act as supplier for production firms but this may involve more standard products, not necessarily resulting in innovative ideas for the supplier. Furthermore, it may be the case that there is not so much interaction between firms of the other four sectors, even if they are located nearby. This might explain the zero effect of diversity for the other sectors. For these sectors Jacobs’ theory is not supported.

5. Discussion
In recent decades, the importance of knowledge spillovers for the processes of innovation and economic growth has been widely recognized. Firms can improve their performance by implementing
innovative ideas that were not originally developed in-house. In this way firms and hence economies may grow without having to use additional labour and capital inputs. Although the importance of knowledge spillovers is undisputed, little is known about the issue what type of spillovers is more important for achieving growth: spillovers emerging within sectors (intra-sectoral spillovers) or spillovers emerging between sectors (inter-sectoral spillovers). Furthermore, the impact of local competition on innovation and growth is not straightforward. These issues are investigated in the present paper, using a regional growth model based on Glaeser et al. (1992).

We find no support for the occurrence of intra-sectoral knowledge spillovers. It might be the case that specialization contributes to static efficiency rather than to dynamic efficiency (i.e. growth). We find strong support for a positive relationship between regional competition and employment growth, especially for the production sector (which is dominated by manufacturing). The positive effect for manufacturing might be related to higher R&D expenses relative to other sectors, making competition especially important in manufacturing industries as it might encourage something like an 'innovation race'. Diversity does not seem to be a dominant factor for regional sector growth in Great Britain. Only for the production sector, the empirical relationship is positive and thus supports Jacobs’ theory. For the other sectors, the effect is not significant. Perhaps this can be explained by the central position of the production sector in the economy, through which production firms benefit from developments in other sectors.

However, we must be cautious with these interpretations as there are some limitations to our approach. We mention three limitations here. First, a clear drawback is that no information is available on the growth of real value added. This is a better measure of performance than the growth of employment. Real value added can grow for example while labour inputs decline by labour saving technological progress.

Second, the sectoral aggregation level strongly determines the meaning of the variables specialization, competition and diversity. Interpretations of results are conditional upon the aggregation level applied. For example, as regards the competition variable, the question arises whether the six-sector classification adopted in the present paper is appropriate. By defining the entire production industry as one sector, one implicitly assumes that businesses in, for instance, the metal industry compete with businesses in the food industry. This is implausible.

Third, our indicators for intra-sectoral and inter-sectoral spillovers, specialization and diversity, are indirect measures. So, one might say that we do not prove but rather assume the existence of knowledge externalities (Breschi and Lissoni, 2001). We acknowledge that other explanations for the effects of specialization and diversity may be possible. However, we think that the spillover-framework proposed by Glaeser et al. (1992) is plausible, and this is supported by the different sector results found in the present paper, which are also plausibly interpretable using this framework.

Despite these limitations, we argue that the present study provides some important insights concerning the mechanisms of knowledge spillovers and innovation like the important role of regional competition in stimulating innovation and economic growth. Future research should concentrate on doing comparable exercises for more countries to see if there are differences. Policy makers may want to base policy measures concerning regional firm clustering on the empirical findings of more countries. Since the sectoral aggregation level applied is crucial in this type of research, it may be worthwhile to perform the regressions while defining the variables specialization, competition and diversity at lower aggregation levels.
References


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