The Dynamics of Industrial Clustering in British Financial Services

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This study examines patterns of clustering in the British financial services industry. It studies the effects of cluster strength on the growth of the firm and on rates of surviving entry. We find positive, large, and statistically significant clustering effects in the British financial services industry, both in the growth model and the entry model. The results for this service industry are very similar to those observed in earlier studies which have examined clustering patterns in high technology manufacturing industries.

INTRODUCTION

Geographical clustering is a major characteristic of industrial growth and has recently become the subject of intense interest in academic [Fujita, Krugman and Venables, 1999; Porter, 1998; Saxenian, 1994; Swann *et al.*, 1998] business practitioner [*The Economist*, 1999; Owen, 1999] and government policy [DTI White Paper, 1998] circles. In line with the UK Department of Trade and Industry we define a cluster as a geographic 'concentration of competing, collaborating and interdependent companies and institutions which are connected by a system of market and non-market links' [DTI White Paper, Analysis and Background Report, 1998: 22]. Important clusters include the City of London (financial services) and the Santa Clara ('Silicon') Valley (microelectronics).

This article builds on earlier work by Swann and others that investigated the rate of growth of the firm as a function of the strength of the cluster in which it is located and whether strong clusters attract a disproportionate number of new start-up firms [Baptista and Swann, 1999; Beaudry *et al.*, 1998; Swann *et al.*, 1998; Swann and Prevezer, 1996]. The focus was on

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The Service Industries Journal, Vol.21, No.4 (October 2001), pp.33–61
PUBLISHED BY FRANK CASS, LONDON

growth and entry since, as Porter [1990, 1998] points out, rapid firm growth and new firm entry are two signals of a successful cluster. The principal objective of the present study is to examine whether the findings of these studies, which investigated high technology manufacturing industries (aerospace, biotechnology and computing), can be generalised to a non high technology *service* industry, namely, British financial services.

The structure of the article is as follows. The next section outlines the theoretical basis of the topic. Section three provides an overview of the British financial services industry and is followed by a preliminary view of financial services clustering in Britain. Section five details the growth and entry models employed in the study and the subsequent two sections discuss the data and variables, and the empirical results in turn. A final section concludes.

THEORETICAL BASIS

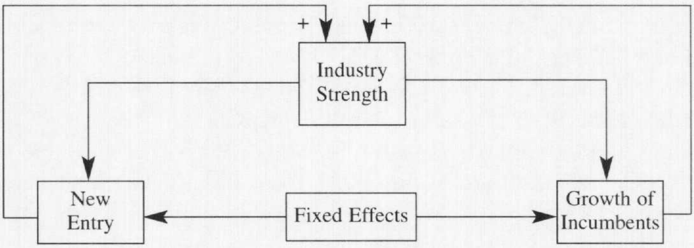
In the conventional analysis of clustering, positive feedback plays a central role. Agglomeration or external economies result in demand and supply conditions that are better in a cluster than in isolation and so promote the growth of incumbent firms and attract the entry of new firms. This growth and entry increases cluster strength and so promotes further growth and entry which begins to accelerate once a cluster has reached a critical mass. Other effects include a higher rate of productivity growth [Henderson, 1986] and more prolific innovation [Baptista and Swann, 1998]. However, positive feedback does not continue indefinitely. Beyond some saturation point, congestion and competition in input and output markets become important, initially slowing individual firms' growth and entry and eventually possibly contributing to the decline of the cluster. This is consistent with the argument advanced by Swann *et al.* [1998] that there may be a cluster life cycle. In addition to the positive and negative externalities associated with cluster strength, the dynamism of a cluster will be influenced by a number of fixed effects. These fixed effects are all the factors which influence the attractiveness of a cluster but are not themselves changed as the cluster expands or contracts. They include climate, infrastructure, and cultural capital. Figure 1 depicts positive feedback in the growth of clusters.

The specific benefits and costs of locating in a cluster from the perspective of the clustered firm are summarised in Table 1.

The benefits on the demand side are stated in the top left quadrant. Firstly, firms may cluster in a particular location to take advantage of close proximity to concentrations of their customers (which, of course, could be other firms). Secondly, under certain conditions, a firm stands to take

FIGURE 1

POSITIVE FEEDBACK IN THE GROWTH OF CLUSTERS



Source: Swann *et al.* [1998, p.68] with slight modifications.

TABLE 1

BENEFITS AND COSTS OF LOCATING IN A CLUSTER FROM THE PERSPECTIVE OF THE CLUSTERED FIRM

	Demand Side	Supply Side
Benefits	Customer proximity Hotelling arguments Reduced consumer search costs Informational externalities	Knowledge spillovers Specialised labour Infrastructure benefits Informational externalities
Costs	Congestion and competition in output markets	Congestion and competition in input markets (real estate, labour)

Source: Swann *et al.* [1998: 57], with slight modifications.

market share from rivals if it locates near them [Hotelling, 1929]. Admittedly, this gain may be short-lived if further firms enter, or if the incumbents in a cluster react to this unwanted competition. A third demand-side motive for clustering can be more long lived. Firms may choose to locate in a cluster because they are more likely to be *found* by customers. Searching is costly for the customer who, other things being equal, will prefer to minimise search costs by purchasing in areas of concentrated supply. This is particularly relevant in markets where potential customers are discerning with specific requirements, and wish to search before purchase (e.g. antique markets). A final demand-side advantage is the informational positive externality about the strength of local demand that a new entrant gains when observing established suppliers trading successfully at a particular location. Related to this, locating in a successful cluster provides potential customers with an indication of quality that translates into the greater likelihood of their custom (e.g. medical and tailoring services on London's Harley Street and Saville Row respectively).

Moving to the top right hand quadrant, supply-side benefits, these consist of knowledge spillovers that are particularly prominent when knowledge is tacit [Jaffe *et al.*, 1993]. They also consist of the benefits of access to the large pool of specialised labour created by positive feedback within the cluster. We can add to that the infrastructure benefits of locating in a cluster. For example, access to major motorways, railways and airports is often cited as an attractor. Finally, a form of informational externality accrues to the new entrant from observing an established firm *producing* successfully at a particular location.

As stated earlier, the benefits of clusters do not persist indefinitely. At some point, costs begin to accelerate. Once again, these costs may be categorised in terms of demand and supply. On the demand side, congestion may result in increased competition in output markets, and that can detract from company performance. In a Cournot model, for example, an increased number of competitors will reduce per-firm sales, prices, per-firm profits and per-firm growth. On the supply side, the costs of clustering again relate to congestion and competition but with respect to *input* markets (e.g. increasing cost of real estate or labour).

In summary, clustering effects can in principle be positive or negative, and can emanate on the demand side or the supply side. In practice, all four cells in Table 1 may be relevant, and then the question for empirical analysis is what are the *relative* magnitudes of these different effects? To some degree, the answer for a given firm in a given cluster will depend on the sectoral makeup of that cluster. Let us take each part of the Table in turn.

Some of the demand-side advantages are most likely to be felt if the firm is located in a cluster that is strong in its own sector; that is, if a chemical firm is located in a region with a strong chemical industry. But that is not all. Suppose that strong local demand for the output of sector i emanates from another sector j, which is a major consumer of the products of i. Then firms located in a cluster enjoy a demand-side advantage emanating from the strength of *another* industry in that cluster. Demand-side disadvantages from clustering are most likely to be felt by the firm located in a cluster which is strong in its own sector; in that case competition in its output markets is strong. Here, the strength of other industrial sectors in the cluster is less relevant.

Some supply-side advantages may be strongest when companies are co-located with others from the same sector. Some Marshallian [1920; 1927] externalities are sector-specific, notably the availability of labour with sector-specific skills. Informational externalities, equally, are in some measure sector-specific. With technology spillovers, on the other hand, the picture is less clear-cut. While the greater part of technology spillovers, perhaps, are sector-specific, nevertheless we know from the work of Patel and Pavitt [1994] and others that firms seek to sustain competence in a rather wider range of technologies than the range of their output markets would suggest. For that reason, we can expect technological spillovers to cut across sectoral boundaries. And with infrastructure benefits, many are not specific to any sector(s), while some may be more relevant to some sectors than to others. Turning finally to supply side disadvantages, many of these are generic rather than sector-specific. The company located in the centre of a large city faces congestion and high property rentals; this cost is imposed on it by the grand total of businesses located in the centre, and not just those in its own sector. Labour costs are higher in such circumstances, whichever the sector. However, some of these disadvantages may be sector-specific.

THE BRITISH FINANCIAL SERVICES INDUSTRY

The industry's origins in Britain date back at least to the late seventeenth century when, in the City of London, goldsmith-bankers began to provide monarchs and merchants with the money they needed to fund their ventures around the world.[1] In the early years, the goldsmith-bankers did not extend their business outside London but did hold accounts for country merchants, some of whom provided banking services for neighbours whose businesses were too small to justify maintaining a London account. These merchants became Britain's first country bankers. Over time, the services offered by such businesses increased in volume and scope and by the 1890s there were some 100 British private banking businesses offering a range of financial services.

Today, the term financial services is broadly understood to include banking, insurance, building societies, stockbroking and investment services [Anderton, 1995]. All of these services involve a process of financial intermediation whereby the financial surpluses or savings of certain groups in the economy are collected and redistributed to other groups that demand them. In most developed countries, the industry has grown rapidly over the past 15 years but has grown fastest in Britain [Davis, 1996]. The importance of financial services to the domestic economy is illustrated in Table 2 which shows the relative contribution of the financial services[2] and manufacturing sectors to gross domestic product and employment.

Prior to the late 1970s, the industry was highly structured and stratified with specific institutions specialising in the provision of specific services. New entry was low due to restrictions in the regulatory framework within which institutions operated, and technical and economic barriers to entry

TABLE 2

GROSS DOMESTIC PRODUCT AND EMPLOYMENT BY SECTOR, 1986–98 (AS % OF TOTAL)

	1986	1988	1990	1992	1994	1996	1998
GDP							
Manufacturing	24.8	24.6	23.2	21.2	21.4	21.3	19.7
Financial Services	21.7	22.4	23.4	24.5	25.6	25	27.6
Employment							
Manufacturing	23	22	21	19	18	18	17.1
Financial Services	13	14	15	15	16	17	18.2

Source: CSO/ONS, *UK National Accounts*, 1990, 1999.

(e.g. the need for banks to provide a branch network and a cheque clearing service). The mid 1980s was a period of large scale deregulation. The UK Financial Services and Building Societies Acts of 1986 radically liberalised the range of activities in which financial institutions could engage. Three main effects occurred. Firstly, the boundaries between financial institutions became increasingly blurred (e.g. banks expanded into stockbroking, and building societies offered current accounts and insurance products). Accordingly, industry incumbents became more homogeneous: it became increasingly difficult to differentiate between different types of institutions since they began to operate in multiple sectors. The second effect, in contrast, has been the greater heterogeneity of similar types of financial institution. For example, whilst small building societies remain largely in the traditional mortgage business, larger societies have diversified and now offer estate agency services, insurance services etc. Thirdly, the lowering of regulatory barriers to entry, coupled with lower technical and economic barriers to entry led to non-financial firms entering the sector (e.g. supermarkets) and international firms both financial and non-financial entering the domestic market. In sum, these three factors have led to less segmentation, greater competition and the increasing internationalisation of financial markets.

A related development has been the growing importance of financial innovation. New types of financial instruments, financial markets and techniques have emerged. Two stand out. Firstly, the growth of financial derivatives such as financial futures, options and swaps. These new instruments guard against volatility in financial markets and broaden the financial management techniques available to firms and financial institutions. Secondly, primary and secondary securitisation. The former refers to borrowers bypassing lending institutions and raising finance directly from capital markets whilst the latter refers to the packaging of assets held on the balance sheet of a bank or building society for sale to a capital market institution which funds the purchase by issuing securities. For the bank or building society the result is greater liquidity and so greater flexibility.

In most countries financial services cluster together. There are a number of reasons for this. On the supply side, large and complex financial services firms need access to large pools of specialised labour. Thus we observe that merchant and investment banks are almost exclusively based in financial centres such as London, New York and Frankfurt. This point is reinforced firstly by the fact that financial services skills are in large part acquired by shared experience (e.g. knowledge of how to trade Eurobonds is usually gained under the supervision of a senior Eurobond dealer) and secondly by the increased pace of innovation in financial services which has further raised the importance of tacit knowledge which is more easily exchanged when agents are geographically close. Conversely, smaller scale financial services companies such as building society branches and independent insurers that are less complex and less reliant on tacit knowledge do not rely on large quantities of highly specialised labour and so tend to be located outside major financial centres.

A second supply related explanation for clustering arises from the reliance of financial services firms on supporting services (accounting, actuarial, legal, computing etc.) and again these are most prevalent in major financial centres. A third factor relates to the greater flexibility gained by trading close to where liquidity is and so it is common to observe financial services companies located in close proximity to national and regional stock exchanges.

Demand side benefits include firstly enhanced reputation by locating in recognised financial districts and secondly lower levels of information asymmetry between financial services firms and customers leading to lower incidences of adverse selection and moral hazard.

A PRELIMINARY VIEW OF BRITISH FINANCIAL SERVICES CLUSTERING

By Sub-Sector

At the two-digit primary SIC (1992) level three financial services classifications can be found:

- 65: Financial intermediation except insurance and pension funding;
- 66: Insurance and pension funding, except compulsory social security; and,
- 67: Activities auxiliary to financial intermediation.

In the Lotus OneSource database (described more fully later), a total of 13,224 firms were listed under these three classifications in 1997. An inspection of the data set revealed that in some cases data had been collected from consolidated companies and also from the companies that constitute the consolidation leading to a double-counting problem. The solution to this problem was to delete all the consolidated companies within the data set and this reduced the sample size by 996 to 12,228 companies. This procedure had the added advantageous outcome of eliminating many holding companies which were essentially legal entities and as such would generate little or no clustering effects.

The two-digit level is of course too broad for our purposes and so the classification of firms according to activity for this study was done on the basis of (a) company SIC codes at the five-digit level (Lotus OneSource attaches a five-digit SIC code to each company based on its main line of activity); and, (b) classifications found in the literature on British financial services [Buckle and Thompson, 1998; Peasnell, Piesse and Ward, 1995].[3] This literature review allowed us to group firms into the principal lines of activity perceived by industry experts rather than relying exclusively on mechanical categorisation by three or four digit SIC code. Naturally, the resulting classifications are still arbitrary to some extent. However, the groupings seem coherent and no superior method of grouping appeared feasible.

Eight sub-sectors were defined. The distribution of companies according to these eight sub-sectors in the sample year 1997 is given in Table 3. As can be seen, the largest sub-sectors in terms of number of companies are trusts with 4,777 incumbents and life insurance with 3,331. Together, these two sub-sectors account for over 66 per cent of all financial services firms. Most trust and life insurance companies are small and this contrasts with the smaller number of larger firms in the banking sub-sector (accounting for 424 or approximately 3.5 per cent of the total).

By Region

The next step was to group the firms in our sample according to geographical region. Company NUTS 3 codes were aggregated to produce 14 regional classes (Table 4). These regions are broad and somewhat arbitrary but were the best that could be produced given the nature of the data. Table 5 shows the distribution of firms according to these regions in 1997. It reveals an overwhelming concentration of financial services firms in the Greater London area and the South East more generally and, to a lesser extent, in other major financial centres such as Birmingham, Bristol, Edinburgh, Glasgow and Manchester.

TABLE 3
FINANCIAL SERVICES SUB-SECTORS

	Sub-Sector	Firms	SIC	Description
1	Banks	424	65110	Central banking
			65120	Other monetary intermediation
			65121	Banks
			65122	Building societies
			65223	Activities of mortgage finance companies
			65234	Activities of bank holding companies
2	Non-bank financial Intermediation (Non-banks)	1240	65210	Financial leasing
			65220	Other credit granting
			65221	Credit granting by non-deposit taking finance houses and other specialist consumer credit grantors
			65222	Factoring
			65224	Other credit granting not elsewhere classified
			65235	Activities of venture and development capital companies
			65236	Financial intermediation not elsewhere classified
3	Trusts	4777	65230	Other financial intermediation not elsewhere classified
			65231	Activities of investment trusts
			65232	Activities of unit trusts and property unit trusts
			65233	Security dealing on own account
			66020	Pension funding
4	Life insurance	3331	66010	Life insurance (i.e. life insurance and life reinsurance, with or without a substantial savings element, including the insurance undertaken by corporate and quasi-corporate insurers such as Lloyd's underwriting syndicates)
5	Non-life insurance	476	66030	Non-life insurance (i.e. insurance and reinsurance of non-life business, including non-life insurance undertaken by corporate insurers and quasi corporate insurers such as Lloyd's underwriting syndicates: accident, fire; health; property; motor, marine, aviation, transport; pecuniary loss and liability insurance)
6	Activities auxiliary to financial inter-mediation (Financial aux.)	334	67130	Activities auxiliary to financial intermediation not elsewhere classified (i.e. mortgage brokers, bureaux de change, etc.)
7	Activities auxiliary to insurance (Insurance aux.)	1030	67200	Activities auxiliary to insurance and pension funding (i.e. activities of insurance agents, activities of insurance brokers, activities of insurance risk and damage evaluators, activities of Lloyd's underwriting brokers; and of managing and underwriting agents of Lloyd's syndicates)
8	Stock markets	616	67110	Administration of financial markets
			67120	Security broking and fund management
			67121	Fund management activities
			67122	Security broking and related activities

TABLE 4

BRITISH NUTS 3-BASED REGIONS FOR FINANCIAL SERVICES

Region	Code	County	Region	Code	County
1 North	uk111	Cleveland	7 Greater London	uk55	Greater London
	uk112	Durham	8 West Midlands	uk711	Hereford and Worcester
	uk12	Cumbria		uk712	Warwickshire
	uk131	Northumberland		uk721	Shropshire
	uk132	Tyne and Wear		uk722	Staffordshire
2 East Midlands	uk311	Derbyshire		uk73	West Midlands (county)
	uk312	Nottinghamshire	9 Yorkshire	uk21	Humberside
	uk321	Leicestershire		uk22	North Yorkshire
	uk322	Northamptonshire		uk23	South Yorkshire
	uk33	Lincolnshire		uk24	West Yorkshire
3 East Anglia	uk401	Cambridgeshire	10 North West	uk81	Cheshire
	uk402	Norfolk		uk82	Greater Manchester
	uk403	Suffolk		uk83	Lancashire
4 NW of London	uk511	Bedfordshire		uk84	Merseyside
	uk512	Hertfordshire	11 North Wales	uk911	Clwyd
	uk521	Berkshire		uk912	Dyfed
	uk522	Buckinghamshire		uk913	Gwynedd
	uk523	Oxfordshire	12 South Wales	uk914	Powys
5 South East	uk531	East Sussex		uk921	Gwent
	uk532	Surrey		uk922	Mid Glamorgan
	uk533	West Sussex		uk923	South Glamorgan
	uk54	Essex		uk924	West Glamorgan
	uk561	Hampshire	13 South Scotland	uka11	Borders
	uk562	Isle of Wight		uka12	Central
	uk57	Kent		uka13	Fife
6 South West	uk611	Avon		uka14	Lothian
	uk612	Gloucestershire		uka15	Tayside
	uk613	Wiltshire		uka21	Dumfries and Galloway
	uk621	Cornwall		uka22	Strathclyde
	uk622	Devon	14 North Scotland	uka31	Highlands
	uk631	Dorset		uka32	Islands
	uk632	Somerset		uka4	Grampian

TABLE 5
DISTRIBUTION OF FINANCIAL SERVICES FIRMS BY REGION, 1997

	Region	Number of firms
1	North	223
2	Yorkshire	565
3	East Midlands	330
4	East Anglia	254
5	NW of London	707
6	South East	1,740
7	Greater London	5,430
8	South West	640
9	West Midlands	666
10	North West	843
11	North Wales	31
12	South Wales	170
13	South Scotland	579
14	North Scotland	51
	Total	12,228

GROWTH AND ENTRY MODELS

The Growth Model

Two approaches to modelling the growth of firms can been used, one at the level of the firm, and the other at the level of the cluster. The most successful approach works at the firm level, and identifies whether firms located in strong clusters grow faster than isolated firms. In its simplest form, a model of the lifetime growth of the firm can be written using employment as a measure of cluster strength:

$$\ln (EmpFirm_{nt}) = a_0 + b_1(Age_{nt}) + b_2 \ln (EmpOwn_{irt}) + b_3 \ln (EmpOth_{jrt}) + u \qquad (1)$$

where:

- firm n is active in sub-sector i, and located in region r
- $EmpFirm_{nt}$ is employment in firm n in year t
- Age_{nt} represents the age of firm n in year t
- $EmpOwn_{irt}$ is employment in sub-sector i, region r at time t
- $EmpOth_{jrt}$ is employment in other sub-sectors ($\neq i$), region r at time t
- u is the disturbance or error term

b_1 yields the trend growth rate of the firm. The model assumes that all firms (in a particular region and/or sub-sector) are the same size at birth and then grow at a constant rate. This is unrealistic but has the benefit of simplicity. b_2 shows the effect of own sub-sector strength in the region on the growth of the firm. A positive coefficient indicates that greater cluster strength increases the growth rate of the firm, and *vice versa* for a negative coefficient. b_3 shows the effect of strength in other sub-sectors on firm growth. A priori these coefficients could take either a positive or a negative sign dependent on whether positive or congestion effects dominate the cluster.

To help with the interpretation of the parameter estimates, it is useful to sketch four scenarios, where the effects in Table 1 are of different magnitudes.

- **Scenario (a)**: The advantages of locating in a cluster outweigh the disadvantages, and there are sector specific and generic advantages. Firms benefit from co-locating with others from the same sub-sector, but also with others from different sub-sectors. In terms of the model, the parameters for own-sector employment and other-sub-sector employment are *both positive* (+,+).
- **Scenario (b)**: The advantages of locating in a cluster occur on both the demand and the supply side, but they are essentially sub-sector-specific. There are also some disadvantages of locating in a cluster: these arise mainly on the supply side, in particular from the generically high costs of locating in a cluster, irrespective of its sectoral makeup. In terms of the model, the parameter for own-sub-sector employment is *positive*, while the parameter for other-sub-sector employment is *negative* (+,-).
- **Scenario (c)**: There are substantial demand-side disadvantages from locating in a cluster, and these are essentially sub-sector-specific. There are however some modest supply-side advantages from locating in a cluster, but these are generic (i.e. infrastructure) rather than sub-sector-specific. In terms of the model, the parameter for own-sub-sector employment is *negative*, while the parameter for other-sub-sector employment is *positive* (-,+).
- **Scenario (d)**: There are disadvantages to locating in a cluster, and these occur on both the demand-side and the supply-side. The disadvantages apply therefore whether the other companies in the cluster come from the same sub-sector, or from other sub-sectors. In terms of the model, the parameters for own-sub-sector employment and for other-sub-sector employment are *both negative* (-,-).

The Entry Model

The entry model has the form:

$$n_{rit} = \beta_o + \beta_1 n_{\cdot it} + \sum_{j=1}^{8} \gamma_{ij} \ln E_{rjt-1} + \sum_{k=1}^{4} \delta_{ik} (\ln E_{c.t-1})^k + u_{rit} \qquad (2)$$

where:

- n_{rit} is the number of entrants at region r into sub-sector i at time t.
- $n_{.it}$ is the total number of entrants in sub-sector i at time t across all regions. This variable is included to control for the effect on entry of the normal economic cycle of the industry and is referred to in the results as *TOTENT*.
- lnE_{rjt-1} is the log of employment in sub-sector j at region r at time t-*1*. Thus it is assumed that cluster strength affects entry with a lag. These variables are referred to in the results as, for example, *LS1EMP*, log of employment in sector 1.
- $lnE_{r.t-1}$ is the log of total employment across all sub-sectors at region r at time t-*1*. These variables are referred to in the results as *LTOTEMP*.

The form of the entry model follows that of Swann *et al.* [1998] and is similar to that employed by Baptista and Swann [1999] and Prevezer [1997]. The model attempts to explain surviving entry into a cluster as a function of cluster size as measured by employment. The sign of the coefficients on log employment in each sub-sector in each cluster indicates whether strength in a particular sub-sector will attract or deter entry from firms in a given sub-sector. The magnitude of the coefficient indicates the strength of the effect. The reason for including polynomials in the log of total employment in each cluster is to investigate whether there is a critical mass for clusters and also whether there is evidence that beyond some size congestion effects dominate spillovers and contribute to cluster decline. Given the maturity of the financial services industry and the fact that there has been substantial activity around big bang, it is conceivable that strong congestion effects may have begun to manifest themselves.

Since the dependent variable is clearly a discrete count variable, a Poisson model was fitted to the data. One shortcoming of the Poisson model is that it constrains mean and variance to be equal. This appears a strong assumption. In order to test whether this restriction was binding, the overdispersion test of Cameron and Trivedi [1990] was used and indicated that in the entry models for sub-sectors 1 to 4, the Poisson restriction was not valid. The regressions were re-run using a negative binomial model which is less restrictive, in so far as mean and variance are allowed to differ. Since the results were somewhat different for sub-sectors 1 and 3, albeit very similar for sub-sectors 2 and 4, the negative binomial results are reported for sub-sectors 1 to 4 and the Poisson models for sub-sectors 5 to 8. For the negative binomial models, overdispersion parameters were not reported because they are not of central interest. For those sub-sectors where the overdispersion test failed to reject the negative binomial regression results were virtually indistinguishable from the Poisson results. Another drawback of Poisson regression is that it is not suitable for estimating regional and sub-sectoral fixed effects.

The Poisson model specifies that each observation y_i is drawn from a Poisson distribution with parameter λ_i. In the context of Poisson regression, the expectation of y_i is conditional on a vector of independent variables $\mathbf{x}_i$. The form of the density function is:

$$\text{Prob}(Y_i=y_i) = \frac{e^{-\lambda i}\lambda_i^{yi}}{y_i!} \tag{3}$$

It follows that $E[y_i \backslash \mathbf{x}_i] = \lambda_i = e^{\beta' \mathbf{xi}}$.

The marginal effect of each x variable on the conditional mean of y_i is given by:

$$\frac{\delta E[y_i \backslash \mathbf{x}_i]}{\delta xi} = \beta_i e^{\beta' \mathbf{xi}} = \beta_i \lambda_i \tag{4}$$

This expression for the marginal effect can be manipulated to reveal that the elasticity of the conditional mean number of entrants per period, λ_i, with respect to x_i is equal to the coefficient β_i multiplied by the value of x_i. In terms of the effect of employment, this implies that the larger the cluster, the larger the elasticity will be.

DATA AND VARIABLES

Lotus OneSource UK was used to extract company data. This database contains detailed information on 360,000 UK registered trading companies and is sourced from ICC Information which has the largest database of analysed UK company information in the world. For the growth model, four categories of company information were required: firm size in the sample year (in terms of number of employees), date of foundation, sub-sector (using five digit SIC [1992] codes), and region (NUTS 3 classification). Unfortunately, for many of the very small financial services companies in the database, employment figures are not reported and missing values of this type resulted in the reduction of our sample size from 12,228 to 5,222.

For the entry model, a time series on firm employment was not available over the whole period, since OneSource provides a maximum ten years' data for firms in the large firm database and only five years for small firms. A time series of firm employment was therefore generated by fitting an exponential growth model to each firm from its date of foundation to the present and thereby interpolating employment in each year. This is clearly crude and misses the ebb and flow of the economic cycle and particular significant events such as mergers and de-mergers in the history of each firm. To some extent over and under-estimates may be expected to cancel out in the process of aggregating up individual firm employment to cluster-level employment, such that the variables actually entered into the regression will be less inaccurate than the individual firm employment series [Baptista and Swann, 1999; Prevezer, 1997].

The time series of entry was based on the reported date of foundation of firms in Lotus OneSource. This actually yields data on surviving entry, because only those firms founded, say, in 1967, which have survived to 1997 will actually appear in the data set. This inevitably means under-recording as the mortality rates over the first ten years of an entry cohort are high [Wagner, 1994]. What is more, some very new firms may not be recorded because they are too small to warrant inclusion in the OneSource data base. A time plot indicated that there was a noticeable dip in recorded entry in both 1996 and during the mid-1960s. For this reason, the time series was constructed for entry between 1968 and 1995, to avoid some of the worst extremes of the under-recording problem. This gives a total of 28 years' observations. The under-recording that remains may be mitigated by the fact that non-surviving entrants are generally very small and make little contribution to the process of competition in an industry [Geroski, 1995]. Thus the surviving entry data set may reasonably capture the entry of firms which have made a contribution to cluster growth.

The fact that only data on surviving firms is available also presents a problem in the growth model. In short, the sample is censored. What would ideally be estimated is a double hurdle model. The first hurdle is the decision to enter the industry and the second is to survive in the industry. There appears to be no practical way in which to model either of these steps as data is available neither on the firms which considered entering, but did not, nor on those which entered but failed to survive. The only practical step which can be taken is to remain alert to the possibility of bias arising from this incomplete modelling.

RESULTS

The Growth Model

The first set of results (Table 6) use a pooled model where observations in all sub-sectors and regions are combined. The next two versions of the model relax the restrictions on the coefficients to some extent by introducing first regional and then sub-sectoral intercept dummies (Tables 7 and 8). Virtually all the models suffered from heteroskedasticity and autocorrelation, therefore results using White standard errors are reported.

TABLE 6

LIFETIME GROWTH REGRESSION, POOLED

Variable	Estimate	White Standard Error	
Intercept	1.235	0.123	***
ln(EmpOwn)	0.286	0.020	***
ln(EmpOth)	–0.155	0.019	**
Age	0.017	0.002	***
n		5222	
R^2		0.089	
Adj. R^2		0.089	
F-Value		170.476	***
Breusch-Pagan $\chi^2(3)$		371.614	***

***: Significant at the 1% level
**: Significant at the 5% level

There was a general problem of non-normally distributed residuals, however residual plots indicated that the non-normality was not marked and in any case standard large sample theory can be appealed so that the 't-ratios' will be asymptotically normally distributed.

Pooled Results

The coefficient on *Age* indicates a trend growth rate of employment of 1.7 per cent per year. This is a modest rate but is probably explained by the existence of a significant number of mature firms within the sector. Growth rate, measured in terms of turnover or assets, would probably be higher. The coefficient on ln(*EmpOwn*) is positive and significant and this indicates cluster strength in the firm's own sub-sector promotes growth. The negative and significant coefficient on ln(*EmpOth*) implies that the strength of employment in other sub-sectors at that cluster tends to lower growth. The low R^2 reflects the fact that this simple model can only account for a small amount of the variation in company size. A model was estimated with the square of *Age* included but this did not significantly affect the explanatory power, therefore the simplification of fitting a constant trend growth rate does not account for the relatively poor fit.

Tables 7 and 8 report the effect of including regional and sub-sectoral intercept dummies. These have the effect of slightly lowering the coefficient on *Age* although the difference is hardly material. What is much more noticeable is that the coefficient on ln(*EmpOth*) moves from negative to positive once regional dummies are introduced and remains positive but becomes insignificant when sub-sectoral dummies are added as well. The coefficient on ln(*EmpOwn*) is much more robust. This implies that own sub-sector strength is more important in affecting firm growth than other sub-sector employment. The regional dummies are all positive and significant. The positive coefficient means that firms are on average larger than firms in Greater London which is the default region. A possible explanation for this is that a large amount of small firm entry may occur in the capital and the existence of small new firms is bringing down the average size in Greater London. It may also reflect the fact that a finer division of labour and greater specialisation is possible in a larger market, allowing a larger number of small niche firms in Greater London.[4] It is interesting that the explanatory power of the model is sharply increased by the addition of the sub-sectoral dummies. Firms in all sub-sectors are smaller on average than firms in the banks sub-sector, the sub-sector without dummies included, significantly so in the case of non-bank financial intermediation, trusts, life insurance, activities auxiliary to finance and activities auxiliary to insurance. A model including sectoral interaction dummies with *Age* (not reported here) was estimated but the interaction term was far from significance. This implies there are important sectoral fixed effects on growth. London shows a weak regional fixed effect, and this may suggest saturation or 'overheating'.

TABLE 7

LIFETIME GROWTH REGRESSION, POOLED, WITH REGIONAL INTERCEPT DUMMIES

Variable	Estimate	White Standard Error
Intercept	–9.062	3.059 ***
In(EmpOwn)	0.429	0.038 ***
In(EmpOth)	0.533	0.213 **
Age	0.016	0.002 ***
DNorth	4.333	1.290 ***
DYorkshire	2.868	0.768 ***
DEast Midlands	3.927	1.111 ***
DEast Anglia	2.806	0.866 ***
DNW of London	2.683	0.846 ***
DSouth East	1.813	0.574 ***
DSouth West	2.675	0.805 ***
DWest Midlands	2.691	0.833 ***
DNorth West	2.593	0.826 ***
DNorth Wales	6.862	2.236 ***
DSouth Wales	4.373	1.198 ***
DSouth Scotland	3.567	1.011 ***
DNorth Scotland	6.089	1.812 ***
n	5222	
R^2	0.098	
Adj. R^2	0.095	
F-Value	35.159 ***	
Breusch-Pagan $\chi^2(16)$	417.200 ***	

*** Significant at the 1% level
** Significant at the 5% level

TABLE 8
LIFETIME GROWTH REGRESSION, POOLED, WITH REGIONAL AND SECTORAL INTERCEPT DUMMIES

Variable	Estimate	White Standard Error	
Intercept	–1.580	3.020	
ln(EmpOwn)	0.247	0.047	***
ln(EmpOth)	0.181	0.207	
Age	0.015	0.002	***
DNorth	2.093	1.294	
DYorkshire	1.476	0.781	*
DEast Midlands	1.949	1.123	*
DEast Anglia	1.377	0.862	
DNW of London	1.146	0.853	
DSouth East	0.919	0.581	
DSouth West	1.330	0.809	
DWest Midlands	1.341	0.838	
DNorth West	1.244	0.827	
DNorth Wales	2.976	2.229	
DSouth Wales	2.134	1.211	*
DSouth Scotland	1.657	1.014	
DNorth Scotland	2.727	1.185	
DS1			
DS2	–0.656	0.190	***
DS3	–1.929	0.172	***
DS4	–1.888	0.168	***
DS5	-0.107	0.198	
DS6	–0.481	0.185	***
DS7	–0.324	0.173	*
DS8	–0.233	0.179	
n	5222		
R^2	0.347		
Adj. R^2	0.344		
F-Value	119.942		***
Breusch-Pagan $\chi^2(23)$	993.865		***

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

S1 = Banks (default)
S2 = Non-banks
S3 = Trusts
S4 = Life insurance
S5 = Non-life insurance
S6 = Financial aux.
S7 = Insurance aux.
S8 = Stock markets

Sub-Sector Specific Regressions

Separate regressions were run using the basic lifetime growth model for each of the eight main sub-sectors. The results are summarised in Table 9.

These models relax the restriction in the pooled models of imposing equal coefficients on each variable in each sub-sector. There are a number of interesting similarities and differences. The coefficient on *Age* is roughly speaking close to 0.02 in all but two cases. The exceptions are sub-sector 3 (trusts) and sub-sector 5 (non-life insurance) which have coefficients of 0.001 and 0.006 respectively. These coefficients represent trend growth rates of a mere 0.1 per cent and 0.6 per cent per year. These figures seem implausibly low and require further investigation. The fastest growing sub-sectors are sub-sector 1 (banks), sub-sector 2 (non-bank financial intermediation) and sub-sector 6 (activities auxiliary to financial intermediation) which each have an estimated trend growth rate of 2.6 per cent per year.

The significant differences between the coefficients for ln(*EmpOwn*) and ln(*EmpOth*) among these models mean that it is very difficult to make any firm general comments. In no less than four out of eight models *neither* variable is significant at conventional levels. In the four cases where ln(*EmpOwn*) is significant, it is positive implying that own sub-sector strength in these clusters enhances growth. In the remaining four sub-sectors ln(*EmpOwn*) is positive but not significant. All that can be said is that the effect of own sub-sector strength in these cases is more likely to exert a positive than a negative effect on firm growth. In one case, ln(*EmpOth*) is negative and significant at the 1 per cent level and two further cases, negative and significant at the 10 per cent level. The interpretation is that in these cases other sub-sector employment has a significant negative effect on firm growth. In the remaining five cases, ln(*EmpOth*) is negative but not significant.

The coefficients of own and other employment have been plotted in Figure 2 which shows how the own-sub-sector and other-sub-sector clustering effects vary across the different sub-sectors. As expected, sub-sectors like banking, non-bank financial intermediation (credit, leasing, factoring, venture capital), and non-life insurance (such as marine) show strong own-sub-sector clustering effects. This effect is much weaker in life insurance and trusts. One surprising result is the relatively low own-sub-sector clustering effect for stock markets.

The sub-sectors with the strongest positive own-sub-sector effects also have the most negative other-sub-sector effects. As before, we suggest that this could reflect severe congestion costs in the City of London.

The earlier empirical results of Swann and others relating to the UK and US biotechnology and computing industries [Swann *et al.*, 1998] show that

TABLE 9

LIFETIME GROWTH REGRESSION FOR INDIVIDUAL SUB-SECTORS

Variable	S1	S2	S3	S4	S5	S6	S7	S8
Intercept	3.084	2.428***	1.345***	1.442***	5.162***	3.593***	2.800***	3.698***
ln(EmpOwn)	0.389**	0.359**	0.136***	0.041	0.393*	0.086	0.076	0.090
ln(EmpOth)	–0.354	–0.280***	–0.091**	–0.043	–0.460*	–0.160	–0.043	–0.136
Age	0.026***	0.027***	0.001	0.023***	0.006	0.026***	0.019***	0.020***
N	185	344	1300	1650	217	263	843	420
R^2	0.189	0.110	0.015	0.103	0.034	0.061	0.061	0.034
Adj. R^2	0.176	0.102	0.013	0.102	0.020	0.050	0.058	0.027
F-Value	14.103***	13.989***	6.587***	63.144***	2.470*	5.641***	18.132***	4.859***
Breusch-Pagan $\chi^2(3)$	4.082	18.495***	132.925***	450.529***	8.105**	6.190	30.016***	5.095

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

S1 = Banks
S2 = Non-banks
S3 = Trusts
S4 = Life insurance
S5 = Non-life insurance
S6 = Financial aux.
S7 = Insurance aux.
S8 = Stock markets

firms located in clusters that were strong in their own industry tended to grow faster and that firms in clusters that were strong in other industries did not grow faster – and might sometimes grow slower. Accordingly, their results were often of type (b) above (p. 44). Our results are also of this type and lead us to conclude that the dynamics of industrial clustering in high technology manufacturing industries is similar to the dynamics of industrial clustering in this non-high technology service industry.

More specifically, in the pooled regressions, the coefficient on own sub-sector employment is consistently positive and significant as it is in four of the eight sub-sector regressions. In no case is this variable negatively signed. The behaviour of other sub-sector employment is less consistent. In the simple pooled model it is negative and significant. When dummy variables are added however, it turns positive. In the sub-sector regressions it is consistently negative and in three cases significantly so. Therefore the conclusion is that cluster strength in other sub-sectors lowers firm growth.

Finally, the regional fixed effects on growth in financial services appear to be weaker in the traditional cluster of London than in most other regions. This could suggest that London as a cluster of this industry is reaching saturation because of high congestion costs.

FIGURE 2

OWN VERSUS OTHER EMPLOYMENT

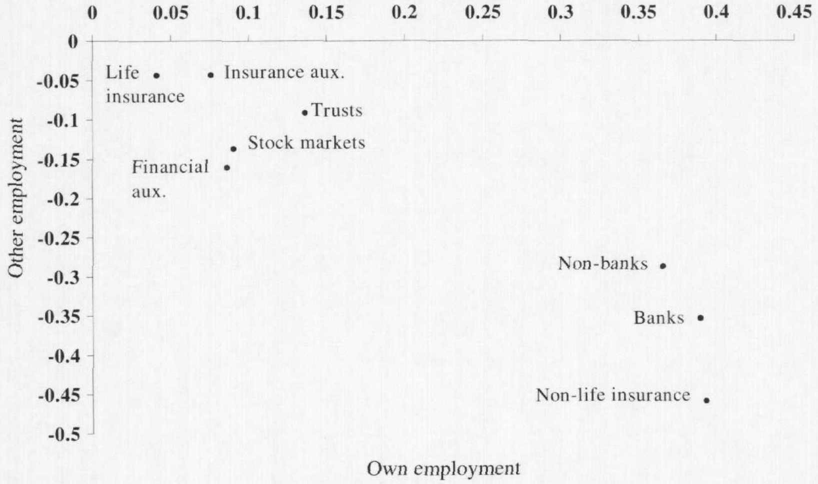


TABLE 10
FULL ENTRY MODELS INCLUDING TOTAL EMPLOYMENT

Attracted by Employment in	Entry into Sub-sector							
	Negative Binomial Models				Poisson Models			
	S1	S2	S3	S4	S5	S6	S7	S8
Constant	–31.636	–29.02 ***	–3.132 ***	–2.125 **	–2.149	–47.309 *	–3.481	–82.363 ***
Totent	0.0453***	0.0166***	0.0020***	0.0051***	0.0273***	0.0536***	0.0201***	0.0296***
LS1EMP	0.3591***	0.1402***	0.0423*	–0.0060	0.0540	0.1224	0.0436	0.2067**
LS2EMP	–0.3713**	–0.3309***	–0.0808**	–0.1956***	–0.4869***	–0.5588***	–0.2389***	–0.3756***
LS3EMP	0.1370	0.6055***	0.2129***	0.0134	0.2518	0.3356	–0.1307	0.8112***
LS4EMP	–0.0516	0.1635	–0.0863	–0.2267***	–0.5651*	–0.1290	–0.1443	0.4988*
LS5EMP	0.1618	0.2345***	0.1530***	0.3368***	0.2429*	0.1203	0.1990***	–0.0348
LS6EMP	0.1624	–0.0203	0.0970**	0.1244***	–0.0173	0.0822	–0.0288	–0.5123***
LS7EMP	0.7537***	0.4199***	0.1553**	0.1715***	0.5634*	1.0489***	0.3159***	0.7151***
LS8EMP	–0.4305***	–0.2206***	–0.0788*	–0.0809**	–0.5295***	–0.3313**	–0.1069	0.0473
LTOTEMP	11.0880	12.9020**	0.6291	–0.1822	–4.0204	19.5260	–0.6581	39.3360***
LTOTEMP2	–1.7077	–2.4436**	–0.0016	0.2775*	1.2758*	–3.3324	0.3874	–7.4782***
LTOTEMP3	0.1132	0.1945**	–0.0075	–0.0366**	–0.1267*	0.2443	–0.0441	0.6007***
LTOTEMP4	–0.0028	–0.0057**	0.0005	0.0014***	0.0044*	–0.0065	–0.0016	–0.0175***
Log–Likelihood	–276.43	–520.27	–860.90	–886.51	–220.82	–248.62	–524.67	–273.86
R2P	N/A	N/A	N/A	N/A	0.91	0.85	0.85	0.96
N	392	392	392	392	392	392	392	392

*** indicates significance at 1%
** indicates significance at 5%
* indicates significance at 10%

S1: Banks S5: Non–life insurance
S2: Non–banks S6: Financial aux.
S3: Trusts S7: Insurance aux.
S4: Life insurance S8: Stock markets

TABLE 11

FULL ENTRY MODELS NOT INCLUDING TOTAL EMPLOYMENT

Attracted by Employment in				Entry into Sub-sector				
	Negative Binomial Models					Poisson Models		
	S1	S2	S3	S4	S5	S6	S7	S8
		S7		S8				
Constant	-5.629 ***	-3.989 ***	-1.488 ***	-0.891 ***	-7.014 ***	-6.908 ***	-3.289 ***	-8.141 ***
Totent	0.0466***	0.0143***	0.0016***	0.0043***	0.0282***	0.0533***	0.0181***	0.0345***
LS1EMP	0.2897***	0.0617**	0.0598***	-0.0074	0.2577***	0.1053**	0.1120***	0.2058***
LS2EMP	-0.2499**	-0.2540***	-0.0581*	-0.0761**	-0.4834***	-0.5563***	-0.1901***	-0.6252***
LS3EMP	-0.0272	0.5133***	0.3233***	0.0920**	0.7482***	0.4401***	0.0541	0.8232***
LS4EMP	-0.0816	-0.0496	0.0267	-0.0344	0.1699	-0.0647	0.1947***	0.3090***
LS5EMP	0.0801	0.1977***	0.1581***	0.2886***	0.2869**	0.0548	0.1959***	-0.1298
LS6EMP	0.1535	0.0509	0.0962**	0.1225***	-0.1029	0.0950	-0.0678	-0.5615***
LS7EMP	0.9261***	0.4934***	0.1551**	0.2327***	0.4127*	1.1850***	0.3107***	1.0118***
LS8EMP	-0.5334***	-0.3422***	-0.1150***	-0.1854***	-0.5157***	-0.5019***	-0.1351*	-0.1808
Log-Likelihood	-281.22	-527.72	-865.99	-903.70	-224.57	-251.51	-529.05	-283.79
R^2p	N/A	N/A	N/A	N/A	0.91	0.85	0.85	0.95
n	392	392	392	392	392	392	392	392
LR test of restriction	9.582**	14.888***	10.172**	34.390***	7.498	5.782	8.758*	19.856**

***indicates significance at 1%
** indicates significance at 5%
* indicates significance at 10%

S1: Banks S5: Non-life insurance
S2: Non-banks S6: Financial aux.
S3: Trusts S7: Insurance aux.
S4: Life insurance S8: Stock markets

The Entry Model

The results are presented in Tables 10 and 11. There are two sets of results reported, an unrestricted model which includes the total employment variables and a restricted model in which the total employment variables are excluded. The restricted model seemed plausible in several cases given the weak or non-significance of the individual powers of this variable. To test the overall restriction of excluding all four total employment variables, a likelihood ratio test was performed calculated as:

$$LR = -2[LL(H_0) - LL(H_1)] \sim \chi^2(4) \qquad (5)$$

where $LL(H_0)$ is the log-likelihood for the restricted model and $LL(H_1)$ is the log-likelihood under the unrestricted model. Only in the cases of sub-sector 6, activities auxiliary to finance, and sub-sector 7, activities auxiliary to insurance, did the null hypothesis that the variables could be excluded fail to reject at least the 10 per cent level. Therefore it appears that life cycle effects on the attractiveness of entry into a cluster are generally present. In the models for sub-sectors 3, 4 and 5 the results have the counter-intuitive feature that the coefficient on the fourth power is positive. This implies that far from entry reaching a maximum at some level of total employment, entry will tend to increase without bound as total employment within a cluster rises. This result is less troublesome in the case of sub-sector 3 because the positive coefficient is not significantly different to zero. In all other cases the fourth power term has a negative coefficient, which does imply that beyond some point entry will decline as the cluster becomes congested.

The entry model results do indicate that clustering effects are important. Employment strength in banking, trusts and activities auxiliary to insurance attract entry from other sub-sectors. In non-bank financial intermediation and life insurance there is a significant negative effect of own sub-sector strength on entry. In the remaining three sub-sectors, non-life insurance, financial auxiliaries and stock markets, there appears to be no significant effect one way or the other. These results mirror quite closely the conclusions from the lifetime growth models. The two exceptions are non-bank financial intermediation where own sub-sector strength exerted a significant positive effect on growth, and life insurance where the effect on growth was positive but not significant. These findings contrast with those of Swann and Prevezer [1996] which found own sub-sector strength in both the computing and biotechnology industries, with just one exception, to negatively influence own sub-sector entry.

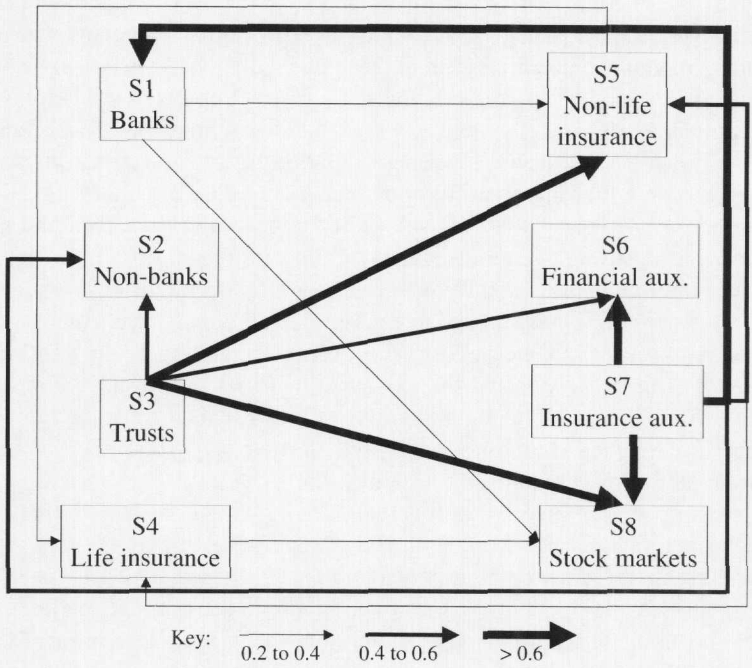
There are some interesting patterns regarding which sub-sectors generally attract entry and those which appear to deter it. Not surprisingly, banks attract entry of other financial services firms, although the effect is significant in only four cases in the full entry model. However, the effect is also significant on entry from non-life insurance and activities auxiliary to financial intermediation (sub-sectors 5 and 6) in the restricted model not including total employment and the likelihood ratio test indicates that the restricted model is data admissible in these two cases. What is less expected but even more readily apparent, is the strong attraction exerted by strength in activities auxiliary to insurance, where the coefficients are consistently positive, always significant and generally large. Life insurance exerts very little influence either in attracting or deterring entry. This is understandable given the a priori belief that this sub-sector is generally dispersed and not marked by any strong clustering effects. Sub-sector 6, activities auxiliary to financial intermediation, also shows no strong effects on cluster growth via entry and again this is understandable given the rather heterogeneous nature of this sub-sector. Sub-sector 3, trusts, exerts strong effects on four sub-sectors. It is unsurprising that the existence of trusts should have a strong positive effect on entry into stock market activities. This is most likely to be driven by demand externalities, although the two activities may share a common labour market pool for certain skills.

Two sub-sectors stand out for their strong and consistent effect in reducing entry. Stock markets, with the exception of effects on own sub-sector entry in the unrestricted model, has a consistent negative effect which is generally strong and highly significant. The effect is most marked for banks and non-life insurance. The other sub-sector which seems to exert negative externalities is non-bank financial intermediation.

The inter-relationships between sub-sectors which attract each other are represented graphically in Figure 3. The cut-off points for different degrees of attraction are of course arbitrary and there are two borderline cases. Nevertheless a reasonable impression is gained and altering the cut-off points would not solve the problem of borderline cases. The attraction effects which are shown are all significant at the 10 per cent level at least. Twelve significant but not very strong coefficients have been excluded from the diagram so that attention may be focused on the most notable results.

There are a number of interesting patterns which are revealed in Figure 3. The first is that there are no positive feedback loops where strength in one sub-sector attracts entry into another whose strength then attracts entry into the original attracting sub-sector. Indeed, in the case of stock markets, the reinforcing effects on entry within clusters appear to run into a dead-end. Most sub-sectors either predominantly exert entry attracting effects or are the beneficiaries of entry attracting externalities. Notable exceptions are non-life insurance and banks which both attract entry and are attracted by cluster strength in a number of other sub-sectors. Thus, these sub-sectors

FIGURE 3
PATTERNS OF ENTRY ATTRACTION



appear to play an important role in cluster dynamics. However, too much emphasis should not be placed on this observation, since it is an inference based on statistical association only and could be a mere statistical artefact. Yet it does appear to merit further investigation.

These patterns are very much in line with those reported in Swann and Prevezer [1996] for high technology manufacturing industries. In computing, no substantial two-way entry attracting effects were reported and in biotechnology there were only two. Moreover, in both biotechnology and computing, firms either appeared to attract entry from other sub-sectors or to be attracted themselves by other sub-sectors, but not both at the same time. These emerging empirical regularities are less explicable on the basis of prior theory and deserve further investigation.

The previous work of Swann *et al.* [1998] showed that clusters that were strong in core activities (i.e. the manufacture of computer hardware, systems and components) tended to attract a disproportionately high number of start-up firms in peripheral activities (i.e. software and peripherals). [See also Scherer, 1982, 1984 on cross-sectoral effects of this sort.] Our results largely corroborate these findings with core activities such as banks and trusts attracting peripheral activities such as non-bank financial intermediation. The anomaly is activities auxiliary to insurance which has a positive and significant attracting effect on every other sub-sector (although only six of the seven effects are shown in the diagram).

Another important finding of Swann *et al.* [1998] was that in terms of new firm start-ups, the strongest effects tend to operate across sub-sectors of an industry. Thus a cluster that is strong in software did not (other things equal) tend to attract a disproportionately high number of software start-ups. Again, our results largely concur. We do find many significant cross sectoral effects. However, we also find some significant own sub-sector effects.

Finally, the polynomial terms in *LTOTEMP* (Table 10) show a quartic shape for S1, S2, S6, S7 and S8, indicating that there is a critical mass effect and a cluster size which maximises the rate of entry. For the remaining three sub-sectors, the positive coefficient on the fourth power of *LTOTEMP* means that the model would start behaving badly if extrapolated.

CONCLUSION

Overall we found significant and positive clustering effects in the British financial services industry. Companies co-located with others in the same sub-sector show a strong tendency to grow faster than average. This is especially true in those sub-sectors where we would expect physical proximity to be a marked source of competitive advantage, for example: banking and non-bank financial intermediation, and non-life insurance. Some quite strong and negative 'other sub-sector' cluster effects on firm growth are found. This means that companies co-located with many companies from other sub-sectors do not benefit. Indeed, the resultant congestion costs appear to detract from company growth. These effects are not strongly negative in all cases: in many, they are small and insignificantly different from zero. But we do not find any strong examples of positive cross-sectoral effects on company growth – suggesting that cross-sectoral learning is weak. The regional fixed effects on growth in financial services appear to be weaker in the traditional cluster of London than in most other regions. This could suggest that London as a cluster of this industry is reaching saturation because of high congestion costs.

A number of interesting conclusions have emerged regarding entry. There appear to be some significant positive effects of own sub-sector employment strength, which contrasts with earlier work on high technology manufacturing industries. In line with previous research there are rich patterns whereby some sub-sectors attract others, while other sub-sectors repel. Moreover, sub-sectors appear to either attract or be attracted, but not both. Finally, in line with Swann *et al.* [1998] there appears to be evidence that clusters can become congested to the extent that they deter entry.

ACKNOWLEDGEMENTS

This research is partly funded by the UK Economic and Social Research Council (grant R000 223258: *A Comparative Study of the Dynamics of Industrial Clustering* and European Community Contract No SOE1 – CT97 – 1058 [DG12 – SOLS], Industrial Districts and Localised Technological Knowledge: The Dynamics of Clustered SME Networking, which is part of the Targeted Socio-Economic Research (TSER) Programme organised by DG XII (Science, Research, and Development). We acknowledge helpful comments from our European partners in this research programme, notably Cristiano Antonelli, Stefano Breschi, Luis Sanz-Menendez and Michel Queré, and also discussions with Catherine Beaudry, and the earlier work of Rui Baptista developing econometric models of entry and growth. We would also like to thank participants at the 26th annual conference of the European Association for Research in Industrial Economics (EARIE 1999, Turin, Italy) for their helpful comments. None of these, however, are responsible for any remaining errors.

NOTES

1. One such business, Barclays bank, was founded by John Freame and his partner Thomas Gould in Lombard Street, London, in 1690. The name Barclay became associated with the company in 1736, when James Barclay – who had married John Freame's daughter – became a partner.
2. Financial services are defined as banking, finance, insurance, business services, renting and real estate services. This definition is therefore broader than the traditional perception of financial services.
3. In addition, drawing from previous work on clustering (e.g. Swann *et al.*, 1998), we made distinctions between 'core' and 'peripheral' activities. As mentioned earlier, many financial services firms now operate in more than one sub-sector. In such cases, our approach is to allocate the firm on the basis of its main sub-sector.
4. We are thankful to Bruce Lyons for this suggestion.

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