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On the spatial stickiness of UK new firm formation rates

Georgios Fotopoulos†

Department of Economics, University of Peloponnese, Greece
†Corresponding author: Georgios Fotopoulos. *email* <gfotop@uop.gr>

Abstract

This research explores persistence of new firm formation at the UK NUTS II level for the 1994–2007 period. The results obtained herewith suggest that interregional differences in new firm formation and their determinants are time persistent. The evidence produced shows that past new firm formation rates determine future ones and that, depending on the econometric specification, human capital, local industry structure, sources of external economies and local economic conditions and wealth are significant determinants. The analysis of new firm formation distribution dynamics suggests that whatever changes may arise in the external shape of distribution are not significant and intra-distribution mobility is limited.

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1. Introduction

The aim of this research is to investigate the sources of persistence in interregional differences of UK new firm formation rates. Such an empirical inquiry has been motivated by recent empirical findings from Germany (Fritsch and Mueller, 2007) and Sweden (Andersson and Koster, 2011) which have suggested high degrees of persistence in regional new firm formation rates. This is something that has been relatively unexplored in the voluminous literature on UK regions.

Earlier views on the importance of a robust regional new formation rate, such as Love (1996, 441) who regarded it as 'a positive indicator of dynamism and growth in spatial economy' and Reynolds et al. (1994) who associated it with regional prosperity, are supported in the recent report of the Local Enterprise Partnership (LEP) Network (2012). The latter suggests that the highest performing LEP areas in England are those with higher start-up rates and business closures. Evidence from different country and regional contexts (Van Praag and Versloot, 2007) suggests that entrepreneurial firms are important job creators, productivity growth contributors, producers of innovations or responsible for innovation commercialisation. At the regional level, entrepreneurial firms produce important spillovers and affect the long-run employment growth prospects of regions. It is thus not surprising that policies have been sought out to

influence the regional birth rates of firms in regions lacking entrepreneurship.[1] However, if interregional differences in new firm formation and their determinants are time persistent, then this would call for the modification of related policy efforts so they may have more time to develop and take effect before any considerable results are expected and produced. An understanding of such persistence thus becomes important.

This research explores the possible sources of persistence of new firm formation at the UK regional NUTS II level for the 1994–2007 period. The results obtained herein suggest that interregional differences in both new firm formation and their determinants are time persistent. Additional evidence is produced that reveals that past new firm formation rates determine future ones. Depending on the specification, variation in regional new firm formation has been significantly accounted for by human capital, local industry structure, sources of external economies and local economic conditions and wealth. By analysing distribution dynamics, the full extent of the data available was used and questions regarding possible changes over time in the shape of the distribution of regional new firm formation as well as regional intra-distribution mobility were addressed. The results obtained, using non-parametric techniques, suggest that whatever changes arise in the external shape of the distribution are insignificant and that intra-distribution mobility is limited.

The following section discusses persistence in new firm formation rates in conjunction with path dependence. In Section 3, the arguments justifying the variables deployed in the related research and the associated empirical findings are reviewed. The data used to define the variables used herein are discussed in Section 4 where a variance decomposition exercise for the dependent and key explanatory variables is undertaken. This sets the background for the econometric analysis results that are next presented and discussed in Section 5. The distributional dynamics of regional new firm formation are analysed in Section 6. Conclusions are provided in the final section.

2. Persistence in interregional differences of new firm formation and path dependence

Path dependency has been invoked in relation to the persistence of interregional differences of new firm formation (Fritsch and Mueller, 2007; Andersson and Koster, 2011). Moreover, Boschma and Frenken (2011) maintain that Fritsch and Mueller's (2007) findings for German regions and Andersson and Koster's (2011) results for Swedish regions contribute towards the emerging empirics of evolutionary economic geography. Central to an evolutionary economic geography approach is '*the spatial evolution of firms, industries, networks, cities and regions from elementary processes of the entry, growth, decline and exit of firms, and their locational behavior*' (Boschma and Frenken, 2011, 295).

The concept of path dependence (David, 1985; Arthur, 1994) centres on the notion that history matters whereby small random events in the past have a large bearing on future outcomes. Page (2006) identifies four related causes of path dependence: increasing returns, self-reinforcement, positive feedbacks and lock-in.

The significance of history is not something new in economic geography as the decisive effect of initial conditions within a self-reinforcing process is found in

1 See Johnson (2005) and Greene et al. (2004) for a critical assessment of such policies.

Myrdalian–Kaldorian cumulative causation models that attempt to replace equilibrium with historical processes in growth theory (Setterfield, 1997). Massey (1995, 114) argues that '*Spatial structures of different kinds can be viewed historically . . . as emerging in a succession in which each is superimposed upon, and combined with, the effects of spatial structures which came before*'. The outcome of the historical process thus becomes a combination of 'layers of activity' whereby each represents a new round of investment and is associated with the role the local economy has played within spatial structures, both national and international. Storper (1988) calls for the need of a new theoretical apparatus to explain 'paths taken' and 'paths foreclosed' in relation to concrete events in economic geography. Within, what he calls, 'mesolevel analytics' he argues that events are outcomes of structured but not fully determined situations. As such, sequences of small events can produce large outcomes which are not fully predictable from the outset. Within such sequences, opportunities are created and choices are made that foreclose other possible sequences of events thus rendering 'paths taken' unpredictable.

Persistence in interregional new firm formation rates could, in part, be attributed to slowly-evolving-in-time (or 'spatially sticky') regional factors that are conducive to entrepreneurship such as incomes, educational levels and population density (Andersson and Koster, 2011). These interregional differences in entrepreneurship enhancing factors could, in turn, be the outcome of path-dependent processes shaping regional economic structures. Andersson and Koster (2011) further introduce a second mechanism that could explain (inter)regional persistence in new firm formation rates. This mechanism concentrates on 'demonstration effects' whereby existing entrepreneurship in the region acts as a role model and further stimulates new entrepreneurship while, concurrently, contributing to the development of institutions that create an 'entrepreneurial climate'.[2] A self-reinforcing factor is thus added alongside path dependency in order to explain persistence in interregional differences of new firm formation. This kind of entrepreneurship cumulative causation rationale is consistent with theoretical developments of multiple equilibria (Parker, 2005) and network externalities (Minniti, 2005) models of entrepreneurship in a spatial context. In Parker's (2005) model, the existing regional occupational structure (essentially the balance between paid employment and entrepreneurship) conveys information that affects human accumulation decisions by individuals which, in turn, could lead to the self-perpetuation of these occupational structures. In Minniti's (2005) model of network externalities, the role of what she calls 'social environment' (a term used in relation to the ability of an individual to observe the behaviour of others as well as the consequences of such an observation) is a central one. In this theorisation, entrepreneurship exhibits increasing returns to adoption and a social environment characterised by entrepreneurship, lowers ambiguities relating to entrepreneurial initiative, offers role models and facilitates information flows and skills acquisition thus favourably affecting individual decisions towards entrepreneurship. In this way, this model also provides an entrepreneurship self-reinforcing mechanism.

Although path dependency has been fundamental in evolutionary geography theorisations of entrepreneurship, its role as an evolutionary economics concept has

2 According to Carlsson (2007), the existing entrepreneurial climate that results from pre-existing conditions may be the most important aspect of path dependency.

not gone without debate. In particular, Martin and Sunley (2006) and Martin (2010) criticize the concept's lack of a process by which paths break up and de-lock while, on the contrary, Setterfield (2001, 111) and Garud and Karnøe (2001, 2) have seen entrepreneurship as having the potential for breaking up lock-ins. Garud and Karnøe (2001, 2) very eloquently note that '*a path dependence perspective has important implications for human agency that are problematic for a theory of entrepreneurship* . . . [as] . . . *Entrepreneurs are embedded in structures* . . . *from which they mindfully depart* . . . [and] . . . *entrepreneurship is a collective effort where paths are continually and progressively modified as new technological fields emerge*'.[3] While persistence in interregional differences in entrepreneurial activity may thus, in part, be attributed to path dependency, entrepreneurship is, at the same time, a dynamic force by which paths break and de-lock and new paths are taken.

The present research concurs that history matters, although not in a very strict sense since regional economies are not immune to change due to endogenous forces such as entrepreneurship. 'Spatial stickiness' is here used synonymously to persistence in time and relates to persistent interregional differences in new firm formation rates and their determinants.[4]

3. Determinants of new firm formation: a review of the evidence[5]

Sternberg (2009, 13) critically makes the valid point that '*entrepreneurship research largely ignores the spatial implications despite the significance of contextual aspects of entrepreneurship, whereas on the other hand the disciplines interested in spatial issues, such as regional science or economic geography, barely touch on the subject of entrepreneurship at least from a theoretical point of view*'. Furthermore, it has been recognised that theories that have been developed to address issues relating to entrepreneurship at individual or organisational levels are not well suited for other levels of analysis (Davidsson and Wiklund, 2001). The regional level presents such a case, whereby the empirical research has proved to be both 'interesting and comprehensive' (Davidsson and Wiklund, 2001). Indeed, research on the determinants of spatial variation in new firm formation has been versatile with regard to the variables deployed as regressors in econometric models or as relevant factors considered in statistical and survey-based analyses. In a collective effort to make cross-national comparisons of spatial processes in new firm formation (Reynolds et al., 1994), the need to narrow the spectrum of potential determinants on an operational and comparable basis has been immense. As a result, six primary processes are considered in association with spatial aspects of firm entry: local demand aspects, urbanisation/agglomeration effects, unemployment, personal household wealth, small firm presence and local government spending and assistance.

3 Note that human agency is also central to Storper's (1988) model in which it takes the form of strategies and choices.

4 It is interesting to note that among the eight types of major urban subsystems distinguished by Wegener (1994) and ordered by the speed by which they change, the one related to employment and population is considered as a fast changing one. Within this subsystem, a key role is that of business demographics responding to changing markets and technologies. An anonymous referee is thanked from bringing this to the author's attention.

5 This section partially draws on my unpublished PhD thesis (Fotopoulos, 1998: Chapter 7).

This section does not aspire to provide an exhaustive account of the empirical literature on the determinants of regional variation in new firm formation rates, but rather to place the variables used in the present study within a context by focusing primarily on UK research.

3.1. Unemployment

The empirical evidence for the much debated (Storey, 1991) effect of unemployment on new firm formation in a spatial analytical context has been somewhat ambiguous. Ambiguities mainly arise from the dual, but inherently contradictory, roles of unemployment affecting new firm formation decisions. While unemployment can increase the supply of potential entrepreneurs as more unemployed individuals (or those facing prospects of unemployment) are pushed to establish their own firms, increased levels of unemployment may concurrently signal that market conditions in a region are less favourable, thus discouraging new firm formation.[6] This has been stressed by Tervo and Niittykangas (1994) who point out that areas with prolonged unemployment are characterised by an inadequate social and public infrastructure and the deterioration of human capital stock which, in turn, further feeds into the backwardness of such areas. Thus the effect of unemployment levels on new firm formation is expected to be negative. In contrast, changes in unemployment are seen as consistent with the 'push' hypothesis and thus ultimately positive (i.e. recessions create new unemployed persons with higher educational and experience levels who may seek out entrepreneurial alternatives). Their results conform with these expectations. Newer Finnish panel data evidence (Kangasharju, 2000), however, as well as most cases considered within the international comparisons analysed by Reynolds et al. (1994) contradict them.

On the UK front, some early and survey-based evidence has offered support to the 'unemployment-push' hypothesis (Fothergill and Gudgin, 1982; Storey, 1982; Gould and Keeble, 1984; Mason, 1989). When it comes to econometric analyses, results are mixed. Pooled (Whittington, 1984) and cross-sectional results (Ashcroft et al., 1991) for periods from early to mid-eighties suggest that changes in the unemployment rate have a positive effect on new firm formation. For the 1980–1988 period, Westhead and Moyes (1992) find that the unemployment rate is negatively and significantly correlated to new firm formation, whereas change in the unemployment rate is positively but insignificantly correlated. The effect of the unemployment rate turns out to be positive and significant in their econometric analysis, only to be blamed on multicollinearity problems by the authors. Over the same period Love (1996) produces cross-sectional evidence at a county level suggesting that the unemployment rate has a negative and significant effect on new firm formation, whereas the effect of unemployment change is positive but insignificant. In Johnson and Parker (1996) 2-year lagged unemployment produced a negative sign suggesting a negative demand pull effect. Keeble and Walker (1994) cover the 1980–1990 period and find that change in unemployment is not a significant determinant of new firm formation while its sign depends on the dependent variable definition.

6 Note, however, that unemployment should not necessarily be equated to necessity entrepreneurship, as the effect of unemployment could be a disruptive one that might trigger individuals into undertaking entrepreneurial activity who, despite having become unemployed, could have successfully sought paid employment. This was pointed out by an anonymous referee.

The Global Entrepreneurship Monitor (G.E.M.) consortium also distinguishes between 'necessity-driven' and 'opportunity-pulled' entrepreneurs. Recent evidence from the UK G.E.M. report suggests that necessity-driven entrepreneurship is low (Levie and Hart, 2008).

3.2. Industry mix, industry structure and sources of external economies

Earlier research has considered the role of industrial structure to account for spatial variations in new firm formation. As new firm formation rates differ between industries due to diverging patterns in demand changes, different innovation and barriers to entry levels, these differences may in turn lead, via regional sectoral composition, to regional differences in new firm formation rates (Fritsch, 1996).

Johnson (1983) first used shift-share analysis to investigate regional new firm formation activity. His results suggested that the effect of industrial mix in accounting for this variation is minimal while the factors that determine the intra-industry preferences in the allocation of industrial activity across space seem far more important. Other studies in various UK spatial contexts (Beesley and Hamilton, 1986; Storey and Johnson, 1987) using shift-share-based methods also produced results suggesting that inter-regional differences in new firm formation stem mainly from marked intra-industry variation. In contrast, Ashcroft et al. (1991) provide mixed results, and other, more recent, studies using variants of the shift-share method (Fotopoulos and Spence, 2001; Johnson, 2004) provide evidence for the importance of industry mix in accounting for new firm formation in UK regions.

Marshall (1890) first recognised the potential of the geographic concentration of firms in the same industry and Krugman (1991), elaborating on Marshall's views, identifies three sources of localised increasing returns: labour market pooling[7], the provision of non-traded inputs specific to an industry in greater variety and at lower cost and increased information flows and technological spillovers. Arrow (1962) and Romer (1986) further formalised the idea that knowledge is sector-specific and emphasised intra-sector externalities emanating from regional specialisation (hence the term Marshall–Arrow–Romer externalities). In contrast to the M.A.R. externalities, Jacobs' (1969) theorisation concentrates on the diversity of economic activities in areas that allow for the cross-fertilisation of all sectors in the economy through inter-sectoral knowledge. Externalities have been identified by Parker (2009, 149) to be a promising source of explanations regarding the persistence of regional rates of entrepreneurship.

The extent of local dependency on industrial activities and its effects on an area's new firm generational activity has been considered early on in the literature of new firm formation. It has been proposed that a higher diversification of the regional industrial base is associated with higher new firm formation activity (Gudgin, 1978; Cross, 1981). The rationale offered for the justification of such a relationship is based on the idea that the higher the degree of diversification, the higher the variety of skills available locally. Skill and the diversity of working experiences can, in turn, give way to greater entrepreneurial choice and opportunity, especially when there is some degree of mobility of individuals between firms and industries. Indirect evidence in favour of the

7 In such a context it is a local supply of highly specialised, rather than diversified, labour which provides local firms with productivity advantages.

diversification argument exists (Cross, 1981; Westhead and Moyes, 1992) based on correlation coefficients between various measures of firm births and industry dominance.[8] Westhead and Moyes (1992) argue that industrial specialisation and a substantial tradition in production activities significantly impede new firm formation in the UK.[9]

While predominant regional manufacturing appears to inhibit new firm formation, Keeble and Walker (1994) link the spatial concentration of high new firm formation rates to the historical spatial concentration of financial, professional and business. Indeed, Anyadike-Danes and Hart (2006) produce empirical evidence suggesting that the share of business services in the regional business stock is a key determinant in accounting for regional variations of new firm formation in the UK and the former largely coincides with higher population density. Very recently, Bishop (2012) produces evidence suggesting that diversity is not a significant determinant of regional new firm formation in the UK. In contrast, variety within the knowledge sector has been positive and significant leading the author to conclude that the impact of diversity is sector-specific. This may be seen in conjunction with the concept of related variety put forward by Frenken et al. (2007) that stands between regional specialisation and regional diversification by paying attention to regional specialisation in a spectrum of technologically interdependent sectors as a means of facilitating innovation and knowledge spillovers between sectors.

Beesley and Hamilton (1994, 234) argue that industry localisation may create an 'unconventionally specified entry barrier'. The authors used an industry localisation variable to account for inter-industry variation in firm entry rates at the national level and attribute the significant negative coefficient obtained on industry localisation on (i) specialised resources and skills that may be more demanding prerequisites for entry into a highly localised industry and (ii) that more localised industries tend to be further specialised through vertical integration, thus becoming less fertile incubators for new businesses.

However, from a spatial point of view, vertical disintegration has been seen as reinforcing locational clustering which in turn encourages further vertical disintegration by widening the opportunities for external economies (Scott, 1986). Central to Porter's (2000) definition of clusters is the geographic concentration of interconnected firms in related industries and it is for this reason that clusters are often associated to Marshallian externalities based on localisation economies. Porter (2000) and Delgado et al. (2010) argue and provide evidence that the presence of clusters surrounding a region-industry enhances new firm formation growth to the extent that individuals working within or around a cluster are better equipped to perceive opportunities by identifying gaps in products, services or suppliers. It is further argued that local entry barriers might be lower. This owes, as is argued, to a multiple of factors e.g. local availability of skills and inputs; local financial institutions familiarity with industry conditions which in turn affects risk premiums required; existence of potential local demand; and existence of role models provided by successful firms.

8 It should be noted that in Cross (1981, 276) industrial specialisation not dominated by a single industry is classified as a positive factor for new firm formation.

9 In contrast, in other country contexts, econometric estimates of regional specialisation variables have produced positive results (Garofoli, 1992; Reynolds, 1994).

Keeble and Walker (1994) maintain that population density should be broadly interpreted as a measure for the existence of either agglomeration economies or diseconomies which are related to cost of premises, labour and accessibility/congestion. The effect of population density on both sectorally independent and manufacturing new firm formation activity has been found positive and significant, confirming that large cities still act as nurseries or incubators for enterprise.

Small firm presence has been one of the most celebrated positive effects on regional new firm formation rates.[10] Small firms have been seen as better incubators for potential new firm founders than large firms (Cross, 1981) since working for a small firm gives employees the chance to familiarise themselves with the entire spectrum of operational processes (Storey, 1982). This provides them with a wide range of task experiences but also gives them closer direct contact with the firm proprietor who can serve as a role model (Lloyd and Mason, 1984, Mason, 1991). In addition, as employment in small firms is often less secure and less well paid than in a large firm, individuals working in small firms are more likely to consider entrepreneurship (Storey, 1982). Alternatively, dominant small plant structures can also reflect the existence of low entry barriers (Gudgin, 1978) and/or the 'youthfulness' of an industry (Cross, 1981).

The empirical evidence supporting the idea that small firm presence is a key determinant in explaining increases in new firm formation is overwhelming. It has concentrated on particular regions (Gudgin, 1978; Johnson and Cathcart, 1979; Cross, 1981; Storey, 1981; Gould and Keeble, 1984; Gudgin and Fothergill, 1984; Lloyd and Mason, 1984), covered the UK (Whittington, 1984; Moyes and Westhead, 1990; Westhead and Moyes, 1992; Love, 1996) or the Great Britain as a whole (Ashcroft et al., 1991) at various levels of spatial disaggregation.

Keeble and Walker's (1994) results further suggest that while small-plant structures may be conducive to firm births in manufacturing industries, this might not be the case in the services sector as new firms are often started by individuals formerly employed in large firms.

3.3. Access to capital and home ownership

Mason (1991) argues that spatial variations in home ownership and house prices are significant as new firm starters can raise capital by using their homes as collateral. The home ownership variable may have both a supply-side role related to its fund-raising capacity and a demand-side effect signalling more wealthy markets (Ashcroft et al., 1991), as well as partially reflecting the local occupational structure (Keeble and Walker, 1994).

The results of Whittington (1984) and Ashcroft et al. (1991) support the hypothesis that associates higher levels of regional home ownership with higher levels of new firm

10 The present study does not employ a variable that explicitly accounts for regional firm size structure due to data constraints. In particular, up to 2002, the ONS PA1003 publication provides firm size data (starting from the 1–9 employees stratum) for manufacturing firms only, while from 2003 onwards, relative ONS publications cover all industries and size bands starting from the 0–4 employees size class. As the present study covers new firm formation in all sectors of the economy, the above data sources could not be combined.

formation activity. However, other studies (Johnson and Parker, 1996; Love, 1996; Robson, 1996) offer rather mixed results.[11]

3.4. Demand side factors

It has been suggested that many new firms, at least in their first period of operation, tend to serve local markets (Gudgin, 1978; Cross, 1981; Storey, 1982; Lloyd and Mason, 1984, Moyes and Westhead, 1990). Consequently, the growth of local demand for goods and services may be important for new firm formation activity. Keeble and Walker (1994) find that the effect of Gross Domestic Product (GDP) growth has been insignificant when new firm formation and growth rates have referred to the total economy, but significant when non-manufacturing sectors were dealt with separately by the econometric analysis. In contrast, Robson (1996) and Johnson and Parker (1996) produce statistically insignificant results.

3.5. Human capital

The attributes of the labour force have been associated with entrepreneurial activity early in the UK literature. Gudgin et al. (1979), Cross (1981), Lloyd and Mason (1983) and Storey (1982) all concur that the level of skills possessed by individuals in a labour market area and the associated labour market of employment are significant factors in accounting for the spatial variations in the rate of new firm formation and entrepreneurship. Cross (1981) highlights that the propensity for self-employment, for example, is higher for individuals with previous managerial experience, a point noted by Storey (1982) too, while Lloyd and Mayson (1983) point out that skilled manual workers are more prone to establish their own firms than workers with no or little skills as they have acquired the necessary problem-solving skills. Furthermore, survey evidence provided by Cross (1981) suggests that the level of administrative employment is positively associated with new firm start-ups, whereas the level of operative employment is negatively associated. Gould and Keeble (1984) also find a strong and positive correlation in specific locations between new firm formation, adjusted for industrial structure, and the percentage of the resident male population in non-manual occupations. Westhead and Moyes (1992) extend this conclusion to Britain as a whole.

Paralleling the suggestive survey and statistical analysis based evidence have been econometric results in a number of British studies which clarify the effect of local occupational structures on new firm formation. Whittington (1984) finds the proportion of manual workers to have a negative and significant effect in accounting for variations in new firm formation across UK regions and Ashcroft et al. (1991) find that the degree of managerial background in a county has a strong positive effect in determining spatial variations in new firm formation in Great Britain. Keeble and Walker (1994), using the percentage of resident economically active population in non-manual socioeconomic groups to proxy occupational structures that relate to professional, managerial and non-manual expertise, find a positive, and statistically significant, effect on both firm births and deaths in the UK counties.

11 The omission of a variable on house prices could be seen as a potential limitation of the present study.

Yet these features of local labour markets are associated not only with a greater supply of entrepreneurs but also with certain qualitative aspects of this supply. Mason (1985) and Barkham (1992) argue that the bias of the spatial distribution of fast-growing firms towards England's south has largely been due to the favourable occupational structure therein. The latter ensures for the local availability of necessary skills, abilities, motivation along with the capability of achieving rapid growth. This favourable milieu, as Mason argues, reinforces the structural advantage of England's south. This concurs with Massey (1995) who critically points out that the lack of entrepreneurship for which some regions have been blamed upon is only one aspect of class structure and their lack of small capital and white collar and technical strata from which, it is argued, entrepreneurs emerge.

On more theoretical grounds, a number of more recent studies for the US highlight the role of regional human capital (proxied by the education level) on regional new firm formation and provide positive supportive evidence (Acs and Armington, 2004; Lee et al., 2004).[12] The theory behind this evidence connects the benefits of human capital to entrepreneurial activity at both the individual and the regional level. At the individual level, human capital, embodied in general and specific skills, facilitates the implementation of new ideas (Acs et al., 2007) and it is related to opportunity identification and pursuit.

Externalities produced by human capital have been associated to urban economic growth (Glaeser et al., 1995) through knowledge spillovers, whereas the productivity gains from the geographic concentration of human capital have been considerable (Rauch, 1993). These externalities may in turn provide a more favourable and promising environment for new firm formation. The knowledge-spillover theory of entrepreneurship (Audretsch and Keilbach, 2006) suggests that knowledge is a source of entrepreneurship opportunities. However, the understanding and exploitation of these opportunities crucially depend on 'entrepreneurial absorptive capacity', defined as entrepreneurs' ability to comprehend new knowledge and its value and commercialise it through new business ventures, something that requires both scientific and business knowledge (Qian and Acs, 2011). Human capital thus creates new knowledge that in turn provides new entrepreneurship opportunities while simultaneously contributing to the creation of entrepreneurship absorptive capacity.

Levie (2007) provides UK-based evidence suggesting that immigrants and regional in-migrants are more prone to entrepreneurship than lifelong residents of the same region. This has been partly attributed to their better education and training. Houston et al. (2008) critically examine whether Florida's (2002) proposition that regions should attract members of the 'creative class'[13] in order to enhance their economic success prospects would be a valid option for Scotland. Their findings challenge the perception that skilled interregional and international migrants respond to quality of life stimuli as they appear to move more in response to economic forces.

12 There is, however, some evidence suggesting that new firm formation in manufacturing might be different in this respect (Hart and Gudgin, 1994; Reynolds, 1994).

13 It includes a wide range of occupations such as science, engineering, education, computer programming, research, arts, design, media workers, health care, business and finance, legal sector. Lee et al. (2004) produce evidence from U.S. regions suggesting that creativity is a significant positive determinant of new firm formation.

3.6. Summary of previous empirical evidence

The previous sections discussed the empirical evidence on the determinants of new firm formation that are of particular importance to the present study. While the evidence reviewed primarily comes from UK studies, where appropriate, an effort was also made to contrast UK evidence with evidence arising from other country contexts.

The evidence reviewed suggests that the effect of unemployment has been rather ambiguous, although more recent evidence seems to imply that unemployment has a negative effect on new firm formation and changes in unemployment levels have been found to be insignificant. With regard to the role of regional industry mix, more recent studies find it increasingly important. Regional specialisation has been traditionally associated with declining manufacturing sectors thus bearing negatively on regional new firm formation. This negative association has given way to the positive role of regional specialisation in business services and the financial sector, and holding more positive results for the effect of regional specialisation on regional new firm formation. Regional diversification, on the other hand, appears to be either insignificant or related only to a specific spectrum of sectors. There is also recent non-UK evidence suggesting that vertical disintegration and clustering have a positive effect on regional new firm formation. A number of determinants relating to regional demand conditions, access to capital and availability of collaterals at the regional level as well as increased presence of small firm presence at the regional level have retained their importance over the years. The role of human capital as a source of positive externalities benefiting local entrepreneurship and also as a decisive factor (together with local occupational structures and existing entrepreneurial activity) in explaining persistence in regional new firm formation has been acknowledged as increasingly important.

4. Data and definitions of variables used

The econometric analysis herewith covers the period 1998–2007, the analysis of regional new firm formation distribution dynamics presented in Section 6 covers the period 1994–2007, and the regional disaggregation level is that of NUTS II. There are 30 NUTS II regions for England, 2 for Wales, 4 for Scotland and 1 for Northern Ireland.

Fritsch and Mueller's (2007) analysis for Germany employed 20 years of observations whereas Andersson and Koster's (2011) analysis for Sweden used 11 years. Ideally, the analysis of a longer time period would have benefited the research purposes of the present study. However, although a separate dataset is available for the period 1980–1993, these figures, according to BERR (2008), could not be directly compared with those in the 1994–2007 file due to large increases in the compulsory VAT registration thresholds in 1991 and 1993.[14]

New firm formation rate (*NFFR*):

Data on VAT registrations (Department for Business, Enterprise and Regulatory Reform (BERR)) NUTSII were used to proxy new firm formation at the NUTS II level. VAT data for 1994–2007 were provided by NOMIS. New firm formation rates were defined as the regional VAT registrations divided by the corresponding active

14 See also http://webarchive.nationalarchives.gov.uk/+/http://stats.berr.gov.uk/ed/vat/index.htm.

population figures. The latter were provided by the Cambridge Econometrics European Regions Database (Summer 2010 edition).

Two broad approaches to standardise new firm formation counts for the production of regional new firm formation rates exist. The first, 'the ecological approach' (Audretsch and Fritsch, 1994), uses the stock of already operating firms as a standardising measure. The use of stocks of firms has been heavily criticised by Garofoli (1992, 1994) because (i) unaccounted-for inequality in the size distribution of firms across space which may introduce bias giving rise to artificially new firm formation rates in regions characterised by large firm structures; and (ii) this seems to imply some sort of 'causality' in the relationship between existing firms and new firms.

The second, 'the labour market approach' (Audretsch and Fritsch, 1994) uses some proxy of the size of local labour market and relies on the argument that it is primarily individuals and not firms who create new firms and often in the same labour market area where they were working as employees (Gudgin, 1978; Fothergill and Gudgin, 1982; Lloyd and Mason, 1984). In the empirical literature, variants of the 'labour market' approach have been employed using the number of production workers (Moyes and Westhead, 1990), total civilian labour force (Keeble and Walker, 1994) and the number of inhabitants (Mueller et al., 2008). As '*entrepreneurs come from the unemployed as well as those in employment*' (Ashcroft et al., 1991, 396), the economically active population was preferred here as the denominator in defining regional NFFR.

The use of VAT registration data for proxying new firm formation is not without its problems. Over the years, the turnover threshold for VAT registration has often changed in pace with inflation while the existence of the threshold has itself meant that many small firms have been excluded from the VAT data (Johnson and Conway, 1997). According to BERR (2008), at the beginning of 2007, only 2 million out of an estimated 4.7 million existing enterprises in the UK were registered for VAT. According to the same source, one-fifth of VAT-registered enterprises had a turnover below the VAT threshold as some firms voluntarily register for VAT. Mason et al. (2011) has also drawn attention to home-based businesses that have a distinctive geography favouring non-metropolitan areas and which have gone largely unaccounted for in VAT registration data. Johnson and Conway (1997) point out that VAT registration often results from business re-reorganisations, i.e. a change of ownership or the purchase of an existing firm, thus rendering the distinction between new firm formation and entry through the acquisition of an existing business more difficult. The identification of the starting date of a new business through the use of VAT registration data also becomes problematic. What seems to have particular bearing on regional analyses, however, is that, according to Johnson and Conway (1997), entry through the acquisition of an existing business presents some sectoral bias (more so in retail and other services than in manufacturing), which in turn may, to some extent, result in regional bias through the effect of regional industry mix. Despite these weaknesses, VAT registration data have been extensively used for regional analyses of new firm formation (Storey and Johnson, 1987; Moyes and Westhead, 1990; Ashcroft et al., 1991; Keeble and Walker, 1994; Johnson, 2004; Anyadike-Danes et al., 2005; Mueller et al., 2008) as they represent '*the most up-to-date, comprehensive, reasonably long-term and spatially disaggregated data source currently available for such investigation*' (Keeble and Walker, 1994, 413–414) and they are the data that the UK policy makers employ and are likely to continue employing (Anyadike-Danes et al., 2005).

Regional industrial diversity (*THEIL*):

The Theil (1972, 26) regional diversity entropy measure $H_r = \sum_i (p_{ri}/p_r) \log (p_r/p_{ri})$ was used. Where $p_{ri} = E_{ri}/\sum_i \sum_i E_{ri}$, having the properly that $\sum_r \sum_i p_{ri} = 1$, E_{ri} is the employment in industry $i = 1, \ldots,$ J and region $r = 1, \ldots, R$, and $p_r = \sum_i p_{ri}$. This measure takes the value of 0 when only one sector is present in region r and the value ln(n) where all n industrial sectors employ the same number of persons in the region in question. To bound the index in the [0, 1] interval, its value is further divided by the log(15). Data on regional employment in 15 broadly defined sectors were obtained from Cambridge Econometrics. The list of these sectors can be found in the Appendix Table A1.

Population density (*POP_DENS*):

Population density was defined as population/area. Both data on population and area were obtained from Cambridge Econometrics.

Specialisation (*SPEC*):

A relative specialisation index was used: $SPEC_r = 1/2 \sum_i E_{ir}/E_r - E_{in}/E_n$, where E_{ir} is the employment in industry $i = 1, \ldots, J$ sectors and $r = 1, \ldots, R$ regions at some point in time. E_{in} is the employment in sector i nationally and E_r and E_n refer to total sectoral employment at the regional and national level, respectively. The index ranges between 0 and 1 taking the value of 1 when only one sector is present in the area and 0 when the sectoral structure of an area is identical to that of the nation as a whole. The same sectors were used as in the construction of *THEIL* above.

Human capital (*HUMAN_CAP*):

Data from Labour Force Survey on the highest educational level attained for people 25–64 years old were used. The data were provided by Eurostat and consider three levels of education, namely low (lower secondary), medium (upper secondary) and high (third level). *HUMAN_CAP* is defined as the ratio of people with high level education over the regional sum in all three categories.

Unemployment rate (*UN_RATE*):

Following Acs and Armington (2004), this is defined as preceding 3-year regional average using data from Cambridge Econometrics.[15]

Home ownership (*HOME_OWN*):

Data on percentage of households that own their houses outright come from the 2001 England and Wales Census. For Scotland, the data come from the 2001/2002 Scottish Household Survey. The Northern Ireland Statistics and Research Agency provide data on dwelling type and accommodation type by tenure from the 2001 Census. Outright ownership is also available although it does not pertain to households but to all persons in households.

15 Note that in the present panel data context this 3-year average is allowed to change over time.

Regional GDP growth (*GDPGR*):

This is defined over the preceding 3 years using data from Cambridge Econometrics and is used to proxy regional demand growth as has often been the case in the relative literature (Reynolds et al., 1994).

Vertical integration (*VERTICAL*):

GROSS VALUE ADDED/TURNOVER (Adelman, 1955) defined at the NUTS I level using data from the Annual Business Inquiry. Its rationale follows the preceding discussion (Section 3.2) regarding spatially confined inter-industry linkages, external economies and industry clusters, and its introduction follows Fotopoulos and Spence (1999). In particular, the extent of local production links for a given level of spatial aggregation maybe inversely proxied by some notion of vertical integration of economic activity spatially. The latter is assumed to have a negative effect on new firm formation. As the present study does not employ a variable to account for the extent of small firm presence locally, *VERTICAL* may be seen as partially accounting for spatial firm size structures as long as vertically integrated firms are also larger firms.

Industry mix (*I_MIX*):

It is essentially an industry mix shift-share component wherein a hypothetical number of new firms per region is calculated by applying national level industry entry rates on regional stocks of firms by industry. From this hypothetical number of new firms, the number of new firms in each sector that could be allocated to the region according to its share in national stock of firms is subtracted to assess the effect of industry structure in excess of what the relative magnitude of a region would have justified. The resulting number is further standardised by dividing it by the regional active population (Fotopoulos and Spence, 2001).

Manufacturing share (*MAN_SHARE*):

Manufacturing share is an alternative control variable to account for regional differences in industry structure. It is defined as the share of manufacturing VAT-registered stock of firms for each of the 37 NUTS II using BERR data.

As the data used are organised along two dimensions, regions and years, it may be helpful to examine the main source of variability in the dependent variable and in key explanatory variables.

The variance of a variable can be decomposed as:

$$\frac{1}{NT}\sum_{r}\sum_{t}(x_{rt}-\bar{x})^2=\frac{1}{NT}\left(\sum_{r}\sum_{t}(x_{rt}-\bar{x}_r)^2+T\sum_{r}(\bar{x}_r-\bar{x})^2\right)$$

where $\bar{x}_r=\frac{1}{T}\sum_{t}x_{rt}$ is the cross-sectional mean,

$\bar{x}_t=\frac{1}{N}\sum_{i}x_{rt}$ is the year mean, and

$\bar{x}=\frac{1}{NT}\sum_{r}\sum_{t}x_{it}$ is the grand (overall) mean.

Table 1 provides the variance decomposition as it would be if there was no between-year variation to be accounted for.

Table 1. Variance decomposition for key variables to account for sample variation due to regional specific effects: 37 NUTS II regions for the 1998–2007 period

	Mean	Total sample variation $\sigma^2 = \frac{1}{NT}\sum_r \sum_t (x_{rt} - \bar{x})^2$	Average within-region variation $W_n = \frac{1}{NT}\sum_i (x_{rt} - \bar{x}_r)^2$	Between-region variation $B_n = \frac{1}{N}\sum_i (\bar{x}_r - \bar{x})^2$	B_n/σ^2	Bn/Wn
NFFR	0.0057	2.00106e-006	1.4459e-007	1.8564e-006	0.9277	12.8398***
THEIL	0.8199	0.0016	3.0544e-004	0.0013	0.8118	4.3144***
SPEC	0.0973	0.0021	1.2196e-004	0.0020	0.9412	16.019***
HUMAN_CAP	0.2804	0.0032	5.2236e-004	0.0027	0.8354	5.0742***
I_MIX	−0.0028	6.8210e-005	2.3991e-006	6.5811e-005	0.9648	27.4318***
MAN_SHARE	0.0900	5.8367e-004	3.9731e-005	5.4394e-004	0.9319	13.6904***
VERTICAL	0.3236	4.9530e-004	9.3412e-005	4.0189e-004	0.8114	4.3023***
UN_RATE	5.3515	3.2374	0.7961	2.4413	0.7541	3.0667***

Notes: Multiplying each of the figures of the last column by 333/36 provides the value of an F test with 36 and 133 degrees of freedom for testing the hypothesis that regional means are not all the same. This is exactly the same test as that obtained by carrying out a one-way analysis of variance for each of the variables that appear in the first column.
***Significant at the 1% level.

The fourth column shows the between-regions variation in relation to total sample variation for each of the variables of interest. Around 93% of the variation of the new firm formation rate is accounted for by differences between regions that are time-invariant. The corresponding percentages for most of the other variables, excluding the unemployment rate, are above 80%. However, even the interregional differences in unemployment rates persist, considerably time as the between-regions variation for this variable accounts for slightly over 75% of the total. All in all, the dependent variable as well as the explanatory variables which the present research focuses on are characterised by vast amounts of between-regions variation.

5. Results of econometric analyses

In Table 2, presenting the econometric results, the population density (*POP_DENS*) variable is separated from the Theil index (*THEIL*) as their between correlation is −0.5465. On the other hand, both the Theil diversity index and the specialisation (*SPEC*) are included in the same regressions since specialisation and diversification are not mutually exclusive. A well-diversified region may still host a larger share of a particular sector when compared with other regions. This follows a practice (Van der Panne, 2004; Van Oort and Atzema, 2004) where specialisation and diversification indices are both included in the same regressions. Moreover, the correlation coefficient between *THEIL* and *SPEC* in this study is 0.0689.

The results reported in column (1) of Table 2 are pooled Ordinary Least Squares (OLS) results with heteroscedasticity-consistent standard errors. All the variables included are statistically significant. In particular, the results seem to indicate that regions with lower sectoral diversity and higher relative specialisation are those with higher new firm formation rates. These results seem to favour a M.A.R. notion of

Table 2. Results of econometric estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$NFFR_{t-1}$									0.5478***
									(0.1206)
THEIL	−0.5593**	−0.0715	−0.6208	−0.6295***					
	(0.2424)	(0.1988)	(0.5400)	(0.1850)					
SPEC	0.9855***	0.2729	0.9900**	1.0811***	0.2416*	0.2245	0.1206	0.6264***	
	(0.1934)	(0.2533)	(0.4231)	(0.0818)	(0.1502)	(0.2560)	(0.4192)	(0.0636)	
POP_DENS					0.0628***	−0.0823***	0.0532***	0.0496***	
					(0.0072)	(0.0169)	(0.0164)	(0.0051)	
HUMAN_CAP	0.7899***	0.3403***	0.8424**	0.5720***	0.3691**	0.3785***	0.8578**	0.1043	0.9644***
	(0.1722)	(0.1185)	(0.3724)	(0.1683)	(0.1634)	(0.1203)	(0.4118)	(0.2185)	(0.1321)
UN_RATE	−0.0098**	−0.0089**	−0.0089	−0.0223***	−0.0267***	−0.0108**	−0.0108**	−0.0412***	−0.0106***
	(0.0051)	(0.0043)	(0.0062)	(0.0024)	(0.0051)	(0.0043)	(0.0045)	(0.0058)	(0.0039)
HOME_OWN	0.7729***		0.8231*		1.1306***		1.4486***		
	(0.2719)		(0.4986)		(0.2567)		(0.4887)		
GDPGR	0.4823***	−0.0752	−0.0752	0.4418***	0.4350***	−0.0654	−0.0654	0.3914***	
	(0.1496)	(0.0600)	(0.0698)	(0.0807)	(0.1366)	(0.0581)	(0.0651)	(0.1010)	
I_MIX	0.5584***	0.3812	0.6404	0.2903***					
	(0.1357)	(0.3699)	(0.4002)	(0.0667)					
MAN_SHARE					−0.0017	−0.0012	0.0018	−0.0041*	
					(0.0030)	(0.0039)	(0.0081)	(0.0022)	
VERTICAL	−0.0101***	−0.0073**	−0.0073***	−0.0107***	−0.0021	−0.0074**	−0.0074	−0.0041**	−0.0152***
	(0.0029)	(0.0030)	(0.0024)	(0.0020)	(0.0026)	(0.0033)	(0.0027)	(0.0020)	(0.0035)
CONSTANT	0.0084***	0.0080***	0.0080	0.0127***	0.0025	0.0082***	0.0012	0.0081***	0.0053***
	(0.0028)	(0.0019)	(0.0049)	(0.0015)	(0.0016)	(0.0016)	(0.0023)	(0.0004)	(0.0014)
PESARAN'S CD		35.551***				32.364***			
SARGAN									32.7518
AR(2)									−1.2161
Wald									145.18***
R^2	0.4572	0.9295	0.9292	0.4359	0.5490	0.9294	0.9291	0.5018	

Standard errors are given in parentheses. *Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

externalities. This result may be seen in conjunction with those of Anyadike-Danes and Hart (2007), where the positive effect of specialisation in business services is highlighted, and those of Bishop (2012) where regional diversity, in general, was not found to be a significant determinant of regional new firm formation in the UK.[16]

The human capital variable (*HUMAN_CAP*) is positive and significant. This result accords with those of Acs and Armington (2004) and Lee et al. (2004) for the US. Ameliorating regional economic conditions as proxied by regional GDP growth over the 3-year proceeding period are found to positively affect new firm formation, but the same does not hold for the regional unemployment rate averaged over the same time period. The negative effect of the latter on new firm formation suggests that the negative demand pull effect is larger than the whatever push effects and conforms with earlier results by Love (1996) and Johnson and Parker (1996). The vertical integration variable (*VERTICAL*) as an inverse proxy of the extent of local production links has a negative effect on new firm formation rates. This highlights the positive role of local production links for new firm formation. Local production structure is also important in determining interregional differences in new firm formation as the significance of the *I-MIX* control variable suggests. Home ownership (*HOME OWN*) accords with the results of earlier studies having a positive effect on regional entrepreneurship.

The effect of population density (*POP_DENS*), along with that of other variables, is examined in (5) within a pooled OLS setting, the difference being that *THEIL* and—in place of the industry mix control—the share of manufacturing share in the local stock of firms has been used instead. The effect of *POP_DENS* is positive and statistically significant. This result accords with that of Anyadike-Danes et al. (2005) where new firm formation rates for 65 counties averaged over the 1980–1999 period were regressed on population density. The latter was found to be positive and significant. In model (5) the vertical integration proxy becomes statistically insignificant.

Provided that most of the variation in the dependent variable comes from the regional dimension of the data, the next step is to estimate the models of column (1) and (5) allowing for regional fixed effects (regional dummies have been absorbed). The results of this estimation are reported in columns (2) and (6) where the corresponding standard errors are heteroscedasticity-consistent. The *F* test for the collective significance of regional fixed effects suggests, as could be anticipated, that these are indeed significant (the corresponding test values for models (2) and (5) in Table 2 are 72.88 and 63.27, respectively). As *HOME_OWN* is, by construction, time invariant, it is dropped from the regional fixed effects estimation reported in columns (2) and (6). The inclusion, however, of regional fixed effects renders the coefficients of the diversity index (*THEIL*), relative specialisation (*SPEC*), GDP growth and industry mix insignificant in column (2). In column (6) SPEC becomes insignificant but population density reverses sign to negative but remains significant. This problem has been aptly described by Beck (2001, 285): '*although we can estimate [equations] with slowly changing independent variables, the fixed effects will soak up most of the explanatory power of those slowly changing variables*. [and] *will make it hard for such variables to appear either substantively or statistically significant*.'

Plümper and Troeger (2007) propose a three-step estimator called fixed-effects vector decomposition (FEVD) to deal with this problem as they perceive it is not only

16 See also discussion in Section 3.2.

significance levels that are affected but estimates become unreliable too. The results of applying the FEVD estimator that allows for the estimation of time-variant coefficients and time-invariant variables are presented in columns (3) and (7). The FEVD restores the statistical significance of *SPEC* in (3) while the same is not evident in (8). Conversely, population density becomes again positive in (7) in comparison to (6). Since FEVD makes it possible, the home ownership variable is reinstated in (3) and (7) where it was found positive and significant.

Models (4) and (8) use Driscoll and Kraay's (1998) consistent covariance matrix for spatially dependent panel data and thus allowing the residuals belonging to different regions to be correlated. The erroneous disregard of spatial dependence can lead to severely biased statistical results. This sort of spatial dependency is validated by the use of Pesaran's (2004) appropriate test based on fixed effects residuals. However, as accounting for regional fixed effects has been demonstrated to seriously affect estimates, spatial dependence was accommodated in the estimation in the absence of regional fixed effects.

In terms of the direction of the effects and statistical significance of the corresponding coefficients, the results of column (4) are comparable to those of column (1), and the results of column (8) comparable to those of column (5). In this last comparison the improvement of the statistical significance of the manufacturing share control variable when accounting for spatial dependency may be noted.

Overall the results obtained seem to suggest that human capital is important in enhancing new firm formation rates in UK regions. Better local economic conditions, as captured by GDP growth and lower unemployment rates, promote entrepreneurship at the regional level. Regions that are more specialised, less diversified and more densely populated have higher new firm formation rates.

The latter result can be discussed in the context of research studying spatial patterns of sectoral diversity in the UK. O'Donoghue and Townshend (2005) find that in the period 1991–2001 the largest travel-to-work areas were becoming more specialised, while the smaller ones were becoming more diversified. In addition, Bishop and Gripaios (2007) didn't find any evidence for a significant effect of population density on total regional diversity.

Lastly we question whether past regional new firm formation rates determine future ones. Here, a dynamic panel data model was estimated using the Blundell and Bond (1998) system estimator. The latter uses moment conditions in which lagged differences are used as instruments for level equation in addition to the moment conditions of lagged levels as instruments for the differenced equation. Robust standard errors were obtained using Windmeijer's (2005) methodology. The system estimator is particularly suited in cases where the contribution of panel fixed effects to total variance becomes large. The dynamic panel model was formulated so to keep the number of instruments less than the number of cross-sectional units (regions) following suggestions by Windmeijer (2005). Column (9) in Table 2 presents the results of estimating the dynamic panel data model. This rather minimalistic right hand side variable deployment uses 33 instruments which is less than the 37 regions used in the analysis.[17] The choice of

17 Despite having only an 11-year period for observation (1994–2004), Andersson and Koster (2011) are able to explore the effect of more lags. The difference with the present study lies in the scale of the spatial dimension which amounts to 286 municipalities in the Swedish study.

instruments passes the Sargan test criterion and the model does not suffer from second-order autocorrelation. The results obtained suggest that new firm formation rates in the previous period positively affect those in the next.

6. Distributional change and intra-distribution mobility dynamics

The analyses of the two previous sections produced evidence suggesting that the main source of variation in both the regional new firm formation rate and its main determinants arises from between- rather than within-region variation while past new firm formation rates determine future ones. This section examines persistence in interregional differences in new firm formation rates from different, but complementary to the analyses of the previous sections, angles. The first is that of examining changes over time in the shape of the regional new firm formation distribution, thus assessing the degree of persistence in the external shape of the distribution. The second is that of assessing the extent of intra-distribution mobility. The latter seeks to answer whether it is the same, or different, regions occupying particular parts of the relevant distribution at different points in time.

In this way, the point of departure here is to assess the extent to which the external shapes of the relative NFFR distributions change between 1994 and 2007. To accomplish this, empirical density estimates (Silverman, 1986) for both years were produced using Gaussian kernels and the bandwidth selection method proposed by Sheather and Jones (1991). Figure 1 presents these empirical density estimates. The two distributions differ in the tails. The left tail of the 2007 distribution lies below that of the 1994 one. The mode of the 2007 distribution comes earlier and there is a larger concentration of probability mass under the 2007 curve for relative NFFR between the 0.565 and 1.2 times the national average.

The relevant question is how significant these differences in shape really are. A procedure proposed by Granger et al. (2004) was used in order to test the null

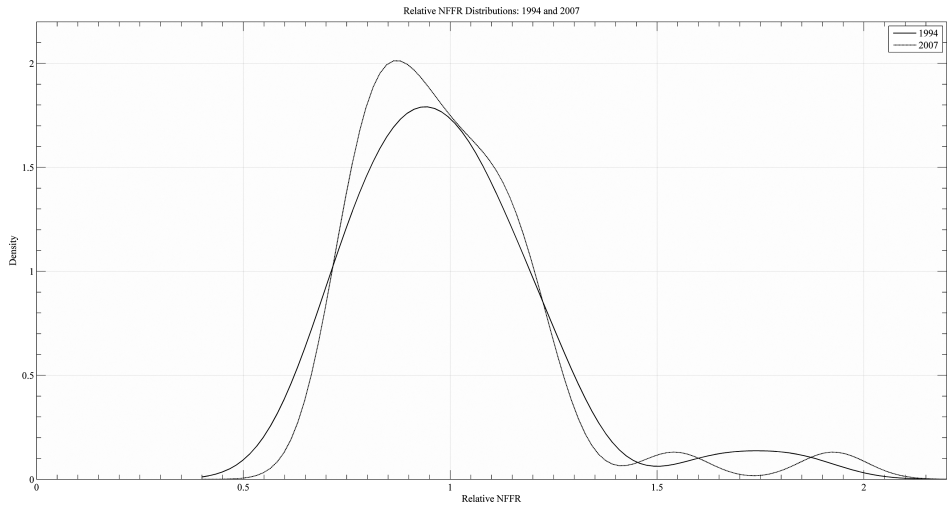

Figure 1. Empirical density estimates for relative NFFR: 1994 and 2007.

hypothesis of the equality of distributions.[18] The testing procedure fails to reject the null hypothesis of equal distributions producing a test value of 0.0144 with probability value of 0.8346. Levie and Hart (2008), analyzing data from the UK G.E.M., note that there is a continuing pattern of no substantial change in entrepreneurial activity rates between 2002 and 2008. A similar picture is drawn in the 2007/8 G.E.M. report for Scotland (Levie and Mason, 2008) where start-up rates have hardly changed since 2000.

In Figure 2 the quintiles of NFFR are mapped using the 1994–2007 average for each region.

As in Keeble and Walker (1994) using VAT data, and Levie and Hart (2008) where G.E.M. data were used, a broad north-south divide in entrepreneurial activity in the UK becomes evident in Figure 2 with a gradual decline towards the north. In Scotland the exception is the Highlands and Islands region, while the rest of Scotland, the North East and North West of England appear to be at the bottom end of new firm formation distribution. As in previous studies, London, South East, South West and parts of the East of England are among the best performers. Earlier studies (Fothergill and Gudgin, 1982; Mason, 1991; Keeble and Walker, 1994; Keeble and Tyler, 1995), using VAT business registration data, suggest that there is a significant urban–rural shift in entrepreneurial activity in the UK that is primarily due to environmentally stimulated interregional migration. Ashcroft et al. (1991), on the other hand, find a statistically insignificant effect of rurality in explaining new firm formation in UK counties for the 1980–1986 period.

More recent evidence (Levie and Hart, 2008) highlight that, apart from the north-south divide, there is a second pattern discerned in the G.E.M. entrepreneurship data favouring rural areas of Scotland (see also Levie and Mason, 2008) and South West of England. Using Eurostat's typology[19] that classifies regions as primarily rural, primarily urban and intermediate ones, the NFFR mapped in Figure 2 broadly conforms with the patterns suggested by Levie and Hart (2008).

It is possible that the persistent external shape of the distribution may mask intra-distributional regional mobility over time. That is, in principle, the external shape of the distribution may not change despite there having been a considerable degree of changes in the identities of regions occupying different parts of the relevant distribution. A graphic device suggested by Trede (1998) for assessing mobility was employed. This uses nonparametric methods to estimate quantile curves of the conditional cumulative distribution function (c.d.f.). The conditional c.d.f. is estimated using the following equation:

$$\hat{F}_{\tau}(y|x) = \frac{\sum_i K\left(\frac{x-x_i}{h_x}\right) R\left(\frac{y-y_i}{h_y}\right)}{\sum_i K\left(\frac{x-x_i}{h_x}\right)}$$

where $R(z) = \int_{-\infty}^{z} K(u)du$ is the integrated kernel, $K(\cdot)$ is a Gaussian kernel $\left(1/\sqrt{2\pi}\right)e^{-0.5(\bullet)^2}$, (h_x, h_y) represent bandwidths estimated using least-square cross-validation recommended for this purpose by Li and Racine (2008), y stands for $NFFR_{t+\tau}$

18 The test was performed using the np package (Hayfield and Racine, 2008) in R.
19 http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Urban-rural_typology.

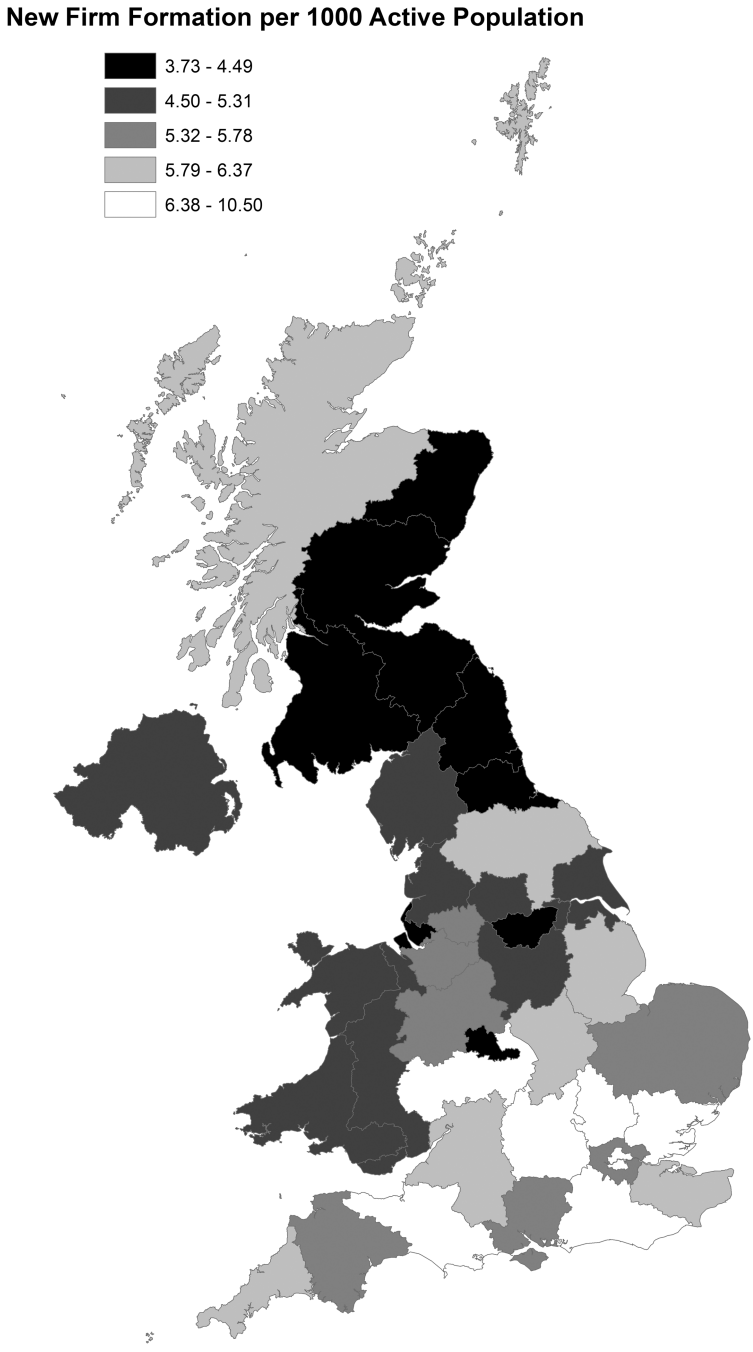

Figure 2. Spatial variations in new firm formation rates: 1994–2007 averages.

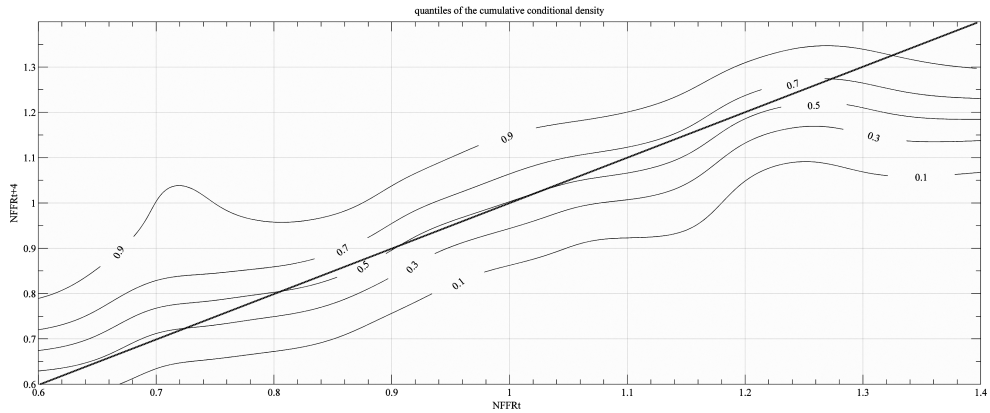

Figure 3. Nonparametric quantiles of the conditional c.d.f.

and x for $NFFR_t$. To get the quantiles of $F_\tau(y|x) = E((Y_i \leq y)|X_i = x)$, $\hat{F}_\tau(y|x)$ is numerically inverted to obtain $\hat{F}_\tau^{-1}(p|x)$ for selected p values.

This analysis uses data on the relative (to the mean) regional new firm formation rates for the period 1994–2006 that are organised to obtain three 4-year transitions: 1994–1998; 1998–2002; 2002–2006. The data for these years were pooled in order to perform the nonparametric regression and derive quantile curves of the conditional c.d.f. so all three 4-year transitions contribute to this estimation. Figure 3 presents these quantile curves. On the horizontal axis the relative regional $NFFR_t$ in the base year is measured, whereas the vertical axis measures the relative new firm formation rate 4 years ahead ($NFFR_{t+4}$).

As in Trede (1998), the graph has been truncated to exclude the edges of the sample as estimates there are likely to be inaccurate due to the scarcity of observations.

If regional immobility were perfect, then all quantile curves would coincide with the diagonal dashed line of inertia (or immobility), suggesting that relative regional new firm formation rates would be completely determined by regional new firm formation rates in the first period (base year) and that no region would alter its position in the relative new firm formation distribution over time. On the other hand, if past regional relative NFFR have no bearing on future ones, the quantile lines would be horizontal.

For NFFR up to 80% of the base year average, the 0.5 quantile curve lies above the diagonal suggesting that regions falling behind this relative NFFR value have more than 50% chance for improving their relative position in terms of NFFR over a 4-year period. However, this improvement would not be much for most regions in this range of base-year NFFR. Taking, for example, those regions that have a relative NFFR of 0.8, Figure 3 suggests that 90% of them will be confined to an NFFR of approximately 95% or less than the average NFFR over a 4-year period. Regions having a relative base-year NFFR between 0.8 and 1.04 have a 50% chance to improve their relative position as the 0.5 quantile curve closely follows the diagonal. Regions with a relative base-year NFFR of 1.32 or more have a less than 10% probability to improve their relative position over a 4-year period. At the centre of the relative NFFR distribution, the graph reveals the following: 50% of the regions with NFFR = 1 will not exceed that value over a 4-year transition period, whereas a 70% of them would not exceed a value of about 1.05, and

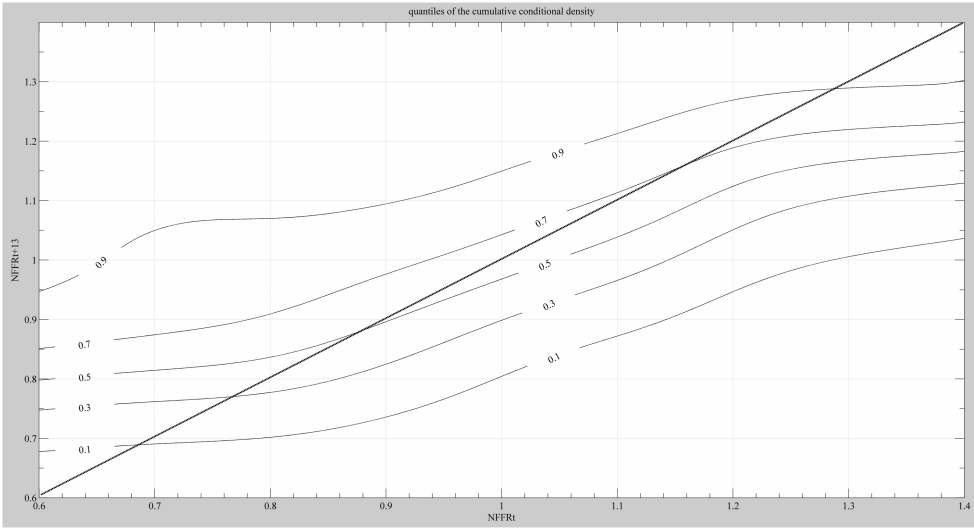

Figure 4. Nonparametric quantiles of the conditional c.d.f.: single transition.

90% would not exceed the value of about 1.16. Mobility is rather limited at the central part of the relative distribution.

As far as a 4-year transition period might be considered too short for any considerable intra-distribution mobility to become discernible, the analysis proceeds with the use of a single transition over a 13-year period at the expense of employing only 37 observations. Figure 4 presents these results[20] revealing a slightly higher mobility in the tails of the distribution and slightly larger tendency for the regions therein to revert towards the mean NFFR. The 0.5 quantile curve falls under the diagonal for base-year NFFR larger than about 0.88 meaning that regions falling short of that value in the base-year have a more than 50% chance to improve their position. This probability deteriorates for regions with a NFFR that matches the average in the base year, and less than 30% of those regions with a relative NFFR of about 1.2 exceed that value over a 13-year interval. For regions with a relative NFFR of 1.3, approximately 90% do not exceed that value.

The results obtained in this section further reinforce those from the econometric analyses. The external shape of the distribution of relative NFFR does not significantly change between 1994 and 2007 and intra-distribution mobility is limited.

7. Conclusions

This research is only the third of its kind following that conducted by Fritsch and Mueller (2007) and Andersson and Koster (2011). Its outcome sheds further light on an

20 The possibility that the persistence found in the analyses conducted herein could be partially dependent on the spatial scale chosen, i.e. NUTS II, was further explored using 121 spatial units that were in majority NUTS III regions, some NUTS II, amalgamations of NUTS III, and London as a single region. To define new firm formation rates, population aged 15–64 years from NOMIS was used. The main conclusions drawn for NUTS II also hold for this finer spatial disaggregation. The results are available upon request.

important issue regarding new firm formation in the UK regions, namely that of persistence.

Persistence is evident in our results in several ways. First, the main source of variation in the new firm formation defined over regions and years is between-region and not within-region variability. The same is also evident for the explanatory variables used in the econometric analysis. These results suggest that both new firm formation rates and their determinants are time persistent. In particular, the econometric results generally suggest that the more densely populated areas, those more specialised (and less diversified) and those with more human capital and extensive local production links were found to enjoy higher new firm formation rates. Moreover, better local economic conditions, as captured by GDP growth and lower unemployment rates, seem to promote entrepreneurship at the regional level along with a higher regional home ownership rate.

The econometric analyses were further complemented by nonparametric analyses to assess the extent that the shape of the relative (to the mean) new firm formation distribution across UK NUTS II changes over time and the extent to which intra-distribution mobility takes place. For this, nonparametric empirical density estimates were produced for both 1994 and 2007. These, in addition to a test for the difference between the estimated probability densities, suggested that the external shape of regional new firm formation distribution in the UK remains stable while, at the same time, the extent to which regions change their position within this distribution is limited.

Ideally, one would like to have a lengthier period of data to analyse, yet this remains adequate for the results to be placed within the context of the related literature. Moreover, the results obtained reinforce views drawn by reports using alternative data sources.

The main finding of this study, that new firm formation rates in the UK and their determinants are 'spatially sticky', has important policy implications. Policies aiming to increase regional business birth rates are, to some extent, antagonised by factors that are important to entrepreneurship but change slowly over time. Anyadike-Danes and Hart (2006, 823–824), in a UK context, suggest that as '*the geography of firm births is largely explained by a combination of extremely uneven industrial growth laid over a pattern of industrial specialisation*', business birth rate policies should take into account the distribution of the existing business stock and be both spatially and sectorally sensitive. The findings of the present study highlighting the importance of regional economic structures concur with these views. It has now been recognised that birth rate stimulation strategies require considerable time to yield any substantial results (Fraser of Allander Institute, 2001; Fritch and Mueller, 2007), while there have been concerns that policies aiming to increase the business birth rate in disadvantaged areas may to some extent achieve this at the expense of the quality of firms (Greene et al., 2004).

While designing and implementing policies to successfully and efficiently stimulate regional entrepreneurship is a difficult task, the results of the present study and its recent peers can propose an alternative approach to policy design. In effect, they suggest that policy makers should attempt to affect regional new firm formation by influencing its slow-changing determinants. Within this certainly long-run view, the results produced here recommend that attention is focused on policies that improve the quality of human capital available locally as well as policies enhancing the strength local production links.

Policies should also separate short-run targets from long-run ones in affecting new firm formation and differentiate their tools accordingly. To accomplish this, more research may be required both on the entrepreneurship front (i.e. to distinguish slowly changing determinants from possible faster ones also from other country contexts) and on that of policy evaluations.

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Appendix

Table A1. Sectors used for the construction of the *THEIL* and *SPEC* variables

Sector name	Sector code
Agriculture	A + B
Energy and manufacturing	C + D + E
Mining, quarrying and energy supply	C + E
Food, beverages and tobacco	DA
Textiles and leather, etc.	DB + DC
Coke, refined petroleum, nuclear fuel and chemicals, etc.	DF + DG + DH
Electrical and optical equipment	DL
Transport equipment	DM
Other manufacturing	DD + DE + DN + DI + DJ + DK
Construction	F
Market services	G + H + I + J + K
Distribution	G
Hotels and restaurants	H
Transport, storage and communications	I
Financial intermediation	J
Real estate, renting and business activities	K
Non-market services	L + M + N + O + P