



**HAL**  
open science

# MEASURING THE DECLINE OF A MARSHALLIAN INDUSTRIAL DISTRICT: THE BIRMINGHAM JEWELLERY QUARTER

Lisa de Propris, Luciana Lazzeretti

► **To cite this version:**

Lisa de Propris, Luciana Lazzeretti. MEASURING THE DECLINE OF A MARSHALLIAN INDUSTRIAL DISTRICT: THE BIRMINGHAM JEWELLERY QUARTER. *Regional Studies*, 2009, 43 (09), pp.1135-1154. 10.1080/00343400802070894 . hal-00526545

**HAL Id: hal-00526545**

**<https://hal.science/hal-00526545>**

Submitted on 15 Oct 2010

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**MEASURING THE DECLINE OF A MARSHALLIAN INDUSTRIAL DISTRICT:  
THE BIRMINGHAM JEWELLERY QUARTER**

Journal:	<i>Regional Studies</i>
Manuscript ID:	CRES-2006-0307.R2
Manuscript Type:	Main Section
JEL codes:	L22 - Firm Organization, Market Structure: Markets vs. Hierarchies; Vertical Integration < L2 - Firm Objectives, Organization, and Behavior < L - Industrial Organization, N01 - Development of the Discipline: Historiographical; Sources; Methods < N0 - General < N - Economic History, O14 - Industrialization; Manufacturing; Service Industries; Tech Choice < O1 - Economic Development < O - Economic Development, Technological Change, and Growth
Keywords:	industrial district, firm demography, firm ecology, cluster lif cycle

SCHOLARONE™  
Manuscripts

1  
2  
3  
4  
5  
6 **MEASURING THE DECLINE OF A MARSHALLIAN INDUSTRIAL DISTRICT:**  
7  
8 **THE BIRMINGHAM JEWELLERY QUARTER**

9  
10  
11 Lisa De Propris<sup>♠</sup> and Luciana Lazzeretti<sup>♦</sup>

12  
13 ♠ The University of Birmingham

14 ♦ The University of Florence

15  
16  
17 First received: December 2006

18 Accepted: December 2007

19  
20  
21 **ABSTRACT**

22  
23 This paper presents the findings of a study on the decline of a typical Marshallian industrial  
24 district: the Birmingham Jewellery Quarter (UK). The paper contributes to the current debate on  
25 clusters' life cycle, by presenting a multidisciplinary methodology that combines historical and  
26 economic analyses with demography and organisational ecology models. We seek to explore the  
27 patterns of firms' birth and mortality rates, as well as firm density across branches of production  
28 activities to measure and understand the decline of the Jewellery Quarter over the last decades.  
29  
30

31  
32  
33 Key words: Marshallian industrial districts, cluster life cycle and ecological theory.

34 JEL classification: L23, N80 and O14

35  
36 Mesurer le déclin d'un district industriel du type Marshall:  
37 le quartier de la bijouterie à Birmingham.

38  
39  
40  
41 De Propris & Lazzeretti

42  
43  
44 Cet article cherche à présenter les résultats provenant d'une étude au sujet du déclin d'un district  
45 industriel du type Marshall: à savoir, le quartier de la bijouterie à Birmingham (R-U). L'article  
46 contribue au débat actuel sur le cycle de vie des regroupements d'entreprises, en présentant une  
47 méthodologie pluridisciplinaire qui associe des analyses chronologiques et économiques aux  
48 modèles de la démographie et de l'écologie organisationnelle. On cherche à étudier la structure des  
49 taux de naissance et de décès des entreprises, ainsi que la densité du parc d'entreprises à travers des  
50 branches d'activités de production afin de mesurer et comprendre le déclin du quartier de la  
51 bijouterie pendant les décennies récentes.  
52  
53

54  
55 Districts industriels du type Marshall / Cycle de vie des regroupements / Théorie écologique

56  
57  
58 Classement JEL: L23; N80; O14.

59  
60 **Messung des Niedergangs eines Marshallischen Industriedistrikts: das  
Juwelierviertel von Birmingham**

1  
2 Lisa De Propris and Luciana Lazzeretti  
3  
4

5  
6 ABSTRACT

7 In diesem Artikel werden die Ergebnisse einer Studie über den Niedergang eines  
8 typischen Marshallschen Industriedistrikts vorgestellt, nämlich des Jewelierviertels von  
9 Birmingham (GB). Der Artikel versteht sich als Beitrag zur aktuellen Debatte über den  
10 Lebenszyklus von Clustern; hierfür präsentieren wir eine multidisziplinäre Methodologie, in  
11 der historische und ökonomische Analysen mit demografischen und organisationellen  
12 Ökologiemodellen kombiniert werden. Wir untersuchen die Muster der Raten von  
13 Firmengründungen und -schließungen sowie die Firmendichte in verschiedenen Branchen  
14 der produzierenden Industrie, um den Niedergang des Jewelierviertels in den letzten  
15 Jahrzehnten zu messen und zu verstehen.  
16  
17

18  
19  
20  
21 Key words:

22 Marshallsche Industriedistrikte  
23 Lebenszyklus von Clustern  
24 Ökologische Theorie  
25

26  
27 JEL classification: L23, N80 and O14  
28

29 Medición del declive de un distrito industrial marshalliano: el Jewellery Quarter de  
30 Birmingham

31 Lisa De Propris and Luciana Lazzeretti  
32  
33

34  
35 ABSTRACT

36 En este artículo presentamos los resultados de un estudio sobre el declive de un  
37 distrito industrial marshalliano típico: el Jewellery Quarter (barrio de las joyas) en  
38 Birmingham (RU). Aquí contribuimos al debate actual sobre el ciclo de vida de las  
39 aglomeraciones presentando una metodología multidisciplinaria que combina los análisis  
40 históricos y económicos con los modelos demográficos y la ecología organizativa. Lo que  
41 pretendemos es analizar los patrones de tasas de nacimientos y mortalidad de las  
42 empresas, así como su densidad en todos los sectores de las actividades de producción  
43 para medir y entender el declive del Jewellery Quarter en las últimas décadas.  
44  
45  
46

47  
48 Key words:

49 Distritos industriales marshallianos  
50 Ciclo de vida de aglomeración y teoría ecológica  
51

52  
53 JEL classification: L23, N80 and O14  
54  
55

56 Contacting author: Dr. Lisa De Propris  
57 Birmingham Business School  
58 The University of Birmingham  
59 B15 2TT Birmingham  
60 Tel: 0121 414 6258  
E-mail: l.de\_propris@bham.ac.uk

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Co-author: [segreteria.lazzeretti@cce.unifi.it](mailto:segreteria.lazzeretti@cce.unifi.it)

(a) The authors gratefully acknowledge the financial support of the British Academy for the funding of this research (Grant No. SG-33827). The authors would also like to thank David Bailey, Gabi Dei Ottati, Marco Bellandi, Davide Parrilli and two anonymous referees for useful comments and suggestions. The usual disclaimers apply.

For Peer Review Only

## 1. Introduction

Over the last two decades, there has been a flourishing debate on the nature, structure and functioning of various forms of clustering and networking. However, contributions on the life cycle of local systems have been much fewer and have mainly tended to look at their emergence, growth, and decline/revival through either qualitative or quantitative analyses (see SWANN *et al.*, 1998; SCOTT, 2000; WOLFE and GERTLER, 2004; MASKELL, 2001 and BRESNAHAN *et al.*, 2001)..

This paper contributes to such a debate with a composite and multi-disciplinary methodology (HEDRON) that combines historical, economic and industrial analyses with demographic and ecological modelling. Demography and population ecology models (HANNAN and FREEMAN, 1989; CARROLL, 1984) were originally used to study variations in the organisational diversity of society and were only later applied to economics. Indeed the novelty of this methodology is to extend the application of firm demography and population ecology models to organisational forms like local production systems and, in particular, to industrial districts, as systems of co-located firms grouped in specific sectors and interlinked by complementarities and synergies. This paper presents an example of cross-fertilisation between industrial organisation and the organisation ecology models (BOONE and VAN WITTELOOSTULIJN, 1995), in fact it refers to a dynamic community approach centred on understanding populations' co-evolution (the latter being one the most interesting streams of the organisation ecology, see AMBURGEY and RAO,1996).

We apply such a methodology to study the decline of the Birmingham Jewellery Quarter in Birmingham (UK) from 1880 to today. The jewellery trade first appeared in Birmingham in the mid-eighteenth century and embedded itself in the vital and vibrant industrial atmosphere that the city had to offer being at the heart of the British Industrial Revolution. The Birmingham Jewellery Quarter grew in size and its organisation of production started to become networked and complex until 1860s when it presented the characteristics of a typical Marshallian industrial district (MARSHALL, 1895 and 1919).<sup>1</sup> Its fortunes, however, depended on external factors such as fashion, input prices and availability, and technological changes, as well as major historical events like the two World Wars.

In our paper, we seek to explore whether and how the patterns of firms' and sectors' birth and mortality rates explain the decline of the Birmingham Jewellery Quarter as an exemplary case of a typical Marshallian industrial district. In this study we investigate the decline rather than the 'death' of a Marshallian industrial district, since the Quarter is still the home of a concentration of jewellery manufacturing and retailing activities within a tight web of streets. Despite a shrinking of the manufacturing base, it can be argued that the Quarter is transforming itself in an 'urban creative district' with a move towards small batch/customised and more design-intensive productions,

1  
2 The paper will proceed as follows. Section 2 will present an historical background of the  
3 Birmingham Jewellery Quarter. Section 3 will introduce the current debate on the theories of the  
4 life cycle of local production systems and present the composite methodology applied in the final  
5 part of the paper. After describing the data collection in Section 4, the findings of the application  
6 are detailed in Section 5. Finally, some final remarks will conclude the paper.  
7  
8  
9

## 10 11 12 13 **2. Historical background of the Birmingham Jewellery Quarter**

14 By the mid 19<sup>th</sup> century, Birmingham had become one of the most industrialised towns in  
15 England. The local economy heavily relied on the metal industries –iron, brass, guns, buttons, pins  
16 and toys- together with jewellery and some minor industries such as coin minting. In this vibrant  
17 context, the Birmingham Jewellery Quarter established itself in a triangle of roads around St.  
18 Paul’s Square, to the north of Birmingham; where it still is today (see Figure 1).  
19  
20  
21  
22

23 Several factors combined to contribute to the development of the jewellery industry in  
24 Birmingham, including: (a) the decline of the buckle, toys and button trades provided skilled labour  
25 that could easily be employed in the jewellery-making; (b) gold discoveries in California (1848),  
26 Colorado (1860), Idaho (1861) and Australia (1860s), silver discoveries in Nevada (mid 1850), and  
27 turquoise, amethyst and diamond stone discoveries in Australia and South Africa (1850) made  
28 jewellery more affordable and popular; (c) Birmingham was then at the centre of regional and  
29 national transport networks -including roads, canals and trains- that provided cheap and easy access  
30 to raw materials (e.g. coal) and ensured that commodities could easily and quickly reach consumers  
31 across the country and overseas; and finally, (d) local and national demand for jewellery was  
32 booming as trade with the colonies made British middle-classes wealthier and personal adornment  
33 more fashionable (TIMMINS, 1866).  
34  
35  
36  
37  
38  
39  
40  
41  
42

43 It was so that by the mid-1800, Birmingham became the centre of Britain jewellery trade and  
44 in 1880 the Birmingham Jewellery Quarter was well established and at its peak. DE PROPRIS and  
45 LAZZERETTI (2007) provide evidence that at this time it had all the characteristics of a mature  
46 Marshallian industrial district (see Section 5.1 for a discussion on this).  
47  
48  
49

50 World War I damaged the Jewellery Quarter quite badly, although jewellery trade picked up  
51 again afterwards. The 1920s and 1930s recessions, and, shortly after, WWII hit the Quarter so  
52 deeply that it never really recovered. In the post-war period (1940s and 1950s), the jewellery trade  
53 struggled with weak demand due to the post-war purchase tax<sup>2</sup>, and with labour shortages as other  
54 growing industries in Birmingham attracted labour by offering higher salaries. The decision taken  
55 decades before to focus on mass production and, to some extent, on the bottom-end of the jewellery  
56 market became a serious weakness in the 1970s to 1980s. Tough competition from low cost  
57 countries like China, India and Thailand eroded domestic markets; and, at the same time, the export  
58  
59  
60

1  
2 of creative and high quality output from Italy flooded the European market, reducing the possibility  
3 for Birmingham jewellers to penetrate foreign markets. Overall, the post-War period was  
4 characterised by a slow but steady decline, caused by firms' inability to adjust to production  
5 changes that were filtering down from technological change, as well as their inability to respond to  
6 a new competitive environment. The lack of competitiveness of the manufacturing base in the  
7 1970s (SMITH, 1990) led to its erosion and consequently to a steady employment fall (see Figure 2).  
8  
9

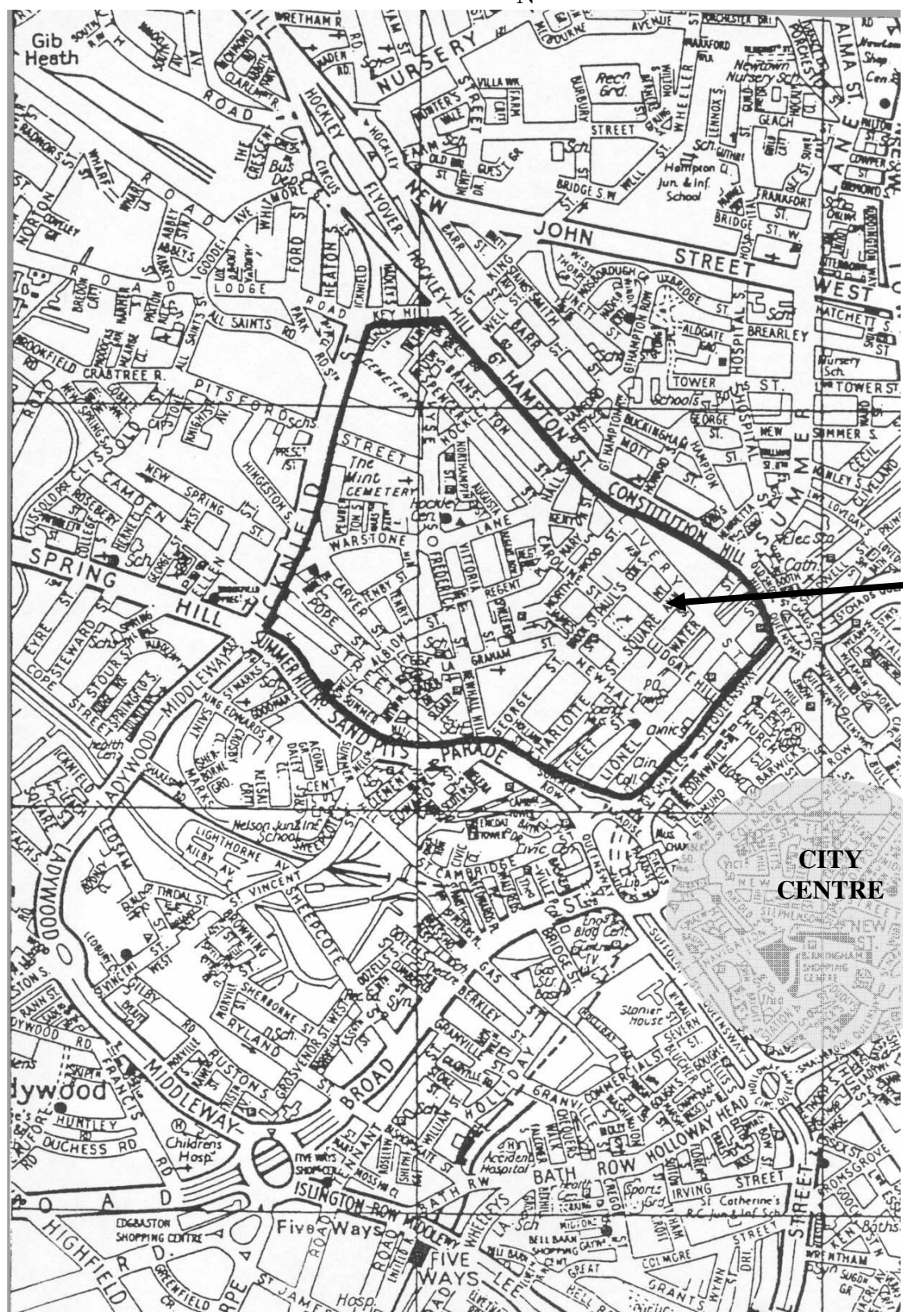
10  
11 A major change in the composition of activities in the Quarter was the opening of shops in the  
12 1970s. Workshops and small firms started to sell their goods directly to customers (rather than  
13 through a networks of salesmen), virtually setting up counters in their front rooms. This paved the  
14 way for the Quarter to become not only a manufacturing but also a retailing centre. Indeed, from  
15 1970 to 2005, the proportion of retailing related activities in the Quarter rose from less than 5% to  
16 more than 40% of the total jewellery activities (DE PROPRIS and WEI, 2007). This move has been  
17 accompanied by an effort to distance itself from mass production and cheap jewellery by  
18 increasingly aiming at high-value added segments of demand with designer jewellery, and unique  
19 and customised pieces. This is reflected in Advantage West Midlands having classified the  
20 jewellery industry in the Quarter as a high-value added consumer cluster (see also BIRMINGHAM  
21 AND SOLIHULL ECONOMIC FORUM, 2005). A shift from manufacturing to design-intensive, creative  
22 jewellery would still mean a re-structuring for the industry but could offer better prospects for its  
23 long term sustainability. At the same time, there is serious pressure to open the area to mixed  
24 development (office space and residential) in a push to turn the Quarter into the Birmingham's  
25 'Greenwich Village'.  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

FIGURE 1 THE BIRMINGHAM JEWELLERY QUARTER

N



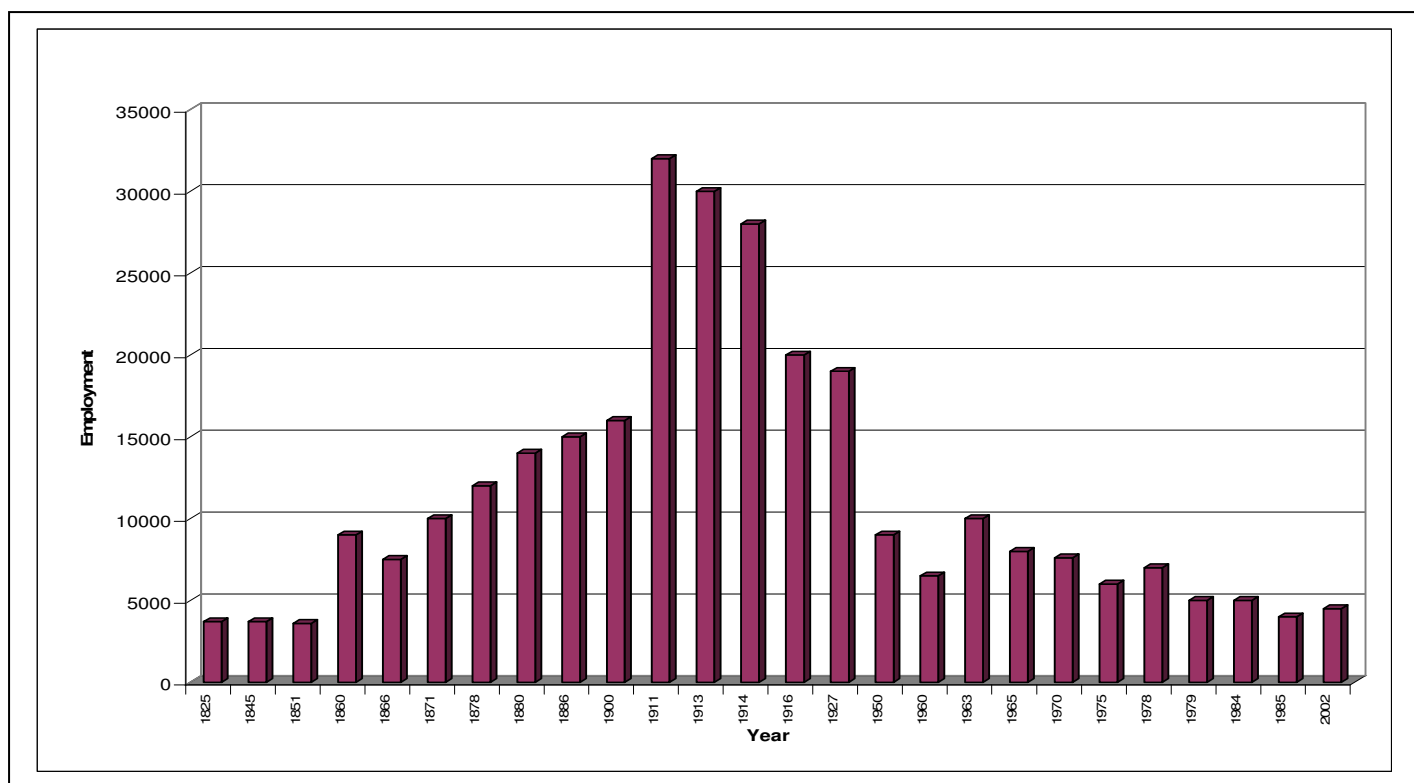
Birmingham Jewellery Quarter

CITY CENTRE

S

Source: SMITH (1987).

**FIGURE 2 EMPLOYMENT FIGURES IN THE BIRMINGHAM JEWELLERY QUARTER**



Sources: DE PROPRIS AND LAZZERETTI (2007).

Review Only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

### 3. A Multidisciplinary Methodology to study the Birmingham Jewellery Quarter: HEDRON

#### 3.1 Current Debate

The ever growing literature on local production systems has studied the nature, structure and functioning of various forms of clustering and networking, creating some ‘chaos’<sup>3</sup> in their definitions and labelling. For this reason, it is worth clarifying that we will refer to local production systems to include all forms of complex geographical agglomeration of firms in specialised activities. These include complex systems like industrial districts (BECATTINI 1990, 2004), clusters (PORTER, 1998; SCOTT 1998), innovative *milieux* (CAMAGNI, 1991), and urban clusters (CUMBERS and MACKINNON, 2004). In particular, in this paper we study a typical ‘Marshallian’ industrial district as we consider a localised trade in Birmingham already established at the turn at the 20<sup>th</sup> century.

The debate on the evolution of local production systems is, on the other hand, much thinner. It has included qualitative case studies that have tended to investigate the (endogenous and exogenous) factors and conditions that impact on local systems’ evolution; or quantitative studies that have measured the evolution of local systems by evaluating changes in their size and structure (i.e. firms’ entry and exit; emergence or disappearance of specific tasks/functions).

In particular, qualitative studies have analysed in detail the life cycle of local production systems as a sequence of stages: emergence, growth, maturity, decline and revival. Those contributions that actually focus on the emergence of local production systems consider firms’ location choices, as well as the advantages of agglomeration and proximity (e.g. agglomeration and external economies, and urbanisation externalities) (BAPTISTA, 1998). In contrast, SCOTT (1998)’s market-led theory of ‘clustering’ stresses the role of demand in determining the structure of the inter-firm division of labour, in that it is market diversification and uncertainty that determine the vertical and horizontal production segmentation internal to the cluster. In other words, demand determines the structure of production within clusters and impacts on their growth and/or decline. SCOTT appreciates that after a certain point co-location can engender agglomeration dis-economies reducing firms’ benefits from proximity. In the same line of argument, drawing on a case study on the Silicon Valley cluster, BRESNAHAN *et al* (2001) argue that clusters’ emergence and growth can depend on technology and market opportunities, as well as on increasing returns and external economies. Similarly, GLASMEIER (1994) analyses the evolution of the Hong Kong watch industry as it had to adjust to global market forces and technological shocks. Somewhat differently, MASKELL (2001)’s theory on cluster dynamics pivots around the role of knowledge, whereby the emergence and the growth of clusters can be driven by processes of knowledge creation and accumulation in specific localities. In line with this, BELUSSI (1996) looks at the evolution of Italian

1  
2 industrial districts also considering the dynamics of the intra-district division of labour and the  
3 processes of knowledge accumulation. The path dependency of knowledge accumulation, however,  
4 means that clusters can face phases of stagnation or decline if they become over-specialised, locked  
5 into obsolete practices and/or closed to external knowledge flows (BATHELT *et al* 2002), unless they  
6 find ways of coordinating adjustment actions (see DEI OTTATI (2003) for a study of the evolution of  
7 the Prato Textile district by means of a Hirschmanian voice-exit approach).  
8  
9

10  
11 In summary, qualitative studies have analysed the evolution of local production systems by  
12 considering their historical development as well as the economic and 'industrial' factors that have  
13 influenced them, such as demand, innovation, and knowledge.  
14  
15

16  
17 On the other hand, quantitative studies have aimed at measuring the structural changes that  
18 local production systems experience over time as a reflection of their evolution. In KLEPPER and  
19 GRADY (1990), the emergence of new industries is measured in terms of firm entry and growth.  
20 Interestingly, they introduce the idea that the rate of firm entry can explain the formation of a new  
21 industry, and suggest that firms' entries peak at a certain point and then stabilise. The main limit of  
22 their study is that it considers industries which do not have a geographical dimension. STABER  
23 (2001) applies the population ecology model to study the decline of the textile district in Baden-  
24 Wurttemberg, looking, in particular, at how the tension between competition and legitimation  
25 processes impact on firms' births and deaths.  
26  
27

28  
29 More interestingly, given the remit of our paper, SWANN (1998) presents a quantitative model  
30 that studies cluster life cycle by looking at new firm formation, incumbent firm growth and cross-  
31 sector effects. In particular, a life cycle comprises four stages: (a) a cluster emerges when new firms  
32 are attracted to the cluster by 'entry attracting' factors, thus contributing to creating a critical mass  
33 of firms; (b) a cluster experiences its 'take off' stage when agglomeration economies kick in and  
34 incumbent firms grow either in the same sector or in different sectors ('growth promoting' factors);  
35 (c) clusters reach maturity when the entry of new firms peaks and the cluster is no longer attractive  
36 for new entrants; this is due to congestion especially in mono-sector highly specialised clusters; and  
37 finally, (d) clusters reach saturation when no new firms are attracted to it. SWANN (1998) suggests a  
38 model where firms' entry and growth are measured and linked to cluster's sector composition, size  
39 and life cycle. In so doing, SWANN's model introduces a new methodology to measure and quantify  
40 clusters life cycle with more intangible and contextual variables at the core of the qualitative models  
41 becoming fixed.  
42  
43

44  
45 Our contribution is framed in this debate and presents a composite and multidisciplinary  
46 methodology that integrates an historical analysis of the evolution of the local system with an  
47 analysis of its economic and industrial structure. In addition, in order to measure such evolution we  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2 draw on firm demography and organisational ecology models which rely on concepts like firms'  
3 entry and exit, and firm and sector density.  
4

### 7 **3.2 The HEDRON Methodology**

8  
9 The HEDRON (Historical, Economic, Demographic, ecological, and economic)  
10 methodology is a composite and multi-disciplinary methodology developed by LAZZERETTI (2006).  
11 It analyses local production systems as 'communities of organisations', by de-composing their  
12 internal structure at different levels, namely firm, sector and overall system, in order to trace their  
13 evolutionary dynamics.  
14  
15  
16  
17

18 The methodology comprises five levels of analysis. The *historical and economic analyses* aim  
19 at identifying the key historical stages of the phenomenon under study, through a survey of the  
20 historical and economic literature and a recount of key events, shocks, moments and turning  
21 points. The aim is to identify a valid start date for the demographic and ecological analyses, as well  
22 as crucial dates and critical periods. Following from these, the *industrial analysis* should provide a  
23 picture of the productive filière and how it has changed over time. In this analysis, firstly, firms are  
24 grouped in sectors, specialisations or trades, then the latter are linked up according to their position  
25 along the value chain; finally, the evolution of such groups is explored by means of data or  
26 anecdotal information. The *demographic and ecological analyses* are meant to measure the life  
27 cycle of the local system under study by means of quantitative data, namely firms' births and  
28 deaths.  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38

#### 39 *Demography and Organisational ecology models*

40  
41  
42 The organisational ecology theory draws on ecological and evolutionary models and it has  
43 emerged as an approach to study long term organisational changes, focusing on organisational  
44 diversity and the processes that influence the evolution of organisational forms (SINGH and  
45 LUMSDEN, 1990; HANNAN and FREEMAN, 1987, 1989).  
46  
47  
48

49 Ecological theories contemplate three levels of analysis. Firstly, organisation demography  
50 models analyse the evolution of organisations. Secondly, population ecology models assume  
51 organisation inertia and look at the evolution of and interactions between populations of  
52 organisations, the latter being defined as meaningful groupings of organisations sharing some form  
53 of similarity (HANNAN and FREEMAN, 1977). Finally, community ecology models study "*the*  
54 *collection of populations that live together in some region*" (CARROLL, 1984:72). In particular,  
55 population ecology looks at populations' vitality flows (births and deaths) as determined by the  
56  
57  
58  
59  
60

1  
2 interactions between co-existing populations, and their impact on the evolution of the organisational  
3 community as a whole (BAUM and SINGH, 1994; HANNAN and FREEMAN, 1987).

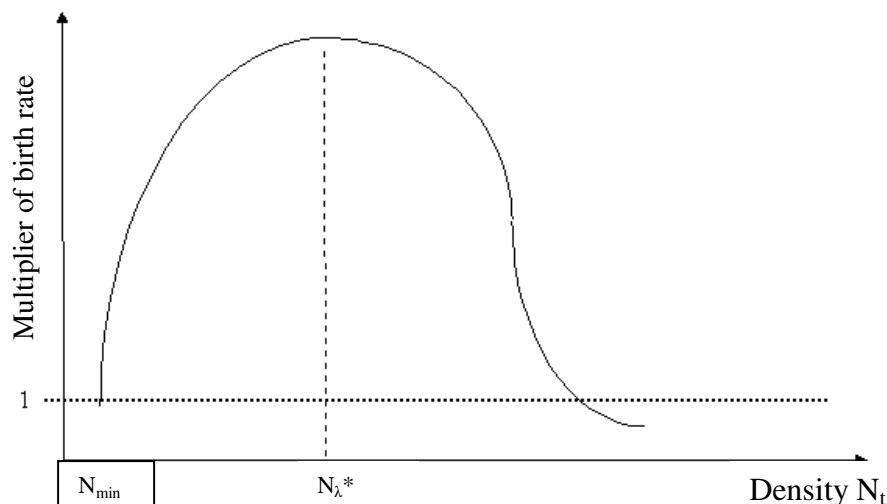
4  
5 In our application of the organisational ecology model, organisations correspond to firms,  
6 populations of organisations to groups of firms, such as sectors or specialisations,<sup>4</sup> and the  
7 community of populations coincides with the collection of inter-related sectors that characterises the  
8 district.  
9

10  
11  
12 There is a wide variety of approaches to organisational evolution (SINGH and LUMSDEN,  
13 1990), but the most appropriate to investigate long-term organisational evolution is the density  
14 dependence. Two pioneering empirical studies by HANNAN and FREEMAN (1987, 1988) try to  
15 explain changes in populations' density (i.e. the number of organisations within a population) and  
16 empirically show that there is a relationship between population density and vitality rates (birth and  
17 mortality rates), and that therefore population density influences the evolution of the population  
18 itself. In other words, the density dependence approach relates the evolution of populations of  
19 organisations to their density. In particular, the evolution of populations and communities is driven  
20 by two main processes: competition and legitimation. The legitimation process takes place when a  
21 population or a community consolidates its position by strengthening the set of social, political and  
22 economic aspects that consistently characterise its organisational form. Legitimation affects the  
23 population's vitality rates, so that as birth rates increase more than mortality rates, firm density rises  
24 (HANNAN and FREEMAN, 1988). More formally, the legitimation coefficient increases with density  
25 at a decreasing rate. On the other hand, the competition process is triggered by the entry of an  
26 additional competitor in the population or community so as to induce a process of crowding out due  
27 to fighting over a limited set of resource; during the competition process mortality rates increase  
28 and the total number of firms decreases. Therefore, the competition coefficient increases with  
29 density at an increasing rate.  
30  
31

32  
33 Both competition and legitimisation processes impact on populations' vitality rates, in that  
34 populations' births and mortality rates vary with populations' density rates. In particular, the  
35 relationship between the birth rate (or mortality rate) and the density of a population is represented  
36 by the rate multiplier coefficient, which is defined as the ratio of the birth rate (or mortality rate) to  
37 the rate calculated for the lowest observed population density. In particular, at low density,  
38 increasing birth rates have a positive effect on the density due to the legitimation process. When the  
39 density of a population peaks, it means that it has reached its carrying capacity. After this point, as  
40 competition forces become stronger, the mortality rate increases and the population's density falls.  
41 Therefore, HANNAN and FREEMAN (1987, 1988) find that the relationship between the density of a  
42 population and the multiplier of its founding rate to be non-monotonic and shaped as an inverse U  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

(Figure 3).<sup>5</sup> In economic terms, a population's carrying capacity reflects the fact that a population (an industry) has reached its critical mass and its growth is peaking.

**FIGURE 3: DENSITY DEPENDENCE THEORY: MULTIPLIER OF BIRTH RATE**



Source: HANNAN and CARROLL (1992)

Sociologists and organisation theorists have mainly applied the organisation ecology theory to the study of industries (including brewing, computer and automotive industries) and trade unions (for a review see for instance, CARROLL and HANNAN, 2004), where industries are considered as populations and firms are the basic organisational forms. Recent contributions have applied the organisation ecology theory to industrial economics. In particular, the organisation demography model has been used to study the evolution of organisational forms such as industries, clusters and industrial districts. More generally, VAN WISSEN (2004) suggests applying the organisation demography model to study the life cycle of industries and firm agglomeration. FORTIS and MAGGIONI (2002) adopt a population ecology model to study the impact of both agglomeration economies and diseconomy in the evolution of some Italian industrial districts. More specifically, for instance, BELUSSI and SCARPEL (2002) analyse the evolutionary pattern of the women's footwear industrial district in Italy (Brenta) by means of an historical and demographical analyses. Similarly, a community-based organisation ecological model (density dependence) is applied to the Prato textile industrial district (LAZZERETTI and STORAI, 2003), and the Arezzo jewellery district (LAZZERETTI, 2006) in Italy. With a different focus, GRAHBER (2001) looks at the relevance of competition processes (rivalry) in the transformation of the British advertising industry as an organisational form; likewise, STABER (2001) adopts the organisation ecology theory to study inter-firm relations, mortality rates (competition processes) and spatial proximity in a declining industrial district in Baden-Württemberg. Drawing from these, it has emerged that industrial districts can be

1  
2 studied as complex organisational forms comprising organisations (firms) and populations (sectors)  
3 that taken together constitute a community (the district) of organisational forms.  
4

5  
6 In this paper, we study the evolution of the Birmingham Jewellery Quarter as a collection of  
7 populations related to the jewellery trade in a specific geographical area; in other words we consider  
8 a typical MASHALLIAN industrial district as a community of populations. The possibility to study, in  
9 particular, industrial districts with the organisation ecology model is endorsed by FOSTER (1993),  
10 who argues that MARSHALL (1895) in the *Principles* was “*acutely aware of the socio-economic*  
11 *relevance of organisational analogies drawn from biology*” (FOSTER, 1993:987). In fact, self-  
12 organisation and the organisation ecology model can describe the growth of systems that are non-  
13 linearly density dependent. Indeed, MARSHALL’s law of increasing returns can be seen as mirroring  
14 the density dependence of the organisation ecology theorised by HANNAN and FREEMAN.  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24

#### 25 **4. Data Collection and Unit of Analysis**

26  
27 We apply the HEDRON methodology to study the decline of the Birmingham Jewellery  
28 Quarter. Since 1860, the Quarter has appeared as a localised jewellery industry situated within a  
29 tight web of streets just off Birmingham’s city centre.<sup>6</sup> Since its geographical borders have been the  
30 object of extensive research in the past (SMITH, 1989, WISE, 1950 and GILBERT, 1972) and this has  
31 generated a broad consensus on its location, we decided to collect data on jewellery and jewellery-  
32 related firms in the 45 streets located within such borders.  
33  
34  
35  
36

37  
38 We have collated a database of firms from 1880 to 1973. Due to data constraints, we had to  
39 start our analysis at a time when the BJQ was already established. The database contains records of  
40 11,400 firms that have existed for any period of time over the 90 years covered by the data: 513  
41 firms were still operating in 1973.  
42  
43  
44

45  
46 The database has been collated by transferring data and information from three historical  
47 Birmingham Directories (Kelly’s Directory of Birmingham, Hulley’s Directory of Birmingham and  
48 Houghton’s Directory of Birmingham) into a spreadsheet.<sup>7</sup>  
49

50  
51 The database comprises a set of information to trace the life and death of firms. For each firm  
52 we have recorded the name, address, production activity and ownership status.<sup>8</sup> As we are  
53 analysing the production activities of artisans, craftsmen and workshops, the activity or  
54 specialisation associated with the firm and the name of the owner (or craftsman) are both crucially  
55 important to identify the firm itself.  
56  
57

58  
59 Reliance on the above Directories presented some problems due to the degree of imprecision  
60 in the actual data collection at the time. For instance, in our study we are interested in tracing firms’  
births and deaths, and for this it is crucially important to ascertain whether the disappearance of a



1  
2 firm from the directory for one year corresponded to an actual death or just an overlook. To offset  
3 this level of imprecision, we considered a firm as surviving if it was missing for one year, but  
4 reappeared the year after. In the same way, the wording used to define production activities tended  
5 to vary, so we decided to classify production activities into broader categories which were also  
6 more manageable from a statistical point of view (for instance, a 'gold wedding ring maker' was  
7 classified as 'gold ring maker' so that we kept the information about the material –that is very  
8 important for the jewellery industry- and the degree of specialisation). Even with this 'rounding' we  
9 identified more than 350 specialisations.<sup>9</sup>

10  
11 Since we are analysing the production activities of artisans, craftsmen and workshops, both  
12 the activity/specialisation of the firm and the name of the owner (or craftsman) are crucially  
13 important to identify the firm itself. A firm's founding is defined as the year when it first appeared  
14 in the directory (new name-new activity-new address) or the year it first appeared with a new name  
15 or a new activity (same address-same activity-new name or same address-same name-new activity).  
16 With this, we are able to compute for each year the firms' birth rate within the Quarter. A firm's  
17 death is defined as the year the firm disappeared from the directory. Given the lack of further  
18 information, we assumed that if a firm disappeared from the Jewellery Quarter, it was, for the  
19 purpose of our study, dead. The reason for this is that we are interested in analysing the evolution of  
20 the production activities within the area as an organisational form, i.e. a community of populations.  
21 A firm's survival corresponds to the presence of the same firm (same address-same name-same  
22 activity or same name-same activity-change of address still within the Quarter) year after year.

## 41 **5. The Decline of a Marshallian Industrial District: the Birmingham Jewellery Quarter**

42 In this section, we present the results of the application of the HEDRON methodology to the  
43 BJQ, by carrying out historical, economic, industrial, demographic and ecological analyses of its  
44 evolution from 1880 to today.

### 51 **5.1 The Historical Analysis**

52 Jewellery craftsmanship in Birmingham can be recorded as early as 1308 (MASON, 1998), but  
53 the first agglomeration of jewellers emerged around 1750-70 in the Newhall and the Colmore  
54 Estates. In the eighteenth century, the Jewellery Quarter went through its pre-district stage thanks to  
55 the skilled labour made available from the declining buckle, toys and button trades. Important  
56 landmarks in the establishment of the Quarter were the 1766 opening of Soho Manufactory at Soho  
57 by Matthew Boulton as the first large factory in Birmingham; in 1773, the establishment of the  
58 Birmingham Assay Office for silver goods only and in 1794, the setting up of the Birmingham  
59  
60

1  
2 Mint.<sup>10</sup> Until 1800, the Birmingham Jewellery Quarter was an emerging agglomeration of jewellers  
3 with production activities not yet clearly identified and integrated (a pre-district stage).  
4

5 Gold and silver discoveries, as well as technological change contributed to its growth  
6 throughout the 1800s, so that, by 1860, the Jewellery Quarter was a fully formed Marshallian  
7 industrial district. Not only was it a district at the time of Marshall's writing (MARSHALL, 1895), but  
8 its production organisation and social context were intertwined and structured like MARSHALL'S  
9 industrial districts. The Jewellery Quarter was, in fact, an agglomeration of small firms specialised  
10 in the jewellery industry; production was segmented but perfectly integrated along production  
11 stages. The combination of an external division of labour with specialisation generated external  
12 economies that resulted in innovation and learning. In addition, production activities were imbued  
13 in a thick social environment given by the presence of a living population, strong personal and  
14 social relationships and the existence of political, social and production related institutions.<sup>11</sup>  
15  
16  
17  
18  
19  
20  
21  
22

23 From 1880 to 1920 the Quarter experienced a consistent period of expansion, which was  
24 abruptly interrupted by WWI when most of the jewellers turned to manufacturing munitions or went  
25 into the army. In this period, although the jewellery trade remained mostly craft-based, some  
26 manufacturing activities such as electroplating and stamping forced firms to grow in size due to the  
27 increasing use of mechanisation associated with mass production and standardisation (HOPKINS,  
28 2001), as well as the introduction of gas-powered machinery (ALLEN, 1929). These larger factories  
29 included the Argent Centre, Bates & Fallows and Elkington, which for instance in 1887 had about  
30 2000 employees. Over this period, production activities in the Birmingham Jewellery Quarter  
31 started also to diversify as new branches of trade were introduced such as silver decorated objects,  
32 ornamental medals, cups, sport related articles, shields, as well as jewellery decorated with diamond  
33 and other precious stones. The expansion and the multiplication of jewellery activities coincided  
34 with the search for workshop premises. So, if until then there was an overlap between living and  
35 working communities, by the early twentieth century space was reallocated from residential to  
36 trading purposes, so that the Quarter became mainly a business area.  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

FIGURE 4 HISTORICAL AND ECONOMIC ANALYSIS

Period	District Structure	Technological and Market Shocks
1750-70 Pre-District Birth	First agglomeration of artisan and hand-craft jewellers following the decline of the buckle & toy trades providing skilled labour	Output market: Local
1770-1800 Pre-District Embryonic stage	-Institutional set-up (Assay Office and B'ham Mint) -Geographical expansion -Creation of production segmentation and specialisation	Output market: Local
1800-60 District Growth	-Max geographical expansion of the BJQ -Completion of the process of production segmentation and integration -Consolidation of legal framework (gold hallmarking)	1840-60 Input market shocks: -gold discoveries in California, Colorado, Idaho and Australia -silver discoveries in Nevada -stone discoveries in Australia and South Africa  Innovation shocks: electroplating, electro-nickel plating and electro-galvanising
1860-1915 District Maturity	-Co-existence of small jewellery craftsmen and large electroplating and stamping firms -Diversification of production activities with new branches of trade -Consolidation of institutional setting (British Jewellery & Silversmith Assoc. and jewellery schools) -Residential population driven out by demand for industrial premises  There were two short depressions (1875-78 and 1880-86) in a period of stable growth. The number of businesses in the BJQ peak in 1914 followed by stagnation during WW1	Input market shocks: -gold discoveries in South Africa  Output market: -domestic markets, trade with colonies and competition from American and Germans jewellers -new markets in Latin America -introduction of mail order -development of retailing within the BJQ  Innovation shocks: introduction of gas supply to burners; stamping machinery and magneto-electro machinery
1915-45 District Recession	WWI and WWII drove labour out of the trade and diverted trade to ammunition production.  Employment increased again after WWI but the 1929 crisis stalled the recovery	Drop in demand
1950-60 Contraction	Employment keeps falling due to: - post-war purchase tax - labour shortages as labour was attracted by other growing industries in Birmingham	Demand picks up again
1970-90 Stagnation	- Manufacturing activities survive - Employment stable but in slight decline - Opening of shops and retailing activities	- Penetration of low cost imports coming from China, India & Thailand - tough competition from Italy at the top end of the market
Today Revival?	<ul style="list-style-type: none"> <li>Focus on designer-makers and marketing activities to re-position the jewellery industry as a creative industry (with policy support)</li> <li>More and better space for retailing and marketing</li> <li>Stronger presence at international trade fairs/aggressive export strategy</li> <li>Regeneration of the area as a mixed-use quarter (office, flats and catering)</li> <li>Re-positioning of the BJQ as part of the Birmingham City Centre</li> <li>The BJQ is being transformed into a Creative Urban District</li> </ul>	

Source: this figure draws on DE PROPRIS and LAZZERETTI (2007).

Between 1880 and 1910 a process of institutional thickening also took place: in 1887, the *Birmingham Jewellers and Silversmiths Association* was set up; in 1880 the *School of Art* was opened, followed in 1890 by the *Jewellery School*, and in 1901 the *Vittoria School of Jewellery and Silversmiths*, finally in 1908-09 the *University of Birmingham* began to organise a course on jewellery management.<sup>12</sup>

In 1911 employment reached its maximum with more than 30,000 workers. WWI stalled its growth. After the war the jewellery trade resumed its activities, but the 1920s and 1930s recessions, and, shortly after, WWII hit the Quarter so badly that it never really recovered.

The historical analysis would seem to suggest that by 1920 the Quarter was a mature and dynamic industrial district, aware of being a complex and efficient production system whereby

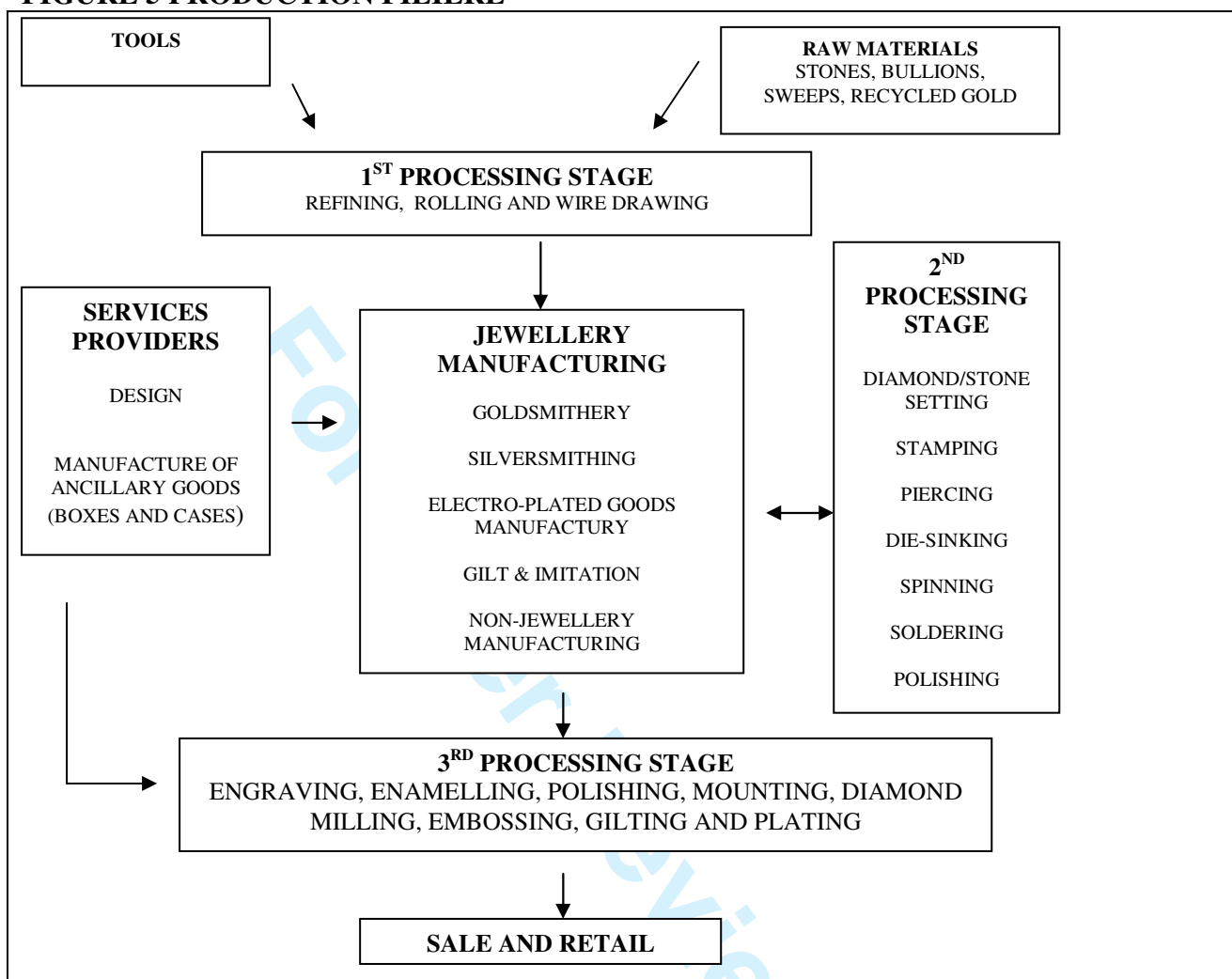
1  
2 shared benefits could be reaped by collective actions as the process of institutional thickening  
3 around the industry demonstrates.  
4

## 5.2 The Economic and Industrial Analyses

5  
6  
7  
8  
9  
10 Drawing on the information gathered in our database, we find that the Birmingham Jewellery  
11 Quarter has been an agglomeration of firms, artisans and workshops specialised in jewellery related  
12 activities. We find 357 task specialisations overall<sup>13</sup>, each corresponding to a stage in the production  
13 process and to a firm/craftsman. SMITH (1989) refers to the external division of labour in the  
14 Quarter as firms being “*effectively linked by a human conveyor belt which carried small but*  
15 *valuable articles from one workshop to another around nearby streets and within factories*” (p.96).  
16 LAZZERETTI and STORAI (2003) argue that specialisation variety is evidence of the maturity for a  
17 local production system; therefore, the highly segmented division of labour especially for the  
18 manufacturing and hand-craft tasks is proof of the Jewellery Quarter’s maturity at the time (for an  
19 historical comment, see GLEDHILL, 1988).  
20  
21

22 In particular, from the historical records gathered in our database, we are able to reconstruct  
23 the production chain or *filière* of the jewellery trade that we summarise in Figure 5 below. The main  
24 production stages are: tools; raw materials; jewellery manufacturing (including goldsmithing,  
25 silversmithing, electroplating, gilding and non-jewellery manufacturing); first, second and third  
26 processing stages; and sales and retail. Some categories contain several specialisations. The arrows  
27 help identify the direction of the production links between stages.  
28

29 Tool manufacturing and the supply of raw materials feed into the first processing stage,  
30 whose output is then passed onto jewellery manufacturing. Jewellery manufacturing is also linked  
31 to production services and the second processing stage. The former supplies manufacturers with  
32 non-jewellery services such as boxes and design, while the latter provides extremely specialised  
33 hand skills that jewellery manufacturers contract out. The final stage of production before sales and  
34 retail is the third processing stage which includes skills that are at the very end of the jewellery  
35 production process, such as polishing and engraving.  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60**FIGURE 5 PRODUCTION FILIÈRE**

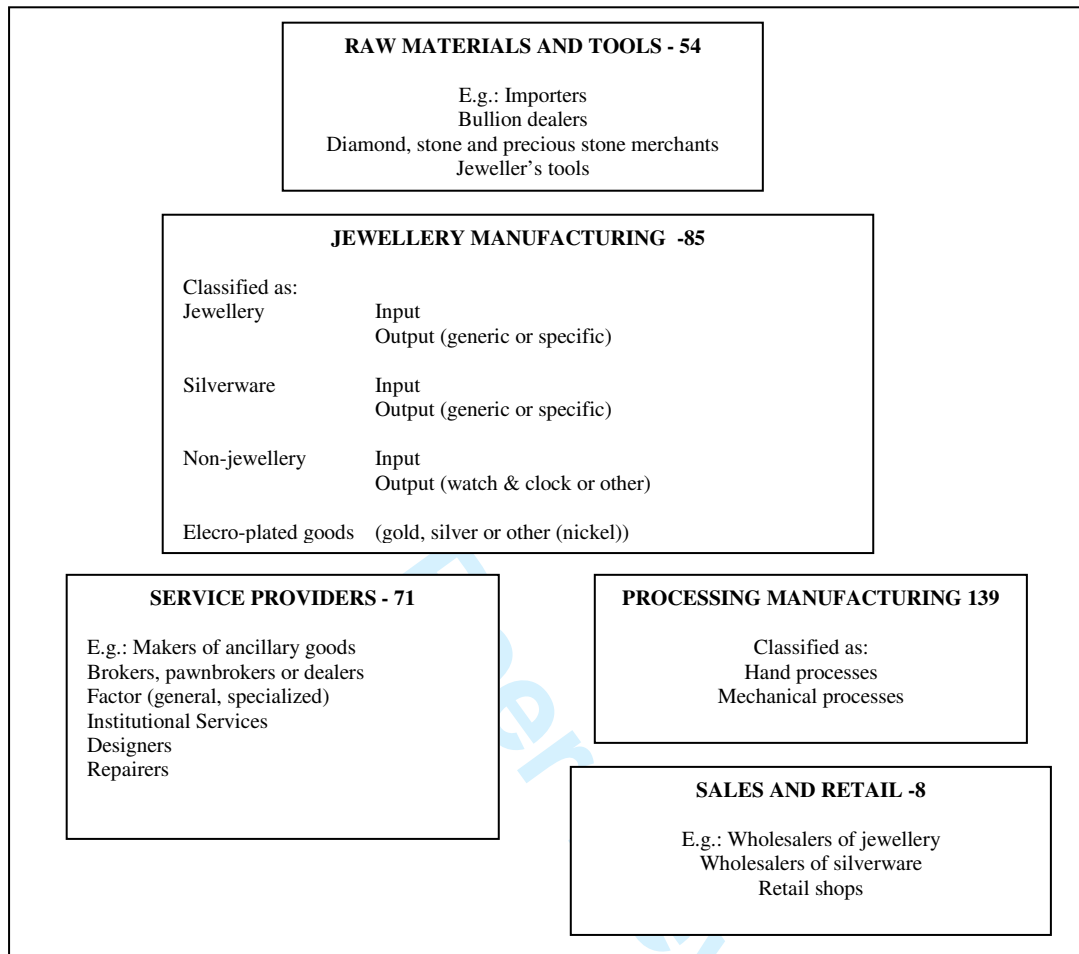
Source: this figure draws on DE PROPRIS and LAZZERETTI (2007).

In order to apply the organisational ecology model, we have translated the 357 specialisations into populations. The evident difficulty in tracing their individual evolution has been overcome by the definition of *multi-populations* as meaningful groups of populations. In particular, we identify five multi-populations on the basis of the production stages just described: (a) Raw materials and tools; (b) Jewellery manufacturing; (c) Processing manufacturing; (d) Service providers; and (e) Sales and retailing (see Figure 6 below).

The largest multi-population is 'processing manufacturing', followed by 'jewellery manufacturing' (as it will be shown later these are actually the core populations that have survived throughout the evolution of the Jewellery Quarter).

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**FIGURE 6 MULTI-POPULATIONS**



Note: The numbers in the boxes for each multi-population correspond to the number of populations, i.e. specialisations/sectors, in each of them.

Source: Authors' calculation drawing on the database.

### 5.3 The Demographical Analysis

The main steps of a demographic analysis are the calculation of firms' births and deaths, and firm total density first at the community level (in our case at the level of the industrial district, the BJQ), and then at the multi-population level. This enables us to measure the evolution of the district in terms of its structure and size. This is the first step in a rigorous analysis of the district's life cycle and it therefore integrates and expands on the historical and economic analysis already presented.

The Birmingham Jewellery Quarter's firm density measures the number of firms ( $N_t$ ) actually operating in the Quarter each year. It is calculated as the sum of firm density ( $N_t$ ) at  $t-1$  and the difference between firms' births ( $B_t$ ) and deaths ( $D_t$ ) at time  $t$ , as described below

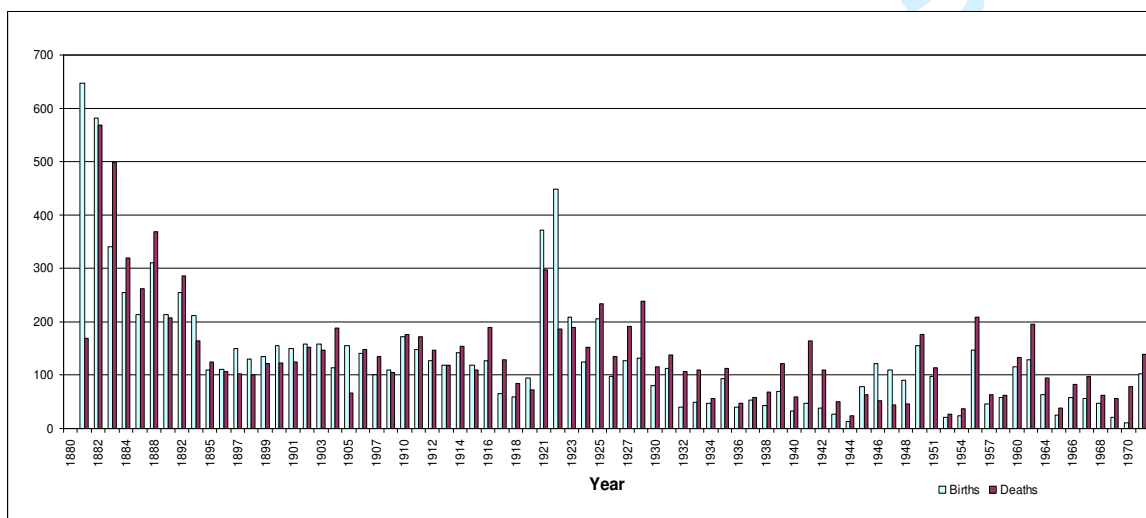
$$N_t = N_{t-1} + (B_t - D_t), \text{ with } t = 1881, 1882, \dots, 1973.$$

In particular, to calculate firm density in 1885, for instance, we need to calculate the firm density in 1884, and then add to it the difference between firms' births and deaths in 1885 (Figure 8).

In order to compute firms' births and deaths, we calculate how many firms were born and how many firms deceased each year (in other words, firms that have appeared and disappeared from the directories). In particular, between 1880 and 1973, we registered 11,400 new firms<sup>14</sup> and more than 10,500 deceased firms (Figure 7).

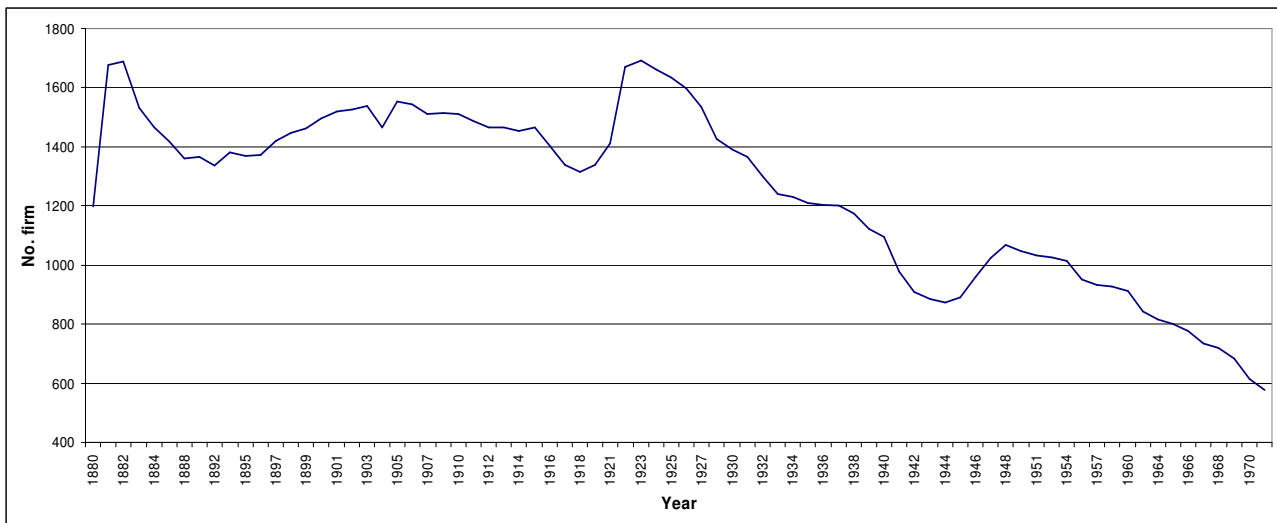
As expected, firms' birth rates are very high in 1880-81 as this is the beginning of our database. Nevertheless, the high birth rate in the early 1880s is in line with the historical analysis that found that the Jewellery Quarter was well established and at its zenith. From 1890 to World War I the internal dynamics of the district show signs of 'vitality', as the fluctuations of the birth and death rates show. As deaths outnumber births, firm density drops between 1915 and 1919 (WWI). In fact, firms' deaths peak in 1915 without a corresponding number of births. This period is followed by a period of great recovery as firm density increases by 20 per cent. Indeed, in 1923 the number of firms peaks with 1691 firms. Between the two World Wars the recovery is dampened by the 1929 crisis, as firm density decreases over time and, at the same time, fluctuations in deaths and births peter out. After WWI, the district moved from its consolidation phase to a phase of decline that the limited recovery in the 1920s could not stop, as shown by the steady drop in firm density. WWII again shakes the district and firm density plummets. The small recovery in the period 1945-48 (in this period firm births outnumber firm deaths) does not take the district back to the size it had in the 1920s and the continuous decline of firm density thereafter validates the hypothesis that it was in continuous 'free fall'. In 1973 there are only 494 firms against 1650 in 1881 (see Figure 8).

**FIGURE 7 FIRMS' BIRTHS AND DEATHS IN THE BJQ AS A COMMUNITY (1880-1973)**



Source: Authors' calculation.

**FIGURE 8 FIRM DENSITY IN THE BJQ AS A COMMUNITY (1880-1973)**



Source: De Propris and Lazzeretti (2007).

For the multi-population analysis, we compute firms' births and deaths for each of these five multi-populations and draw density functions. In order to calculate the density of each multi-population, we use the following formula:

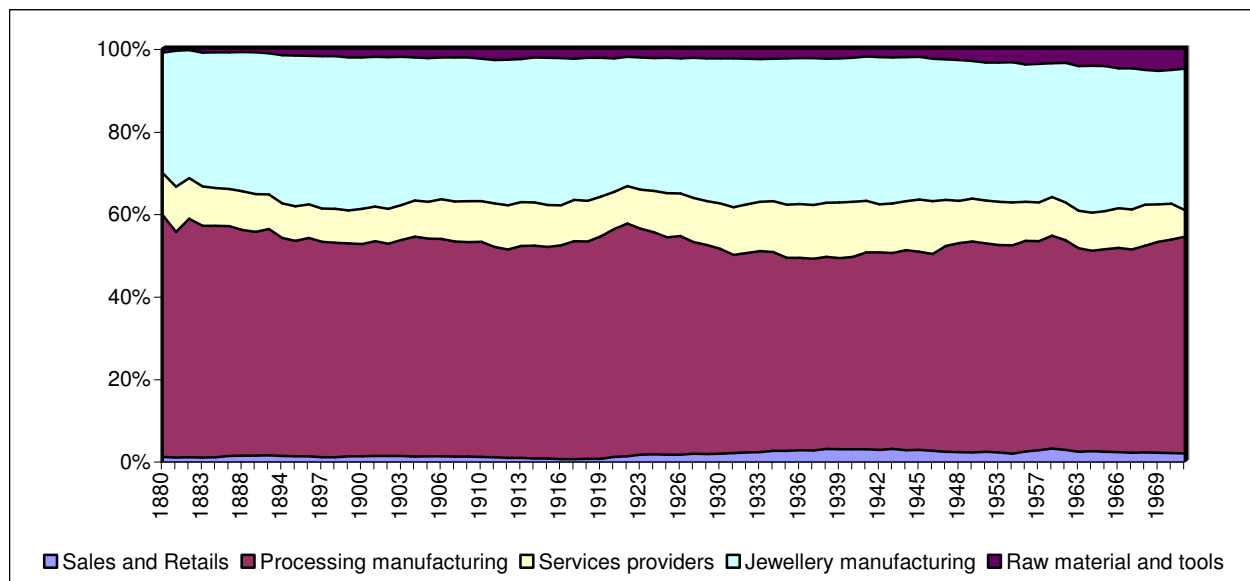
$$N_{ij} = N_{(t-1)j} + (B_{ij} - D_{ij}),$$

where  $t$  = years and  $j = 1, \dots, 5$  multi-populations

Figure 9 below summarises the evolution of the shares of the five multi-populations, providing a picture of the composition of activities. It is worth noticing that the two major groups over the entire period remain 'process manufacturing' and 'jewellery manufacturing'. It must be noted that these include all the key manufacturing stages of the external division of labour through which semi-finished and finished goods pass. This is evidence that throughout the period of study the Quarter has remained heavily manufacturing and handcraft-based as a traditional Marshallian industrial district. The other three groups look small in size, especially the 'sales and retail' and 'raw materials and tools'. This is not a surprise given that the historical analysis has shown that, for instance, shops started opening only in the 1970s.



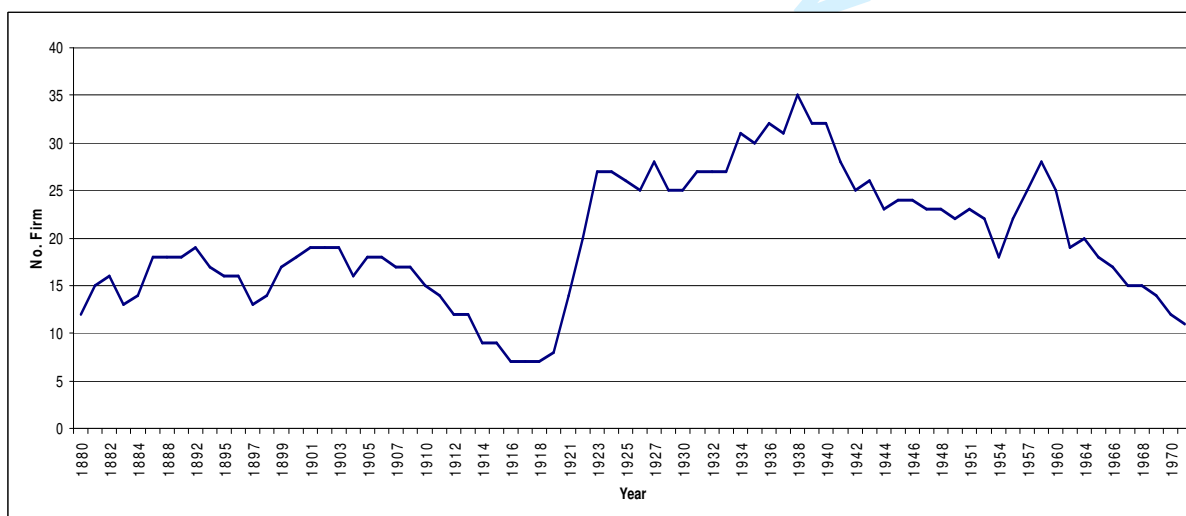
**FIGURE 9 FIRM DENSITY IN THE FIVE MULTI-POPULATIONS (1880-1973)**



Source: Authors' calculation.

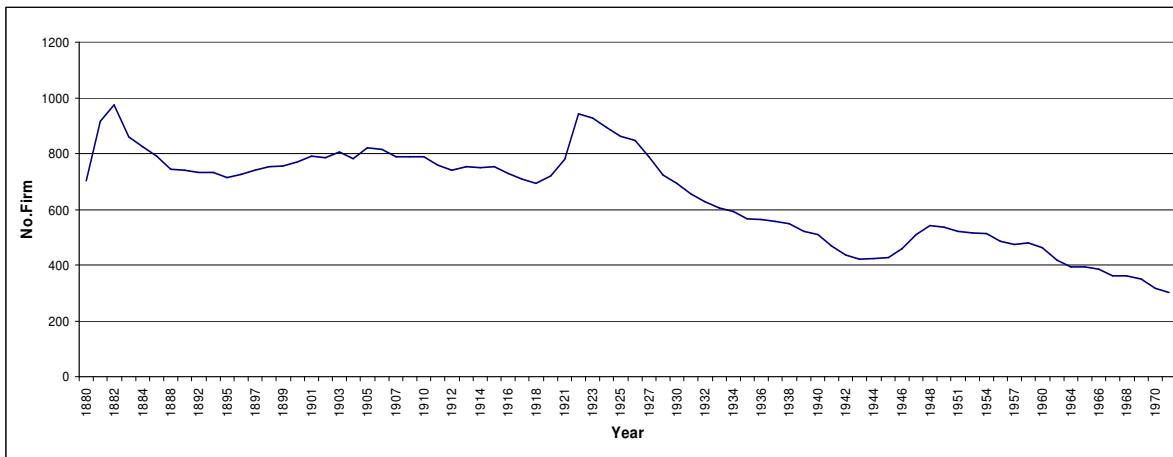
The trend of each individual multi-population is shown in Figures 10-14. From these it emerges that the number of firms in the 'jewellery manufacturing', 'service providers' and 'process manufacturing' categories shows signs of a slow decline over the entire period with visible dips for the two World Wars. On the other hand, the trend of the 'sales and retail' category is the only one that has increased after WWII and remained high in the post-war period.

**FIGURE 10 FIRM DENSITY OF THE RAW MATERIALS AND TOOLS MULTI-POPULATION**



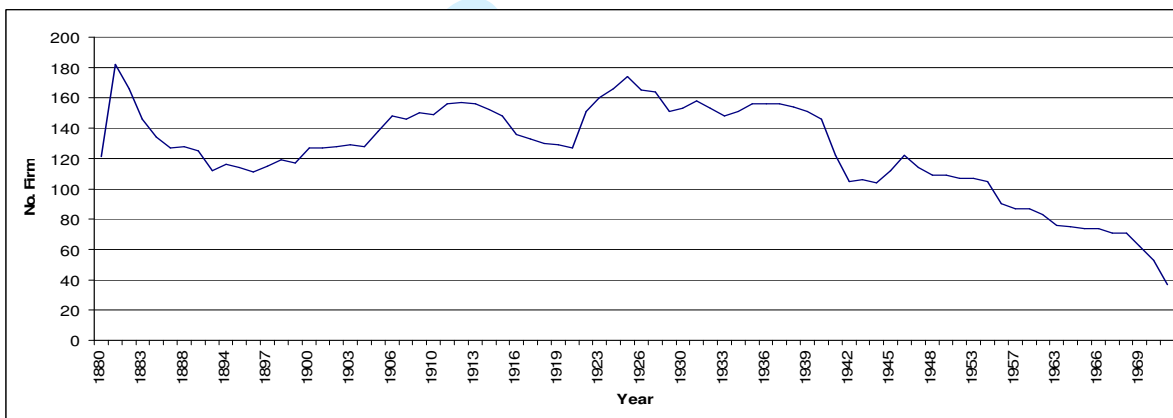
Source: Authors' calculation.

**FIGURE 11 FIRM DENSITY OF THE JEWELLERY MANUFACTURING MULTI-POPULATION**



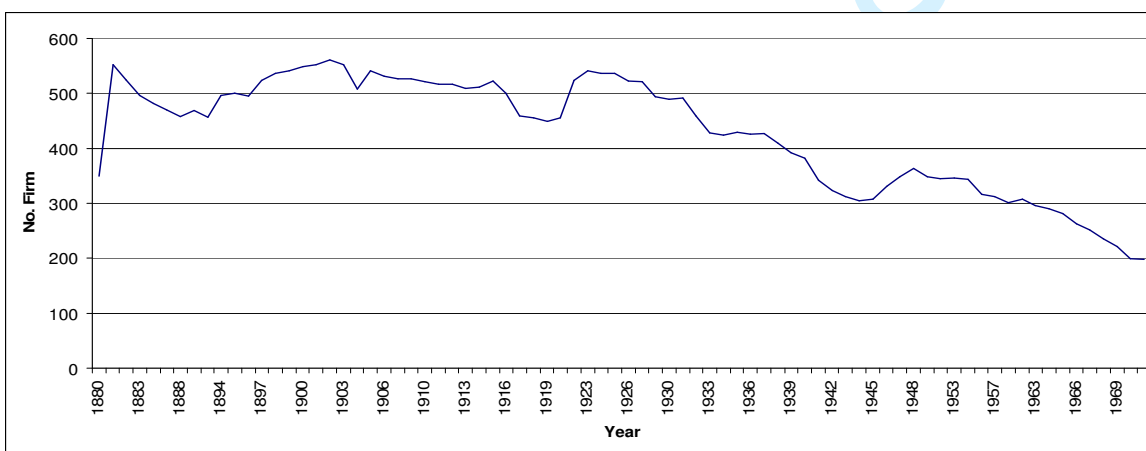
Source: Authors' calculation.

**FIGURE 12 FIRM DENSITY OF THE SERVICE PROVIDERS MULTI-POPULATION**

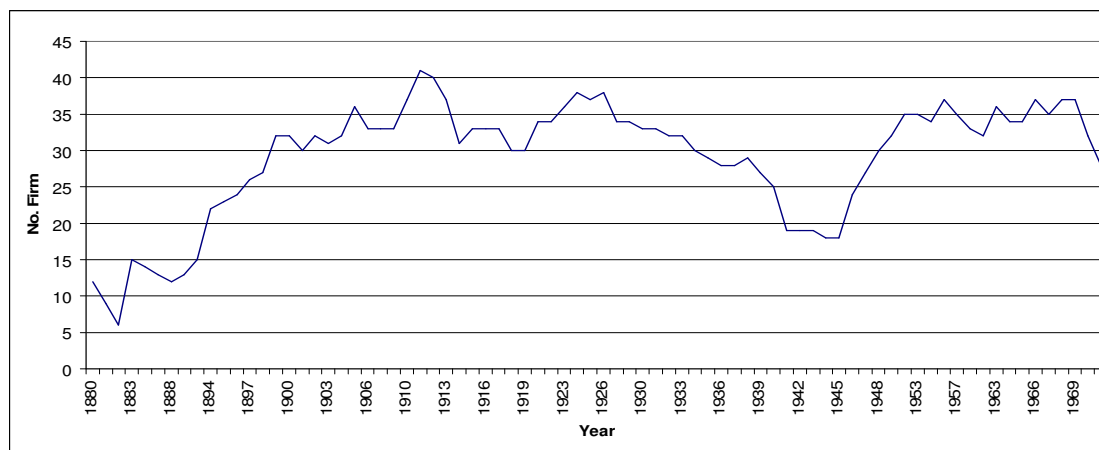


Source: Authors' calculation.

**FIGURE 13 FIRM DENSITY OF THE PROCESSING MANUFACTURING MULTI-POPULATION**



Source: Authors' calculation.

**FIGURE 14 FIRM DENSITY OF THE SALES AND RETAIL MULTI-POPULATION**

Source: Authors' calculation.

#### 5.4 The Ecological Analysis

In Section 5.3, we find that the firm density curve for the Birmingham Jewellery Quarter is non-monotonic and inversely U-shaped (Figure 8). Given that this is a necessary condition for the ecological analysis to be applied, it is possible to proceed to the ecological analysis.

The contribution of ecological modelling is to measure the life cycle of the industrial district by means of a density dependence model. A methodology to study social or economic events is the event history analysis. In particular, event history analysis uses different methodologies according to the kind of event being studied. When analysing firm foundings, the most frequently models are those that consider recurring events as outcomes of stochastic processes. As a consequence, the cumulative number of events observed up to a certain point in time  $t$  is assumed to be a non-decreasing stochastic process (ALLISON, 1988).

Firm births are considered discrete events,<sup>15</sup> therefore the stochastic process – and the underlying distribution of probability - must be discrete. In particular, Poisson processes are used (HANNAN and FREEMAN, 1989; LOMI and LEVIE, 1995). A Poisson process assumes that the rate of arrival is independent from the history of previous arrivals and from the current state of the system. Among other things, this assumption implies that the order of events does not affect the arrival rate. If the rate at which new organisations are born in a population follows a Poisson process, then the rate is a time-independent constant. Since we know the number of births per year, the model of the founding rate is based on a simple Poisson model:<sup>16</sup>

$$\lambda(t) = \exp(\theta_1 N_t + \theta_2 N_t^2 + \delta_1 B_{t-1} + \delta_2 D_t) \exp(\sum \phi_i X_{it})$$

1  
2  
3  
4 where  $\lambda(t)$  is the multiplier of the founding rate, the two orders of density are represented by  $N_t$   
5 and  $N_t^2$ ;  $X_{it}$  is the vector of covariates, and the vector of parameters  $\phi_i$  correspond to the period  
6 variables.<sup>17</sup> Finally, we introduce in the model, firms' births at  $t-1$  ( $B_{t-1}$ ) and firms' deaths ( $D_t$ ) in  
7 order to ascertain how they influence the density rate over the period.<sup>18</sup>  
8  
9  
10  
11  
12

### 13 14 **The Model**

15  
16 Figure 15 reports the maximum likelihood estimates of the Poisson model of density-  
17 dependence for firms' foundings in the Jewellery Quarter. All parameters are significant and in line  
18 with the hypothesis, except for model (1) where the parameter of the second order effects  
19 (density<sup>2</sup>) is positive.  
20  
21  
22

23 Model (1) estimates first (*density*) and second (*density*<sup>2</sup>) order effects of density. Model (2)  
24 includes also lagged births (*birth*<sub>(t-1)</sub>). Model (3) analyses also the second order effect of lagged  
25 births (*births*<sub>(t-1)</sub><sup>2</sup>). Model (4) also considers lagged deaths (*deaths*<sub>(t-1)</sub>). Model (5) contains all the  
26 previous variables and it adds also period effects, allowing the study of different probabilities of  
27 births with respect to the period 1956-70 which is omitted in the model.  
28  
29  
30  
31

32 According to our hypothesis, the first order effect of density (*density*) is significant and  
33 positive in all models and the second order effect (*density*<sup>2</sup>) is significant and negative in all  
34 models except for Model (1): this confirms the inversely U shape of the birth rate (Figure 1). The  
35 first order parameter associated with lagged births (*birth*<sub>(t-1)</sub>) is positive and the second order  
36 parameter (*births*<sub>(t-1)</sub><sup>2</sup>) is negative. Lagged births are found, therefore, also to be inversely U-  
37 shaped, since the effect of the competition process prevails on the legitimation process in  
38 determining firms' births. The parameters of firm deaths (*deaths*<sub>(t-1)</sub>) are significant and negative as  
39 expected.  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

**FIGURE 15 POISSON REGRESSION MODEL ESTIMATIONS OF BIRTHS IN THE BJQ, 1881-1973**

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>	<b>Model 5</b>
Intercept	4,2075***	1,9546***	0,2.5968***	2,3498***	- 0,4534***
	(0,1166)	(0,1429)	(0,1461)	(0,1519)	(0,3867)
Density	0,001***	0,0038***	0,0021***	0,0026***	0.0072***
	(0,0002)	(0,0003)	(0,003)	(0,0003)	(0.0006)
Density ^2	0,0012***	- 0,0014***	-0,0007***	- 0,0010***	- 0.0025***
	(0,0001)	(0,0001)	(0,0001)	(0000,1)	(0.0002)
Births (t-1)		0,0031***	0,0063***	0,0079***	0.0049***
		(0,0001)	(0,0003)	(0,0003)	(0.0004)
Births (t-1)^2			-0,0050***	- 0,0064***	- 0.0035***
			(0,0004)	(0,0004)	(0.0005)
Deaths (t-1)				- 0,0010***	- 0.0011***
				(0,0001)	(0.0001)
Period 1881-95					- 0.3703***
					(0.0437)
Period 1896-1910					- 0.2276***
					(0.0369)
Period 1911-25					- 0.5166***
					(0.0459)
Period 1926-40					0.1947***
					(0.0693)
Period 1941-55					0.8075*
					(0.1087)
DF	87	85	84	83	78
Log likelihood	46.892	46.898	46.985	47.013	47140

Standard error in brackets. \*:  $p < 0,0001$ ; \*\*:  $p < 0,001$ , \*:  $p < 0,01$ ; Period Variable Omitted P 1956-1973

The analysis of firms' births has focused on two aspects. Firstly, the maximum value of the multiplier of the entry rate ( $\lambda^*$ ) shows the maximum level of the relative strength of legitimation and competition processes. A high value of  $\lambda^*$  implies that the density effect on legitimation is relatively strong compared to that of competition. As evidence of this, we report the multiplier of the rate calculated for its maximum and minimum value of density observed:  $\lambda(N_{MAX})$  and  $\lambda(N_{MIN})$ .

Figure 16 presents the main quantitative implications of the effects of density on founding rates. The first two columns show the range of density of models (4) and (5) over the period 1881-1973. The minimum density ( $N_{\text{MIN}}$ ) is 523 in 1973, while the maximum density ( $N_{\text{MAX}}$ ) is 1689 in 1881 as the density curve is over the whole period decreasing. Column 3 reports the estimates for the multiplier of the founding rate when it reaches its maximum value ( $\lambda^*$ ), while column 4 and 5 contains the estimates for the multiplier computed at the maximum  $\lambda(N_{\text{MAX}})$  and minimum  $\lambda(N_{\text{MIN}})$  observed population density. Column 6 shows the year when the density is at its maximum and column 7 shows the year when density is at its minimum. Column 8 and 9 estimate the effect of density dependence legitimation and competition processes.

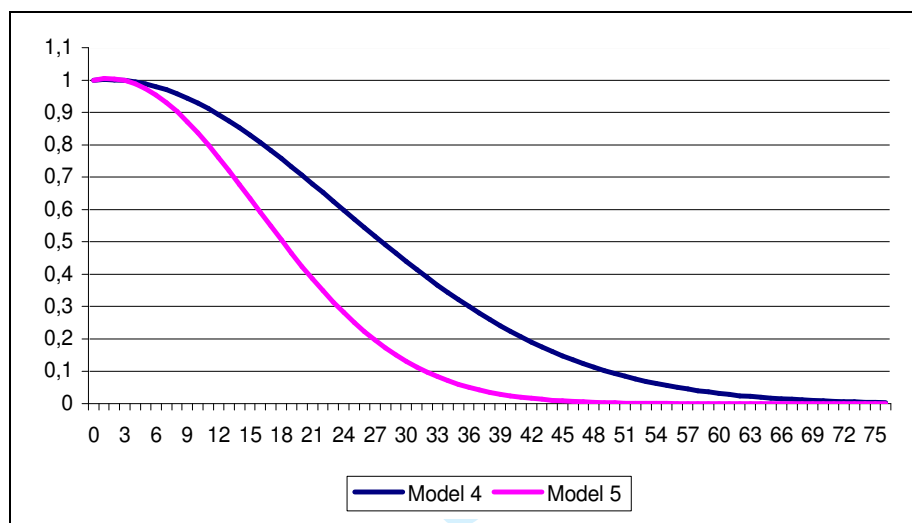
**FIGURE 16 QUANTITATIVE IMPLICATIONS OF ESTIMATES OF DENSITY-DEPENDENCE IN FOUNDING RATES**

MODEL	$N_{\text{MIN}}$	$N_{\text{MAX}}$	$\lambda^*$	$\lambda(N_{\text{MIN}})$	$\lambda(N_{\text{MAX}})$	T( $N_{\text{MAX}}$ )	T( $N_{\text{MIN}}$ )	Legittimation effect	Competition effect
Model (4)	523	1689	$\approx 1$	$\approx 1$	$\approx 0$	1881	1971	+0.26%	-0.1%
Model (5)	523	1689	$\approx 1$	$\approx 1$	$\approx 0$	1881	1971	+0.72%	-0.25%

Source: Authors' calculation.

Figure 16 shows the multiplier of the founding rates of models (4) and (5) for the BJQ. In both models, the organisational founding rate reaches its maximum when population density is close to 1 and, from there, it decreases because of null legitimation processes ( $\lambda^*$  is around 1). At the maximum density in 1881 (1689 firms), the founding rate tends to 0 ( $\lambda(N_{\text{MAX}})$ ) because of competition processes. In both models the hypotheses about density parameters are confirmed, but the second order effects dominate the first order effects over the entire range of density, therefore the multiplier of the founding rate curve is an inversely U-shaped, as it declines immediately as the competition process prevails on the legitimation one.

**FIGURE 17 MULTIPLIER OF THE FOUNDING RATE<sup>19</sup> FOR THE BJQ (MODEL 4 AND MODEL 5)**



Source: Authors' calculation.

To summarise, Figure 17 delivers a very important result for the study of the decline of the Jewellery Quarter, in that it shows that at the starting point of our analysis (it is worth remembering that the start date was decided on the basis of data availability) it had passed its growth phase; it had reached its zenith and maturity, and was starting to decline. According to the density dependence approach, this means that in 1880 the Quarter, as an organisational form (as a community of populations), was probably at its carrying capacity, since competition processes started to replace legitimation processes. In other words, as firms' births increase the community total density decreases.

## 6. Conclusion: From Industrial District to Urban Creative District

In this paper we have presented the findings of a study on the decline of the Birmingham Jewellery Quarter as a Marshallian industrial district. The first key result of the paper is to provide some qualitative and quantitative evidence that the Quarter peaked in its life cycle at the turn of the 20<sup>th</sup> century, followed by a period of stagnation and more recent contraction.

A second novelty is to present a composite and multidisciplinary methodology that contributes to the debate on the life cycle of local production system by integrating historical and economic analyses with demographic and ecological modelling (HEDRON methodology). This methodological novelty has relevant implications for studies on industrial districts –and of local production systems more generally– as dynamic organisational forms. In fact, not only does it acknowledge that external and internal events shape the historical context that frames the evolutions

1  
2 of such system, but it appreciates how such events affect the organisation of systems in terms of  
3 activities and specialisations and, ultimately impact on their overall evolution. In particular,  
4 quantitative evidence of the decline of the Birmingham Jewellery Quarter has been provided by  
5 means of business demography and organisational ecology.  
6  
7  
8

9 Drawing on a unique database with more than 11,400 firm recorded, we have been able to  
10 describe the organisation of production in the jewellery industry; to calculate firms' births and  
11 deaths, and firms' density curves by production activities and for the entire Quarter; and finally to  
12 run the ecological model.  
13  
14  
15

16 Our findings are that in demography terms, firm density in the Jewellery Quarter peaked by  
17 the early 1900s and the multiplier of the founding rate decreased thereafter; while, in ecological  
18 terms, it can be concluded that the Quarter had by then reached its point of maximum expansion –  
19 the so called carrying capacity. It was unfortunate for us that data was available only after 1880,  
20 because the stages of emergence and growth had taken place before.  
21  
22  
23  
24

25 Since the 1970s, the Jewellery Quarter has experienced a process of slow decline which is  
26 evident from employment figures (Figure 2). On the demand side, this is due to a weakening of its  
27 domestic market and an inability to penetrate foreign markets. On the supply side, there has been a  
28 break down of the internal division of labour as some specialisations have disappeared, retailing has  
29 expanded, and finally, imports of cheaper finished or unfinished goods have replaced internal  
30 production and have flooded the domestic market. Nevertheless, the Jewellery Quarter is still a  
31 concentration of jewellery and jewellery-related manufacturing and service firms.  
32  
33  
34  
35  
36

37 Today there is a smaller but still significant manufacturing base, whilst retailing has been  
38 steadily expanding. If in 1973 there were less than 30 firms in sales and retails (corresponding to  
39 less than 5% of the total), a census of activities in the Quarter in 2005 (DE PROPRIIS and WEI, 2007)  
40 has found that there are 124 firms in retailing related activities, corresponding to more than 40% of  
41 activities overall. The move to increase retailing activities has been accompanied by an effort to  
42 target high-value added segments of demand with designers' jewellery, and unique and customised  
43 pieces. This is reflected in local policy agencies increasingly recognising the creative content of  
44 jewellery making and the added value that this can bring to the industry; for instance, Advantage  
45 West Midlands has classified the jewellery industry in the Quarter as a high-value added consumer  
46 cluster (see also BIRMINGHAM AND SOLIHULL ECONOMIC FORUM, 2005; HALL and WELCH, 2005)  
47 and recognised that design can be central to business success. The shift from manufacturing to  
48 design-intensive, creative jewellery would still coincide with some re-structuring in the industry but  
49 could also offer more hope its long term sustainability. We would, therefore, suggest that the  
50 decline of the Jewellery Quarter as a Marshallian industrial district is not coinciding with its death,  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

rather with its reshaping and possible renaissance as an urban creative district, whereby differences in the nature of activities are coupled with continuity in the form of socio-production organisation.

For Peer Review Only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## REFERENCE

- ALLISON P.D. (1988) *Event History Analysis: Regression for Longitudinal Event Data*, Beverly Hills, Sage University.
- ALLEN G.C. A. (1929) *The Industrial Development of Birmingham and the Black Country*, Allen and Unwin, London.
- AMBURGEY T.L. and RAO H. (1996) Organization Ecology: Past, Present and future, *Academy of Management Journal*, Vol.39, n.5, 1265-1286.
- BAPTISTA R. (1998) Clusters, Innovation and Growth: A Survey of the Literature, In SWANN G.M., PREVEZER M. and STOUT D. (Eds) *The Dynamics of Industrial Clustering*, OUP, Oxford.
- BATHELT H.M., MALBERG A. and MASKELL P. (2002) *Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation*. DRUID Working Paper No. 02-12, Copenhagen.
- BAUM J. and SINGH J (1994) *Evolutionary dynamic of organizations*, N.Y., Oxford University Press.
- BECATTINI G. (1990) The Marshallian Industrial District as a Socio-Economic Notion, in PYKE F., BECATTINI G. and SENGENBERGER W. (1990) *Industrial Districts and Inter-firm Cooperation in Italy*, Geneva, International Institute for Labour Studies.
- BECATTINI G. (2004) *Industrial Districts. A New Approach to Industrial Change*, Edward Elgar, Cheltenham.
- BELUSSI F. (1996) Local Systems, Industrial Districts and Institutional Networks: Towards a New Evolutionary Paradigm of Industrial Economics, *European Planning Studies*, Vol. 4, No.1, 5-22.
- BELUSSI F. and SCARPEL M. (2002) L'evoluzione recente del distretto della Riviera del Brenta: un approccio organizzativo, *Economia e politica industriale*, n. 115, pp. 43-70.
- BIRMINGHAM & SOLIHULL ECONOMIC FORUM (2005) Annual Report. *Birmingham Chamber of Commerce*
- BOONE C. and VAN WITTELOOSTUIJN (1995), Industrial Organization and Organizational Ecology: the Potentials for Cross-fertilisation, *Organization Studies*, 16/2, pp 265-298.
- BRESNAHAN T., GAMBARELLA A. and SAXENIAN A. (2001) 'Old Economy' Inputs for 'New Economy' Outcomes: Cluster Formation in the New Silicon Valley, *Industrial and Corporate Change*, Vol. 10, No. 4, 835-860.
- CAMAGNI R.P. (ed.) (1991) *Innovation Networks. Spatial Perspective*, Belhaven, London.
- CARROLL G.R. (1984) Organizational ecology, *Annual review of sociology*, No 10, pp. 71-93.
- CARROLL G. R. and HANNAN M. T. (2004) *The Demography of Corporations and Industries*, Princeton University Press, Princeton.
- CHERRY G.E. (1994) *Birmingham. A Study in Geography, History and Planning*, Chichester, Wiley.
- CUMBERS A. and MACKINNON D. (2004) Introduction: Clusters in Urban and Regional Development, *Urban Studies*, Vol. 41, No. 5/6.
- DE PROPRIIS L. and LAZZERETTI L. (2007) The Birmingham Jewellery Quarter: A Marshallian Industrial District, *European Planning Studies*, vol. 15, no. 10, pp.1-31.

- 1  
2 DE PROPRIIS L. and WEI P. (2007) Governance and Competitiveness in the Birmingham Jewellery  
3 Cluster, *Urban Studies*. vol 44, No.12.  
4
- 5 DE PROPRIIS L., LAZZERETTI L., STORAI D. (2004) *Impannatori* and Business Angels: Two Models  
6 of Informal Capital Provision, *International Journal of Urban and Regional Research*, Vol.  
7 28, No. 4, 839-854.  
8
- 9 DEI OTTATI G. (2003) Exit, Voice and the Evolution of Industrial Districts: The Case of the Post-  
10 world War II Economic Development of Prato, *Cambridge Journal of Economics*, Vol. 27,  
11 501-522.  
12
- 13 DELACROIX J. and CARROLL G. R. (1983), Organizational Foundings: An Ecological Study of the  
14 newspaper Industries of Argentina and Ireland, *Administrative Science Quarterly*, vol. 28, nr.  
15 2.  
16
- 17 FOSTER J. (1993) Economics and the Self-organisational Approach: Alfred Marshall Revisited? *The*  
18 *Economic Journal*, Vol. 103, No. 419, 975-991.  
19
- 20 FORTIS M. and MAGGIONI M. (2002) Competitive and Synergic Behaviours in the Development of  
21 Industrial Clusters: Ecological Modelling and Empirical Evidence, CURZIO A.Q. and FORTIS  
22 M. (Eds.) *Complexity and Industrial Clusters*, Physica-Verlag, Heidelberg, 123-165.  
23
- 24 GILBERT C. (1972) *The Evolution of an Urban Craft: The Gold, Silver and Allied trades of the West*  
25 *Midlands*, PhD Thesis, The University of Birmingham.  
26
- 27 GLEDHILL A. (1988) *Birmingham Jewellery Quarter*, Brewin Books, Reddich.  
28
- 29 GLASMEIER A.K. (1994) Flexibility and Adjustment: The Hong Kong Watch Industry and Global  
30 Change, *Growth and Change*. Vol 25, 223-246  
31
- 32 GRABHER G (2001) Ecologies of Creativity: the Village, the Group, and the Heterarchic  
33 Organisation of the British Advertising Industry. *Environment and Planning* vol. 33 pp351-  
34 374  
35
- 36 HALL C. and WELCH I. (2005) *Study of Designer Makers Operating in Birmingham's Jewellery*  
37 *Quarter*, Archway  
38
- 39 HANNAN M.T. and CARROLL G.R. (1992) *Dynamics of Organizational Populations: Density,*  
40 *Legitimation and Competition*, New York, OUP.  
41
- 42 HANNAN M.T. and FREEMAN J. (1977) The Population Ecology of Organisations, *American Journal*  
43 *of Sociology*, No. 82, 929-964.  
44
- 45 HANNAN M.T. and FREEMAN J. (1987) The Ecology of Organisational Founding: American Labour  
46 Unions 1936-1985, *American Journal of Sociology*, Vol. 94, No. 4, 910-943.  
47
- 48 HANNAN M.T. and FREEMAN J. (1988) The Ecology of Organisational Mortality: American Labour  
49 Unions, 1836-1985, *American Journal of Sociology*, Vol. 94, No. 1, 25-52.  
50
- 51 HANNAN M.T. and FREEMAN J. (1989) *Organisational Ecology*, Harvard University Press,  
52 Cambridge.  
53
- 54 HASSALL M. (1993) *The Growth and Development of the Jewellery Quarter*, mimeo, The  
55 University of Birmingham.  
56
- 57 HOPKINS E. (1998) *The Rise of the Manufacturing Town. Birmingham and the Industrial*  
58 *Revolution*, Sutton, Stroud.  
59
- 60 HOPKINS E. (2001) *Birmingham. The Making of the Second City 1850-1939*, Tempus, Strout.
- HOUGHTON'S DIRECTORY (1882) *Street Directory*, Birmingham, Houghton & Co.
- HULLEY'S DIRECTORY (1881) *Street Directory*, London, Kelly & Co.

- 1  
2 KELLY'S DIRECTORY (1880, 1883-1974) *Street Directory*, London, Kelly & Co.
- 3  
4 KLEPPER S. and GRADY E. (1990) The Evolution of New Industries and the Determinants of  
5 Market Structure, *The Rand Journal of Economics*, Vol. 21, No.1, 27-44.
- 6  
7 LAZZERETTI L. and STORAI D. (2003) An ecology based interpretation of district complexity: the  
8 Prato district evolution from 1946-1993, in BELUSSI F., GOTTARDI G. and RULLANI E. (Eds.)  
9 *The Technological evolution of Industrial Districts*, Kluwer, Dordrecht, 409-435.
- 10  
11 LAZZERETTI L., (2006) Density Dependent Dynamics in Arezzo Jewellery District (1947-2001):  
12 Focus on Foundings, *European Planning Studies*, vol 14(4) 431-458
- 13  
14 LOMI A. and LEVIE J. (1995) *Density Dependence and Spatial Duality in the Foundings Rates of*  
15 *Danish Commercial Banks 1846-1989*, WP Academy of Management Meeting, Vancouver  
16 No. 6-9, 1-28.
- 17  
18 MARSHALL A. (1895) *Principles of Economics*, Third Edition, Vol. 1, London, Macmillan and Co.
- 19  
20 MARSHALL A. (1919) *Industry and Trade*, London, Macmillan.
- 21  
22 MARTIN R. and P. SUNLEY (2003) Deconstructing clusters: chaotic concept or policy panacea?,  
23 *Journal of Economic Geography*, vol. 3
- 24  
25 MASKELL P. (2001) Towards a Knowledge-based Theory of the Geographic Cluster, *Industrial and*  
26 *Corporate Change*, Vol. 10, no. 4, 921-943.
- 27  
28 MASON S. (1998) *Jewellery Making in Birmingham, 1750-1995*, Phillimore, London.
- 29  
30 POLLARD J. S. (2004) From Industrial District to Urban Village? Manufacturing, Money and  
31 Consumption in Birmingham's Jewellery Quarter, *Urban Studies*, Vol. 41, No. 1, 173-193.
- 32  
33 PORTER (1998) Clusters and the New Economics of Competition, *Harvard Business Review*,  
34 Nov/Dec, 77-90.
- 35  
36 ROCHE J.C. (1927) *The History, Development and Organisation of the Birmingham Jewellery and*  
37 *Allied Trades*, Birmingham, Dennison Watch Case Co. Ltd..
- 38  
39 SARGANT FLORENCE P. (1948) *Investment, Location and Size of Plant*, Cambridge, Cambridge  
40 University Press.
- 41  
42 SCOTT A.J. (1998) *Regions and the World Economy: The Coming Shape of Global Production,*  
43 *Competition and Political Order*, OUP, Oxford.
- 44  
45 SCOTT A.J. (2000) *Regions and the World Economy*, Oxford, Oxford University Press.
- 46  
47 SINGH J. and LUMSDEN C. (1990) Theory and research in organizational ecology, *Annual Review of*  
48 *Sociology*, vol. 16, pp. 161-195.
- 49  
50 SMITH B.M.D. (1987) *Report of an Interview-based Survey in the Birmingham Jewellery Quarter*  
51 *relating to the Jewellery Industry*, Centre for Urban and Regional Studies, The University of  
52 Birmingham.
- 53  
54 SMITH B.M.D. (1989) The Birmingham Jewellery Quarter, a Civic Problem that Has Become an  
55 Opportunity in the 1980s, in TILSON B. (Ed.) *Made in Birmingham. Design and Industry*  
56 *1889-1989*. Studley, Brewin Books.
- 57  
58 SMITH B.M.D. (1990) *Economic Regeneration Strategies in Birmingham, England, Illustrated by a*  
59 *Case Study of the Jewellery Quarter in Birmingham*. The University of Birmingham. Mimeo.
- 60  
61 STABER U. (2001) Spatial Proximity and Firm Survival in a Declining Industrial District: The case  
62 of Knitwear Firms in Baden Württemberg, *Regional Studies*, Vol. 35 No. 4, 329-341.

- 1  
2 SWANN G.M. (1998) Towards a Model of Clustering on High-Technology Industries, in SWANN  
3 G.M., PREVEZER M. and STOUT D. (Eds) *The Dynamics of Industrial Clustering*, OUP,  
4 Oxford.  
5  
6 SWANN G.M., PREVEZER M. and STOUT D. (Eds), (1998) *The Dynamics of Industrial Clustering*,  
7 OUP, Oxford.  
8  
9 TIMMINS S. (1866) *Resources, Products and Industrial History of Birmingham and the Midland*  
10 *Hardware District*, London, Robert Hardwicke.  
11  
12 VAN WISSEN L. (2004) A Spatial Interpretation of the Density Dependence Model in Industrial  
13 Demography, *Small Business Economics*, 22:253-264.  
14  
15 WISE M.J. (1950) *On the Evolution of the Jewellery and Gun Quarters in Birmingham*, Institute of  
16 British Geographers, Vol. 15.  
17  
18 WOLFE D. A. and GERTLER M.S. (2004) Clusters from the Inside and Out: Local Dynamics and  
19 Global Linkage, *Urban Studies*, Vol. 41, No.5/6, 1071-1093.  
20  
21  
22  
23  
24

## 25 NOTES

- 26  
27  
28 <sup>1</sup> DE PROPRIIS and LAZZERETTI (2007).  
29 <sup>2</sup> In 1947, taxes on luxury items like jewellery increased to 145%, remained as high as 75% in the  
30 1950s, to be abolished only in 1973 when VAT was introduced (MASON, 1998).  
31 <sup>3</sup> MARTIN and SUNLEY (2003).  
32 <sup>4</sup> Organisational populations could correspond, for instance, to sectors as defined by the standard  
33 SIC classification. For the BJQ we could not rely on such a structured classification of economic  
34 activities; we had therefore to group service and production activities according to their role along  
35 the value chain.  
36 <sup>5</sup> If the density curve is not non-monotonic, some descriptive statistics (univariate, bi-variate, multi-  
37 variate, spatial, etc.) can be carried out in order to support the qualitative study of the  
38 phenomenon.  
39 <sup>6</sup> For more details on the BJQ location, see CHERRY (1994), HOPKINS (1998) and DE PROPRIIS and  
40 LAZZERETTI (2007).  
41 <sup>7</sup> Data was not available for the following years: 1885, 1887, 1889, 1891, 1893, 1909, 1920, 1928,  
42 1949, 1951, 1955, 1959, 1961 and 1962. When computing the density, we have filled these gaps  
43 by estimating proxies; it is standard procedure to calculate proxy values for each firm as the  
44 average between density of the year before and the year after the gap. We apply the following  
45 formula:  
46 
$$Density_z = \frac{density_{z-1} + density_{z+1}}{2} \quad \text{with } z = \text{missing year.}$$
  
47  
48  
49  
50  
51 <sup>8</sup> There is little information about how data was collected, but it is well accepted that the most likely  
52 way was for publishers to have had people who physically walked around the streets of  
53 Birmingham and stopped at every shop or household asking for names and types of economic  
54 activity/trade or looking at name plates. In this way, every year they gathered data and  
55 information that was then published in a directory. Each directory classified economic activities  
56 by street, name and trade.  
57 <sup>9</sup> See DE PROPRIIS and LAZZERETTI (2007).  
58  
59 <sup>10</sup> For the history of the Birmingham Assay Office, see RYLAND (1866) and GLEDHILL (1988).  
60 <sup>11</sup> For more information of the evolution of the BJQ, see DE PROPRIIS and LAZZERETTI (2007).  
<sup>12</sup> For more information, see HORTON (1908) and SMITH (2003).

<sup>13</sup> Previous contributions that have described the organisation of production in the BJQ include ROCHE (1927), SARGANT FLORENCE (1948) and GILBERT (1972).

<sup>14</sup> This number is the sum of all firms in 1880 and the number of firms that were born from 1880 to 1973.

<sup>15</sup> Firms' births are considered as discrete events since they are computed at  $t_1, t_2, t_3$ , etc. usually corresponding to years, rather than as continuous events, because this would require the exact day, month and year of birth.

<sup>16</sup> The most frequently used model to represent these relationships is the log-quadratic approximation (HANNAN and FREEMAN, 1989; HANNAN and CARROLL, 1992). The log-quadratic approximation applied to the founding rates has the form:

$$\lambda(t) = L_t / C_t = \varphi(N_t) / \psi(N_t) = \kappa \lambda(t) \exp(\theta_1 N_t + \theta_2 N_t^2), \text{ with hypotheses: } H_1: \theta_1 > 0; H_2: \theta_2 < 0.$$

$L_t$  captures the legitimation process, and  $C_t$  the competition process. This means that the effect of density due to  $N_t$ , namely the first-order derivative of density, is positive but less than one; whereas the second-order derivative due to  $N_t^2$  is negative. The relationship is non-monotonic and has the form of an inverse-U with a maximum at:  $N_\lambda^* = -\theta_1 / 2\theta_2$ . Other models to represent these relationships are the generalised-Yule models (GY) and the log-quadratic approximation model. However, some authors have demonstrated how these latter models do not always offer convergent estimates (HANNAN and FREEMAN, 1989; HANNAN and CARROLL, 1992). In case the Poisson distribution model does not adequately fit the model (because it does not pick up the tendency of the founding rate to vary faster than its average - over-dispersion), the negative binomial model might fit the relation better. Nevertheless, a valuation of the variance of the estimated of the Poisson regression does not reveal high levels of over-dispersion.

<sup>17</sup> Period variables have been computed as dummy variables each covering 15 years: 1881-1895, 1896-1910, 1911-1925, 1926-1940, 1941-1955 and 1956-1970.

<sup>18</sup> In density dependence models, it is often the case that populations' characteristics are considered as independent variables. In particular, when analysing firm birth in a population, it is reasonable to verify whether the firms' founding rate at time  $t$  is correlated with the lagged variable at  $t-1$ . A large wave of firms' births at time  $t$  can increase the founding rate due to imitation processes, but at the same time, it can hinder the birth of new firms due to the depletion of resources that competition processes have put in motion. Again the firm founding rate can be drawn as an inverse U (DELACROIX and CARROLL, 1983).

<sup>19</sup> To calculate the multiplier of the founding rate we consider the two parameters of the density setting equal to 0 the covariates. This is given by the ratio of the value of density function over the value the density function takes at  $N_{\text{MIN}}$ .