

## THE RELATIONSHIP BETWEEN FIRM SIZE DISTRIBUTION AND AGGLOMERATIONS IN THE SCOTTISH INDUSTRIAL CLUSTERS

GERALD MUNYORO

Graduate Business School, School of Entrepreneurship and Business Sciences  
Chinhoyi University of Technology, Chinhoyi, Zimbabwe

### ABSTRACT

It is evident that some of the difficulties that have been faced by the policy makers, especially when developing and carrying out this economic plan, have been caused by the failure to delineate and identify industrial clusters. In addition, these problems have also been compounded by the absence of knowledge about the association or otherwise between the organization of economic activity in clusters and the sizes of their constituent firms. Basically, the results will be based on the chi-squared test. Therefore, the results from the chi-squared study, which were used to calculate and examine whether the distribution of firm sizes in Scottish industrial clusters were significantly the same as the size distribution of firms in the rest of Scotland. The results of the study show that in the ICT sector, financial sector, Biotechnology sector, Oil and Gas sector and Mechanical engineering sectors show that the size distribution of firms within these industrial clusters is significantly different from the size distribution of firms in the rest of the country. However, in the Creative industrial sector the findings show that the size distribution of firms within the industrial cluster is significantly the same as the size distribution of firms in the rest of the country. The results in the creative cluster may be attributed to the fact that the cluster was started by local entrepreneurs who are living in different parts of the country and are interested in developing their own regions, or simply that the cluster is still in the introduction stage of development. The study also presented the significant finding that small establishments tend to operate outside the industrial clusters rather than within them because small establishments enter and exit clusters faster than large establishments and this is good for economic planning by regional economists.

**KEYWORDS:** Industrial clusters, Regional disparities, Scottish Government, Economic development, Economic activity, Chi-squared test, Economic planning

### INTRODUCTION

Although the industrial cluster approach has emerged in recent years as a component of a wider set of regional economic development policies that can be used by governments and regional economic development agencies to tackle regional disparities, as highlighted in previous studies, it is evident that some of the difficulties that have been faced by the policy makers, especially when developing and carrying out this economic plan, have been caused by the failure to delineate and identify industrial clusters. In addition, these problems have also been compounded by the absence of

knowledge about the association or otherwise between the organization of economic activity in clusters and the sizes of their constituent firms. Basically, the results will be based on the chi-squared test.

### **The Association between the organization of economic activity in clusters and the sizes of their constituent firms theory**

The results of this exercise are as important as any other exercise carried out in the previous studies in that, apart from intellectual curiosity, the renewed interest in the relationship between firm size distribution and agglomerations has arisen due to the need to involve industrial clustering policy in regional economic development. As discussed in the literature on industrial clustering in previous studies, the performance of a few key industrial clusters such as Silicon Valley, Silicon Glen and others which are primarily characterised by a large number of small firms (Pandit and Cook, 2005) has resulted in intellectuals and policy makers being interested in addressing the absence of knowledge about the association or otherwise between the organization of economic activity in clusters and the sizes of their constituent firms. As suggested by Gordon and McCann (2005), smallness is argued to provide flexibility in a firm's relations with other firms, thereby maximizing the firm's ability to make the appropriate alliances for the duration of the industrial cluster, as was also the case with Marshallian districts and Third Italian districts. On the contrary, however, Lipczynski and Wilson (2001) suggest that firm size plays an important role in defining the structural characteristics of an industrial cluster in that large firms are more likely to exploit technical efficiencies and exercise market power advantages than small firms. Hence, observation of these arguments has led to this new discussion centered on the potential impacts of small firms operating within and outwith industrial clusters. However, the terms 'firm' and 'establishment' appear to have created some more difficulties for regional economic development analysts, who have employed them more or less interchangeably, and with little concern about how and when to use them, something that has also led people to interpret these words in quite different ways, depending on the analyst's point of view. This level of ambiguity is not unique to this study, as witnessed also in Carbal and Mata (2003), Pandit and Cook (2005), Berghall (2006) and Growiec et al's (2008) studies, making it difficult to make a distinction at times between a firm and an establishment. Nevertheless, this is not surprising given that this study seems to be in its premature stage, as evidenced by the absence of knowledge about the association or otherwise between the organization of economic activity in clusters and the sizes of their constituent firms in Scotland and the UK at large.

Nonetheless, a firm, according to Casson (2000), may be regarded as social unit comprising individuals who regularly cooperate in problem solving. Conversely, in this study a firm refers to any business entity such as corporation, partnership or sole proprietorship. However, as Black (2002) suggests, a firm in turn may have numerous establishments or branches, such as factories or shops, all over the country and abroad. In short, then, an establishment refers to a single plant of a company which is engaged in a single activity. In the same way, an establishment as stated above can be a store, office or other physical entity that produces goods or services, and that may be physically distinct from any other facility operated by a given firm.

## **METHODOLOGY**

In this study, the positivism approach was used (Bryman, 2006; Symonds and Gorard; Saunders et al (2009), because it required that the researcher assumes the position of a natural scientist who develops hypotheses that was tested

and confirmed using factual collected data. This philosophy was concerned with facts instead of impressions. In addition, Churchill (1996), Carson et al (2001) and Kaboub (2008) further reveal that positivists take a controlled and structural approach in conducting research by identifying a clear research topic as was the case in this study by constructing appropriate hypotheses and by adopting a suitable research methodology which was accordingly done in this study (Churchill, 1996; Carson et al., 2001; Kaboub, 2008). Therefore, The Chi-Squared Test was used in this study. All the same, as stated above, the establishment data was used in this study to analyse the firm size distribution within the industrial cluster and the size distribution in the rest of Scotland. However, as shown below, it is important to note that the exercise was not confined to merging size bands only but to industrial sectors as well. For example, in the Information and Communication Technology industrial sector, the Edinburgh and Glasgow clusters were combined into one. In the Biotechnology industrial sector, the Dundee and Edinburgh clusters were combined as well, and so on for the other remaining sectors. Thus, once the expected number had reached a total of at least 5, it was possible to use the chi-squared test in analysing the distribution of establishment sizes in Scottish industrial sectors. The study focused mainly on small establishments and large establishments only, in order to avoid any needless vagueness that medium-sized establishments may cause. Moreover, there is no hard and fast rule which says that small or large establishments should employ, for example, less or more than 50 employees, as evidenced by the tables below; rather, the classification depending on the industrial sector to which a given establishment belongs. In some tables, small establishments are denoted by 10-20 employees.

- Thus the null hypothesis ( $H_0$ ): states that the distribution of firm sizes in Scottish industrial clusters is significantly different from the distribution in the rest of Scotland.
- Whilst the alternative hypothesis ( $H_1$ ): states that the distribution of firm sizes in the Scottish industrial clusters is significantly the same as the distribution in the rest of Scotland

In this study 5% was used as level of significance as shown below. The critical value of  $\chi^2$  in this study is calculated as:  $df = (r-1) (c-1)$ . In this case  $df$  stands for degrees of freedom whilst  $r$  stands for row and  $c$  for column. These calculations were repeated for each year and each sector respectively and this is shown in the tables below. It is worth noting that the alternate hypothesis is true when the null hypothesis is rejected (*when we reject the null hypothesis*), and that the null hypothesis may be true when the null hypothesis is accepted (*when we fail to reject the null hypothesis*). In this case (*rejecting  $H_0$* ) means it is significant. What this means is that when the p-value is below the significance level the test is significant, and when the p-value is greater than the significance level the test is not significant. The significance level is often given as a percentage, as shown below. It is also important to note that significance testing is concerned with accepting or rejecting ideas, and these ideas are known as hypotheses. The term 'null' can be thought of as meaning 'no change' or 'no difference,' something that needs to be judged as true or false on the basis of statistical evidence. If the null hypothesis was contained within the confidence interval it is understandable that it would be accepted; otherwise, it would be rejected. In this case, then, a confidence interval can be regarded as a set of acceptable hypotheses.

## The Key Findings of Chi-Squared Test Methodology

Information, Communication and Technology Industrial sector

**Table 1: 2005 Data**

SIZEBAND	EDINBURGH & GLASGOW	REST OF SCOTLAND
1-4 employees	45	102
5-10 employees	11	26
11-24 employees	4	28
25-49 employees	7	14
50-99 employees	7	19
100+ employees	16	15
TOTAL	90	204

$$\chi^2 = \underline{11.63201}$$

**Table 2: 1997 Data**

SIZEBAND	EDINBURGH & GLASGOW	REST OF SCOTLAND
1-4 employees	39	132
5-10 employees	13	37
11-24 employees	18	18
25-49 employees	10	24
50-199 employees	12	21
200+ employees	14	22
TOTAL	106	259

$$\chi^2 = \underline{14.22331}$$

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1)(c-1)$ , and as a result  $df = (6-1)(2-1) = 5$  within 5% significance for the year 2005 and 5% significance for the year 1997 respectively as shown in the table below:

**Table 3**

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	11.632	5%	5	11.070	Reject the $H_0$
1997	14.233	5%	5	11.070	Reject the $H_0$

For that reason, the 2005 data show that there is a difference between the calculated value and the critical value. Therefore the null hypothesis was rejected and the study concluded that at 95% confidence interval, the firm size distributions within the ICT industrial clusters were significantly different from the rest of Scotland. It is essential to note that in this industrial sector, the Edinburgh and Glasgow industrial clusters were combined. The Information and Communication Technology (ICT) industrial sector is made up of three sub-sectors, namely: manufacture of computers and other information processing, manufacture of electronic valves and tubes and other components, manufacture of instruments and appliances for measuring. Here the figures in 2005 show that there is a difference between the way the establishments are distributed in the industrial clusters and outwith the industrial clusters. The evidence for this industrial sector shows that more large establishments are crammed into the industrial clusters than are located outwith the industrial

clusters for the reason that industrial clusters are determined by critical mass, among other factors. In fact, there is a higher number of large establishments operating inside the industrial clusters than outwith the industrial clusters. The reason for this difference could be that most small firms must have moved out of the industrial clusters because co-operation among establishments becomes less important in the maturity stage than was the case in the initial stages of the industrial cluster’s life cycle. In addition, collaboration on sophisticated high-level services such as research and development or product development is considerably lower, resulting in low level of regional ‘embeddedness’ and interaction between MNCs and small firms. What this means is that small firms disappear as competition intensifies at the expense of cooperation, and hence the dominance of large establishments within the ICT industrial sector because they are less financially constrained than small establishments.

**Financial Services Industrial Sector**

**Table 4: 2005 Data**

SIZEBAND	EGDM&L	REST OF SCOTLAND
1-4 employees	696	959
5-10 employees	399	636
11-24 employees	272	427
25-49 employees	126	156
50-99 employees	67	70
100-199 employees	56	28
200+ employees	60	21
Total	1,676	2,297

$\chi^2 = 66.35812$

**Table 5: 1997 Data**

SIZEBAND	EGDM & L	REST OF SCOTLAND
1-4 employees	726	651
5-10 employees	796	857
11-24 employees	549	469
25-49 employees	204	142
50-99 employees	82	55
100-199 employees	59	10
200-749 employees	39	2
750+ employees	25	2
TOTAL	2,480	2,188

$\chi^2 = 98.95536$

**NOTE: EGDM & L represents Edinburgh, Glasgow, Dunfermline, and Motherwell & Lanark**

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1) (c-1)$ , and as a result  $df = (7-1) (8-1) (2-1) = 6$  and 7 within 5% significance for the year 2005 and 5% significance for the year 1997 respectively as shown in the table below:

**Table 6**

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	66.358	5%	6	12.592	Reject the Ho
1997	98.955	5%	7	14.067	Reject the Ho

At 95 % confidence interval, there is enough statistical evidence to conclude that the firm size distribution within the industrial clusters in the Financial Services sector and the rest of Scotland was significantly different in 1997 and in 2005. For example, there are fewer establishments in industrial clusters than there were in 1997. In fact, there are more small establishments outside the clusters in 2005 than was the case in 1997. Overall, there are 3,973 firms in the whole sector as compared to 4,668 in 1997. Generally, a higher number of establishments are now located in the rest of Scotland than inside the clusters, and the majority of these establishments outwith the clusters are small establishments. The reason for the presence of more establishments in 1997 could be due to cooperation when the sector was still developing, while the figures are the opposite in 2005 due to a lack of cooperation among firms. Other factors may include the distribution of branches of firms established in industrial clusters all over Scotland, and the fact that the sector has reached the developed stage of cluster development. It is important to note that the financial services sector comprises of the following seven sub-sectors: other monetary intermediation; other credit granting; other financial intermediation not elsewhere classified; life insurance, security broking and fund management; non-life insurance; activities auxiliary to insurance; and pension funding. All these sub-sectors coalesced to form one sector, and later one cluster. This sector is dominated mainly by the other credit granting sub-sector, and consists of four clusters, namely Edinburgh, Glasgow, Dunfermline, and Motherwell & Lanark. According to Pandit and Cook (2005), the financial services sector is dominated by the Bank of Scotland; Royal Bank of Scotland; Clydesdale Bank; Lloyds TSB; Dunfermline Building Society; Standard Life; Scottish Equitable Life; Scottish Widows; Morgan Stanley; Noble; Grossart; Aviva; and Direct Line. These are the leading financial firms in this industrial sector.

### Biotechnology Industrial Sector

**Table 7: 2005 Data**

SIZEBAND	EDINBURGH & DUNDEE	REST OF SCOTLAND
1-4 employees	58	145
5-10 employees	16	37
11-24 employees	17	24
25-99 employees	17	14
100+ employees	12	10
TOTAL	120	230

$$\chi^2 = \underline{14.09449}$$

**Table 8: 1997 Data**

SIZEBAND	EDINBURGH & DUNDEE	REST OF SCOTLAND
1-4 employees	41	73
5-24 employees	16	35
25-49 employees	9	11
50+ employees	16	8
TOTAL	82	127

$$\chi^2 = \underline{9.687668}$$

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1)(c-1)$ , and as a result  $df = (5-1)(4-1) = 4$  and 3 within 5% significance for the year 2005 and 5% significance for the year 1997 respectively as shown in the table below:

Table 9

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	14.094	5%	4	9.488	Reject the Ho
1997	9.688	5%	3	7.815	Reject the Ho

The results show that there is enough statistical evidence to conclude that in the biotechnology sector the distribution of firm sizes in Scottish industrial clusters is significantly different from the distribution in the rest of Scotland in both 1997 and 2005. The biotechnology industrial sector consists of research and experimental development in natural science, and research and experimental development in social science. There are two clusters, one in Edinburgh and one in Dundee. The number of establishments operating inside the industrial clusters as compared to those operating in the rest of Scotland is low in both years, and there are consistently fewer establishments within the industrial clusters than in the rest of Scotland. The most remarkable observation arising from this study is that there is a rise in the number of establishments in the whole sector from 209 in 1997 to 350 in 2005. This trend is contrary to what is happening to other sectors such as ICT and the financial services sector. Another extraordinary fact that has been observed in this study is that large establishments within the clusters dominate in this sector, rather than small establishments. In both years the tables show that more small establishments are operating outside the clusters than within them, contrary to what has been previously suggested by Cooke (2003).

As noted by Gordon and McCann (2005), innovation is significant in industrial clusters because it involves the successful implementation of a new product, service or process. This commercial success, it is suggested, comes as a result of the process of inter-firm learning and imitation, leading to rapid innovation, which in turn leads to fundamental changes in the nature of economic activity in industrial clusters. This is only possible if these large establishments with their vast resources share their rich 'soup' of skills, ideas, technologies and cultures, within which new compounds and forms of life can change and develop in a permissive environment, enabling unconventional initiatives to be brought to the market place, such as industrial clusters. The biotechnology industrial sector is characterised by the presence of large firms due to high financial requirements, time-consuming research and development processes, and high uncertainty regarding the success on the market due to new technological openings. The bottom line is that, the Scottish biotechnology clusters are still in the early stages, hence the dominance by large establishments, as small establishments cannot afford the frequent product and establishment failures that currently characterise the sector.

### Creative Industrial Sector

Table 10: 2005 Data

SIZEBAND	EDINBURGH	REST OF SCOTLAND
1-4 employees	287	1092
5-10 employees	26	83
11-24 employees	16	53
25-49 employees	13	34
50+ employees	11	40
TOTAL	353	1302

$$\chi^2 = 1.899836$$

**Table 11: 1997 Data**

SIZEBAND	EDINBURGH	REST OF SCOTLAND
1-4 employees	43	204
5-10 employees	9	32
11-24 employees	10	34
25+ employees	9	25
TOTAL	71	295

$$\chi^2 = 2.195586$$

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1)(c-1)$ , and as a result  $df = (5-1)(4-1) = 4$  and 3 within 5% significance for the year 2005 and 5 % significance for the year 1997 respectively as shown in the table below:

**Table 12**

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	1.899	5%	4	9.488	Accept the Ho
1997	2.196	5%	3	7.815	Accept the Ho

At 95 % confidence interval, the null hypothesis is not rejected and consequently the study concludes that the size distribution of firms within the industrial cluster is significantly the same as the size distribution of firms in the rest of Scotland in both 1997 and 2005. The creative industrial cluster encompasses the fields of motion picture projection, radio and television activities, operation of arts facilities and other entertainment activities. The subsectors that fall under the heading of Creative Industry include computer games and electronic entertainment, film, TV and radio, animation, graphic design, marketing and advertising, music, publishing, software and communications technologies, arts and cultural industries, architectural design and new media, all of which are clustered in Edinburgh rather than the rest of Scotland as suggested by Turok (2003). In fact, the Edinburgh cluster is the only noteworthy industrial cluster currently in existence in the whole sector in Scotland.

The figures above show that both small establishments and large establishments are concentrated in the industrial clusters but most of the establishments are still located outwith the Edinburgh industrial clusters, something that is indicated by the figures from 2005, which show that there is a rise in the establishments starting to crowd together in Edinburgh. This is possible because there has been a surge of establishments related to this industrial sector in recent years in Edinburgh, unlike Glasgow, Dundee, Aberdeen and Inverness, as suggested by Turok (2003). The Edinburgh creative industrial cluster is made up largely by those with specialist expertise such as writers, musicians, artists, designers and producers, to name but a few. Spatial proximity is fundamental in industrial clusters such as the creative sector since it fosters social interaction and trust, particularly in cities where institutions and infrastructures enable establishments in clusters to learn, compare, compete and collaborate. Dense local networks resulting from a concentration of establishments create a dynamic atmosphere that spurs innovation, lures talent, attracts investment and generates growth through a self-reinforcing endogenous process, as is being witnessed in Edinburgh. The creative industrial sector seems to be indigenous-



oriented because, as Turok (2003) suggests, it is dominated by several Scottish entrepreneurs who have created very successful national cinema chains. None have succeeded in production, however, due to the fact that small establishments do not have a magnet that enables them to pull in financial institutions as expected from clusters dominated by large firms, such as the biotechnology and ICT industrial clusters. Indeed, only large establishments such STV, BBC and Channel 4 have so far managed to produce films of high quality in Scotland.

### Oil and Gas Industrial Sector

**Table 13: 2005 Data**

SIZEBAND	ABERDEEN	REST OF SCOTLAND
1-4 employees	95	39
5-24 employees	27	4
25-99 employees	25	6
100 <sup>+</sup> employees	41	3
TOTAL	188	52

$$\chi^2 = \underline{11.5839}$$

**Table 14: 1997 Data**

SIZEBAND	ABERDEEN	REST OF SCOT
1-4 employees	112	36
5-24 employees	32	11
25-99 employees	36	5
100 <sup>+</sup> employees	35	2
TOTAL	215	54

$$\chi^2 = \underline{9.027522}$$

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1)(c-1)$ , and as a result  $df = (4-1)(2-1) = 3$  within 5% significance for the year 2005 and 5% significance for the year 1997 respectively as shown in the table below:

**Table 15**

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	11.584	5%	3	7.815	Reject the Ho
1997	9.028	5%	3	7.815	Reject the Ho

The results show that in the oil and gas industrial sector the distribution of firm sizes in Scottish industrial clusters is significantly different from the distribution in the rest of Scotland. The oil and gas industrial sector comprises of two sub-sectors, namely extraction of crude petroleum and natural gas, and service activities incidental to oil and gas extraction. Major establishments that are involved in this cluster are BP Shell, BP Amoco, ABB, Vetco, Gray Ltd (manufacturing specialist equipment), Dril-Quip (Europe) Ltd (drilling equipment), Babcocks (exploration equipment), as well as establishments more concerned with production of rigs and platforms, whilst Console Engineering UK and Kvaerner Oil and Gas Ltd are involved in manufacturing accommodation modules. These establishments are concentrated in and around Aberdeen and produce equipment almost exclusively for the oil and gas industry (Scottish Government, 2005). The presence of large firms in the cluster is also regarded as a symptom of a mature cluster as shown in Tables above.

## Mechanical Engineering Industrial Sector

**Table 16: 2005 Data**

SIZEBAND	ABERDEEN, BRECHIN & MONTROSE	REST OF SCOTLAND
1-4 employees	1616	3,007
5-10 employees	82	475
11-24 employees	45	259
25-49 employees	20	99
50-99 employees	12	41
100-199 employees	2	16
200+ employees	12	4
TOTAL	1789	3,901

$$\chi^2 = \underline{169.028}$$

**Table 17: 1997 Data**

SIZEBAND	ABERDEEN, BRECHIN & MONTROSE	REST OF SCOTLAND
1-4 employees	1,675	2,652
5-10 employees	83	448
11-24 employees	53	231
25-49 employees	15	71
50-99 employees	12	36
100+ employees	9	16
TOTAL	1,847	3,454

$$\chi^2 = \underline{161.1263}$$

Therefore, to calculate the critical value of  $\chi^2$  is  $df = (r-1)(c-1)$ , and as a result  $df = (7-1)(2-1) = 6$  and 5 within 5% significance for the year 2005 and 5% significance for the year 1997 as shown in the table below:

**Table 18**

YEAR	$\chi^2$ calculated	The level of significance	Degrees of freedom	$\chi^2$ critical	DECISION
2005	169.028	5%	6	12.592	Reject the Ho
1997	161.126	5%	5	11.070	Reject the Ho

The null hypothesis is rejected and therefore, at 95% confidence interval, the distribution of firm sizes in Scottish industrial clusters is significantly different from the distribution in the rest of Scotland in both 2005 and 1997. The mechanical engineering industrial sector has two sub-sectors, that is, architectural and engineering activities and related technology, and technical testing and analysis. The 2005 and 1997 tables confirm that there are more firms outside the industrial cluster than within it, while the 2005 table provides an idea of the rising number of establishments in the whole sector. At the same time, the number of establishments within the industrial cluster is on the decrease, a trend that is particularly noticeable in relation to small establishments in the clusters. In 2005, the number of small establishments diminished compared to the rest of Scotland, although the actual number of small establishments within the industrial

cluster is high compared to other sectors. The rise in large establishments and dwindling of small establishments in mechanical engineering is another testament to the importance of the presence and dominance of large establishments in an industrial cluster. The presence of universities, colleges and larger establishments in this industrial cluster suggest that these larger establishments are important to the development of industrial clusters, as small establishments cannot afford the costs involved in R and D. Wallsten (2004) suggests that the existence of these knowledge spill overs indicate that universities, colleges and venture capital are components in the virtual circle of high-tech agglomeration.

### **The Explanation for Firm Size Distribution within and out with Industrial Clusters in Scotland**

The results of the study show that in the ICT sector, financial sector, Biotechnology sector, Oil and Gas sector and Mechanical engineering, there is enough evidence to reject the null hypothesis. However, in the Creative industrial sector, the results fail to reject the null hypothesis because of a lack of evidence. This may be due to the fact that the cluster was started by local entrepreneurs who are living in different parts of the country and are interested in developing their own regions, or that the cluster is still in the introduction stage of development, whilst the ICT and Biotechnology industrial sector, for example, developed as a result of a lead or anchor firm (MNCs) or they have reached the maturity stage of development, hence the dominance by large establishments (Munyoro, 2017). Generally the study shows that small establishments tend to operate outside the industrial clusters rather than within them, which must support Hall's 1986 study suggesting that small establishments enter and exit clusters faster than large establishments. The most notable examples are the industrial clusters in the ICT industrial sector, which started with 106 establishments in 1997 yet had only 90 establishments by 2005. In fact, the literature suggest that small firms tended to benefit from MNCs at the embryonic stage, as this stage is characterised by high expenditures such as market research, test marketing and launch costs and possibly by financial losses, owing to the need for a great deal of money to attract distributors and build their inventories. In 2005, the figures showed that most small firms might have moved out of the industrial clusters due to a lack of co-operation among establishments as collaboration on sophisticated high-level services such as research and development or product development is considerably lower, resulting in a low level of regional 'embeddedness' and interaction between MNCs and small firms. What this means is that small firms disappear as competition intensifies at the expense of cooperation, hence the dominance within the ICT industrial sector of large firms that are less financially constrained than small establishments. In the literature, it is suggested that small establishments are active in the introduction and growth stages, especially the latter, but tend to die or continue to operate outside the cluster, for the simple reason that most of the positive externalities that attracted them will have disappeared by the time they reach the maturity stage (Munyoro, 2017). Once positive externalities such as knowledge spill-overs - which Glaeser et al (1992) view as the "engine of growth" because they stimulate economic growth - flow away, then small establishments tend to leave the industrial cluster or cease to operate. It is common knowledge that geographical proximity facilitates the transmission of ideas and once these ebbs away, then small establishments are bound to leave, for the simple reason that there will be no positive externalities available.

As observed by Pagano and Schivardi (2003), the study concerning ICT and Oil and Gas industrial sectors shows that innovation influences the movement of firms as well as their growth and size, hence the uneven firm size distribution within the industrial clusters and outwith the clusters. For example, as noted by Hall (1986), small firms which have slow or negative growth are also more likely to disappear from industrial clusters because they do not feel part of the cluster, due to their lack of contribution towards the innovation process and costs. Fuchs and Koch (2005) also suggest that small

firms with rapidly growing and successful operations do not last long, because in most cases they do not contribute a great deal when the clusters start to develop; instead, they rely mostly on large firms' innovation and are not able to continue imitating, since large firms will make it hard for small firms to get information for free. Therefore, because of the need to protect large firms in the industrial clusters from poaching, small firms are moved out of the industrial cluster by being denied access to positive externalities, which results in a decrease in the critical mass of small firms. Furthermore, Cabral and Mata (2003) suggest that foreign multinationals may be expected to be less financially constrained than domestic firms and can choose to set up at the most advantageous size, unlike domestic firms which are likely to enter an industrial cluster at a less than optimal size due to financial constraints.

Another important factor which was noted in this study is that some industrial sectors grow faster than others. Thus, the movement of establishments to and from clusters is intrinsically important in this study. The same applies to the size of establishments and the way establishments develop, because the growth of establishments is the main ingredient of economic growth and job creation. As noted by Hall (1986) and in this study, the actual dynamics of industrial sectors have an impact on the consequences of industrial concentration. The study shows that the speed at which some industrial sectors grow affects the way in which industrial clusters develop. What this means is that the faster the large establishments in the same industrial sector and geographical area are created, the faster they create the magnet effect that exerts a pull on other large establishments in the same industrial sector. This generally results in the concentration of establishments, especially the large ones, in one geographical area, and financial services is a good example of this. However, the study also seems to suggest that large establishments appear to attract other establishments into industrial clusters more so than small establishments, as is the case with Oil and Gas, for example. Large establishments are attracted into industrial clusters because of the presence of innovation, something that is seen as significant not only to those who wish to accelerate or maintain the rate of economic growth, but also to change the direction of economic advance, as high technology has proved in some advanced countries including USA, Japan, Germany and Sweden, to name but a few. In fact, innovation is the key driver of competitiveness and productivity nowadays, especially if it is geographically localised. As Pagano and Schivardi (2003) have noted, innovation influences the movement of establishments as well as their growth and size. It is suggested by Fields (2004) that the main reason for the concentration of large establishments, as this study shows, is to share costs on research and development (R and D), sourcing raw materials, production process and distribution. In this case, small establishments are seen as an offshoot of innovation and technology, whereby large establishments will use small establishments for outsourcing in order to reduce costs.

In Scotland, there are some suggestions that the concentration of large establishments in some industrial sectors such as ICT, Biotechnology and Oil and Gas might be due to foreign direct investment, because foreign establishments on average tend to be larger in size than domestic establishments, as discussed elsewhere in the literature and noted by Barrios et al (2005). As was also observed in Munyoro and Dewhurst (2010), most of the major establishments operating in the ICT industrial cluster are from the USA and Japan, which is partly as a result of the long-term relationship that exists between the UK and USA (Armstrong and Taylor, 2004). Cabral and Mata (2003) suggest that foreign multinationals may be expected to be less financially constrained than domestic establishments and can choose to set up at the most advantageous size, unlike domestic establishments which are likely to enter an industrial cluster at a less than optimal size due to financial constraints. As suggested by Barrios et al (2005), Scotland initially concentrated on promoting foreign

investment as the government realised that it takes considerably longer to develop locally based ICT establishments than to attract inward investment from establishments based overseas. This, then, suggests that foreign establishments have various ways of financing their operations, such as transferring capital from the parent company, something that is not feasible to indigenous establishments. The only negative side of this inward investment is the way in which establishments are distributed within and outwith the industrial clusters. The study shows that small establishments are operating outwith the industrial clusters whilst large establishments are operating within them, resulting in the latter benefiting from the positive externalities derived from industrial clustering.

The dominance in Scottish industrial clusters of large establishments might also be a result of mergers and acquisitions, whereby small establishments are incorporated into large establishments, the aim of which is to exploit economies of scale such as overcoming the barriers to growth that small establishments always face. For instance, the acquisition of suppliers of raw materials (upstream) and marketing (downstream) operations afford a reduction in transportation costs, employee development and R and D costs. Foreign firms often use this method when entering a market, but when they establish themselves they end up acquiring small establishments because they have the financial brute force to take over ownership thereof, as witnessed in this study and as noted by Johnson et al (2005). The positive side of the introduction of foreign-based establishments in Scottish industries, as suggested by Hood and Young in their 1982 and 1984 studies, is that they created employment and made it possible as well for local small establishments to learn from these larger establishments through the sharing of technological know-how. This was achieved by forming linkages within the local economy, thereby becoming deeply embedded, and enabling some of the local establishments to grow and compete in world markets, as argued by Armstrong and Taylor (2004). FDI, it is argued, brought management practices and skills which domestic establishments did not have but were able to acquire through observation and imitation, while the domestic establishments in turn helped foreign establishments by supplying them with high quality local inputs.

## CONCLUSIONS

The intention of this study was to discuss the key findings of the work on chi-squared test. The results of the chi-squared test show that in the ICT sector, financial sector, Biotechnology sector, Oil and Gas sector and Mechanical engineering there is enough evidence to reject the null hypothesis. This, then, suggests that the distribution of firm sizes in Scottish industrial clusters in five industrial sectors is significantly different from the distribution in the rest of Scotland. However, in the Creative industrial sector, the results fail to reject the null hypothesis because there is not enough evidence to do this, which suggests that the size distribution of firms within the Creative industrial cluster is significantly the same as the size distribution of firms in the rest of Scotland. In addition, the study shows that larger establishments dominate in industrial clusters in some sectors. This is attributed to the need for them to be located in close geographical proximity, enabling them to share knowledge and costs such as R and D expenses, and is contrary to previous studies which suggested that industrial clusters were developed in order to help small firms overcome barriers to growth. As already suggested elsewhere in the chapter, positive externalities such as sharing of costs emerged as the most important reason behind the clustering of high-tech establishments, especially larger establishments. The concentration of larger establishments in the same geographical area in some industrial sectors, such as Oil and Gas, demonstrates that these establishments tend to invest far more in innovation than small establishments. Nevertheless, despite being financially stable, it is clear from this study that larger establishments still need to share their costs as, for example, it is expensive to run R and D facilities, including the process of researching and developing technology.

## RECOMMENDATIONS

This study shows that there are chances of reproducing industrial cluster success in other parts of the regions, especially rural-based regions. There is also a belief that the development of industrial clusters could be an effective tool for sustained development and growth in rural based regions, a goal that will benefit every region in Scotland and beyond.

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