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The spatial dynamics of new firm births during an economic crisis: the case of Great Britain, 2004-12.

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Abstract

Spatial variations in entrepreneurial activity have been shown to be a time persistent phenomenon in many countries. This paper analyses how these spatial variations have been affected by the recent financial crisis within the context of theories of regional resilience and adaptability. The analysis applies Exploratory Spatial Data Analysis techniques to data on firm births across Local Authority Districts of Great Britain during the period 2004-12. The results demonstrate that, whilst the overall shape of the spatial distribution of firm births remained persistent, there is evidence of an increase in regional inequality. This is primarily associated with a divergence between London and the rest of the distribution. London, together with part of its surrounding area, appears to constitute a resilient entrepreneurial regime that has generated a dynamic, adaptive response to the crisis with high rates of new firm formation in contrast to other regions which have remained locked into lower rates of entrepreneurship. This supports the view that regional entrepreneurship is a path dependent process: entrepreneurial regions are more adaptable to the effects of an exogenous shock than less entrepreneurial regions. Accordingly, entrepreneurship is a critical factor influencing the resilience of regions in responding to an economic crisis.

Keywords: Entrepreneurship, adaptability, regional resilience, spatial dynamics, spatial inequality.

1. Introduction

Since the 1980s, there has been a growing recognition of the importance of entrepreneurship to economic growth at both the national and local level (Mueller, van Stel and Storey, 2008). As a consequence, strategies aimed at encouraging enterprise have become part of the policy portfolio of governments seeking to improve the economic performance of poorly performing regions (Williams and Vorley, 2014; Anyadike-Danes and Hart, 2006). However, recent research in a number of countries has suggested that regional differences in new firm births are remarkably persistent over time and that this may be related to path dependency in regional development (Fotopoulos, 2013; Andersson and Koster, 2011; Fritsch and Mueller, 2008). This dependency may be associated with a variety of factors including entrepreneurial cultures (Fritsch and Wyrwich, 2012), regional industrial specialisation (Anyadike-Danes and Hart, 2006), regional knowledge accumulations (Essletzbichler and Rigby, 2005) and demonstration effects arising from entrepreneurial role models (Andersson and Koster, 2011).

Most of the recent research concerning persistence in firm births uses data that pre-date the world financial shock and recession of the late 2000s and covers periods of relative economic stability. Given the severity of the financial crisis and its uneven impact at both the national and regional level, it is of some interest to examine the extent to which previous spatial patterns in firm births have survived or been disrupted. Such an analysis also offers the opportunity to link entrepreneurship with the idea of regional resilience. This latter concept refers to the capacity of an area to withstand and adapt to exogenous shocks and has attracted considerable debate in recent academic literature (Martin, 2012).

It can be argued that enterprising behaviour is a key factor that enables regions to withstand crises and adapt to new economic conditions. However, as Williams, Vorley and Ketikidis (2013) note, the links between entrepreneurship and resilience have not been fully explored in the existing literature.

This paper examines the spatial pattern of new firm births during an economic crisis by presenting an empirical study of Great Britain during the period 2004-12. This embraces a period of relative economic stability, crisis and then gradual recovery. The crisis provided a particularly challenging environment for potential UK entrepreneurs as the scale of the crisis was severe due to the presence of a large financial sector in which the crisis originated and high existing levels of personal indebtedness (Smallbone et al. 2012). In addition, uncertainty concerning future prospects for growth made lenders less willing to provide finance to new and small firms due to the perceived risk of such ventures compared to lending to more established, larger firms (Price, Rae and Cini, 2013). Poor and uncertain growth prospects also undoubtedly reduced the perceived opportunities available to those considering new ventures. As a consequence of these factors, the new firm birth rate fell significantly during the period 2007-10.

The paper makes a contribution at a theoretical level by deepening the analysis of the links between persistence, resilience and regional entrepreneurship and, at an empirical level, by examining the issue within the context of a relatively new and up-to-date dataset. The analysis utilises an Exploratory Spatial Data Analysis (ESDA) methodology that incorporates a wide range of techniques including measures of inequality, spatial autocorrelation, global and local clusters and Markov chain methods. The analysis begins with a theoretical analysis

of the regional persistence of firm births rates and the links between entrepreneurship, adaptability and resilience, with a particular focus on notions of path dependency. This is followed by a discussion of the dataset and ESDA methodology. The analysis is then presented in four stages: first, an overview of the main features of the dynamic evolution of firm births using global measures of dispersion and inequality; second, a focus on broad regional patterns by decomposing the inequality measures across regions; third, a detailed examination of local clusters and spatial autocorrelation, and, finally an analysis of mobility and change using distribution dynamics. The paper concludes with an overview of the implications of the study for existing theory and future research on the spatial dynamics of firm births.

2. Regional entrepreneurship, persistence and resilience

There is considerable empirical support for the view that the incidence of entrepreneurial activity is heterogeneous across regions (Reynolds et al. 2005; Audretsch and Keilbach, 2007; Acs et al. 2009; Bishop, 2012). The time persistent nature of this heterogeneity has also been noted in studies of a number of countries including the Netherlands (Stel and Suddle 2008), the USA (Acs and Mueller, 2008), Germany (Fritsch and Wyrwich, 2012), the UK (Fotopoulos, 2013) and Sweden (Andersson and Koster, 2011). Several of these studies have suggested explanations based on a path dependency framework (Fotopoulos, 2013). This reflects a wider focus in recent years on the role of history in evolutionary economic geography and, more specifically, on the role of path dependence in determining a region's development trajectory. Path dependency is typically considered a dynamic process in which future conditions depend on prior conditions such that the evolution of regional

development is governed by its own history (David, 2007). Remote historical events and past investments may constrain future development and lock-in regions to particular development paths (Martin and Sunley, 2006).

From an evolutionary perspective, one factor that may explain persistent differences in new firm birth rates across regions is the existence of spatial stickiness (Fotopoulos, 2013). Regions are heterogeneous entities due to their specific history, resource endowments, physical geography, culture, institutional make-up, past investments and social composition. Many of these factors are either fixed or evolve slowly over time (i.e. they are 'sticky') – hence they significantly constrain and impact on future development opportunities. If these factors impact on entrepreneurship, then persistent variations in firm births may be associated with this underlying heterogeneity and spatial stickiness.

A variety of factors might link spatial stickiness to entrepreneurship. For example, it is often argued that industrial structure is an important determinant of regional variations in birth rates as sectors have different propensities to generate new firms (Ashcroft, Plotnikova and Ritchie, 2007). In a sector analysis of VAT data from 1994-2003, Anyadike-Danes and Hart (2006) conclude that spatial variations in UK birth rates are strongly associated with uneven sector growth applied to an established pattern of sector specialisation. The degree of specialisation in business services is a critical factor as this sector has a high propensity to generate new firms. Thus, a persistently high level of firm births in some regions is associated with the strong presence of business services. The sector's capacity to spawn new firms is related to specific sector characteristics such as relatively low entry barriers and widespread opportunities for entrepreneurs to evolve new services that, in turn, reflect

specific technological and market characteristics (Stam, 2010). Conversely, other industries may have high barriers to entry (e.g. the high capital requirements for some manufacturing sectors) and relatively limited opportunities for new entrepreneurs. Industrial structure is, at least in economically stable times, often slow to evolve and this may create spatial persistence in birth rates.

A second factor that may exhibit spatial stickiness is knowledge capital. Recent research has argued that that knowledge capital is critical for entrepreneurship as it has a high propensity to spillover from existing firms, thus providing opportunities for nascent entrepreneurs to exploit (Bishop and Brand, 2014; Bishop, 2012). Such spillovers have a regional dimension if proximity reduces the cost of transmission, thereby promoting information flows between local agents. However, knowledge capital tends to accumulate over long periods of time and may be slow to change due to the scale of the investment required, the stickiness in a region's industrial structure and the spatially bounded nature of some spillovers. Essletzbichler and Rigby (2005) note that spatial patterns of differences in production technologies tend to be persistent and are related to regional accumulations of process-specific knowledge which lock-in regions to specific technological trajectories. Brekke's (2015) recent study of a high technology cluster in Norway provides an interesting example of a region that became locked into a particular development path, characterised by a lack of knowledge spillovers and interactive learning that resulted in problems in generating new eentrepreneurs. A further aspect of this process is that entrepreneurs typically exhibit significant locational inertia due to the advantages accruing from access to local business networks, proximity to family and friends and the costs of movement (Stam, 2010). Thus,

new knowledge acquired through local spillovers is often exploited within a local area, further reinforcing entrepreneurial persistence.

An additional factor that may contribute to stickiness is institutional hysteresis, which refers to the tendency for institutions, social interactions and norms to be self-replicating over time (Martin and Sunley, 2006). Entrepreneurship is influenced by the effectiveness of supporting institutions that provide a variety of services including access to finance, advice and informal business networks. These institutions influence the incentives to partake in entrepreneurship, the manner in which resources and opportunities are exploited, and the generation and dissemination of knowledge that results from entrepreneurial activity (Sautet, 2005). Saxenian's (1990) study of Silicon Valley, for example, identifies how local institutions, service firms, educational organisations, and networks can be conducive to local entrepreneurial culture and promote the diffusion of technology and knowledge (Audretsch and Fritsch 2002). Stickiness may arise from the fact that institutions tend to evolve slowly over time. Fritsch and Wyrwich (2012) argue that this is particularly the case for informal institutions and that these are a critical aspect of a local entrepreneurial culture, an aggregate psychological trait that positively effects entrepreneurial activity (Freytag and Thurik, 2007). In a recent empirical study of Great Britain, Huggins and Thompson (2014) conclude that the embeddedness of a community culture that is not conducive to entrepreneurship may provide a significant impediment to progress for places seeking to generate entrepreneurially-led economic development. Of course, intervention by local policy makers may attempt to enhance the effectiveness of supporting institutions. A recent study of the Sheffield City Region by Williams and Vorley (2014), for example, documents how local policy makers have begun to develop a more entrepreneurially

focused policy, within the context of a traditional industrial region locked into relatively low levels of entrepreneurship.

A second aspect of path dependence that might impact on entrepreneurship is the argument that social interactions between agents are characterised by positive feedbacks and self-reinforcement (Andersson and Kostler, 2011). One important mechanism through which these feedbacks operate is dynamic increasing returns (Martin and Sunley, 2006). These arise when the advantages accruing to an activity increase with the scale of that activity over time and may have a spatial dimension if these advantages are localised. Within this context, spatial externalities and learning mechanisms produce positive feedback effects that reinforce development paths through a process of circular causation (Krugman, 1991; Martin and Sunley 2006). Feedback effects may also operate through the existence of entrepreneurial role models and the self-reinforcing nature of peer effects which creates a non-pecuniary externality that fuels further entrepreneurship (Fritsch and Wyrwich, 2012). Thus, an initial advantage in the factors conducive to entrepreneurship may be reinforced over time through these feedback mechanisms.

It is important to note that path dependency, spatial stickiness and feedback mechanisms may operate across the spatial units of observation that are used in empirical studies. Typically, these units are administrative rather than economic entities and there may be significant economic linkages across boundaries through mechanisms such as commuting and business networks. These effects will impact on entrepreneurship: for example, role models, peer effects, informal networks and business organisations supporting entrepreneurship, whilst affected by distance, are unlikely to respect administrative

boundaries. This implies a linkage between rates of entrepreneurship in neighbouring locations that may give rise to spatial clusters of areas with high or low rates of entrepreneurship.

Whilst there is considerable empirical evidence to support persistence, an important limitation of existing literature is that many studies cover periods of relative economic stability. For example, Andersson and Koster's (2011) Swedish study covers the period 1994-2004, whilst Fotopoulos (2013) examines the UK over the period 1994-2007. These involve periods of unbroken growth in GDP between the recession of the early 1990s and the financial crisis of 2007. Although Fritsch and Wyrwich (2012) cover a time frame for Germany that includes the Wall Street Crash and Great Depression, the study only analyses a sampled cross section from a single year of this period; most of the detailed data covers 1984-2005, a period in which only two years exhibited modest negative growth in GDP.

The role of economic crises is of some importance from a theoretical perspective as severe economic shocks may disrupt the existing institutions, networks and culture that contribute to spatial stickiness and self-reinforcing path development. There is a clear link here to the recent literature on regional resilience (Williams, Vorley and Ketikidis, 2013), a concept which refers to the capacity of a region to recover from a shock or disruption (Martin 2012). A critical aspect of resilience is adaptability – the ability of a region to adapt its technological, industrial, and institutional structures (in either an anticipatory or reactionary fashion) in order to maintain economic prosperity. Williams, Vorley and Ketikidis (2013) argue that entrepreneurship is a key component of this adaptive process. Given that entrepreneurship is of critical significance to economic growth, regions with high rates of

entrepreneurship have a plentiful supply of a key growth component and are well placed to adapt to new circumstances. Furthermore, the key to finding new opportunities is flexibility and innovation and these are qualities that are typically associated with entrepreneurial cultures and enterprising individuals. This argument is reinforced by Soininen, Puumalainen, Jögrén, Syrjä and Durst's (2012) recent study of Finish firms which concludes that scoring high in certain aspects of entrepreneurial orientation had a positive impact on firm performance during the financial crisis, suggesting a link between entrepreneurial characteristics and adaptability.

Whilst the arguments of Williams, Vorley and Ketikidis (2013) provide a useful starting point, this line of reasoning can be developed further, as there are several additional factors related to path dependence that might suggest a deeper link between entrepreneurship and resilience. First, sector specialisation might be crucial to this relationship. As has already been noted, those regions with high rates of entrepreneurship tend to specialise in sectors that have low entry barriers and high rates of new opportunities - hence they should also be well placed to renew and replace activities that have been adversely affected by economic shocks. Clusters of similar firms may also promote entrepreneurship through, for example, providing a pool of specialised labour for new ventures to access and the generation of external information spillovers (Stam, 2010; Brown, Lambert and Florax, 2013). This may create an environment in which the resources and opportunities required for entrepreneurship in the sector are readily available and can be exploited to create new ventures following an economic shock. For example, during the recent period of recovery in the UK, three service sectors with traditionally high birth rates (business administration and

support, professional, scientific & technical services and information & communication) have continued to consistently generate the highest rate of firm births.

Second, feedback loops and self-reinforcing mechanisms may be more deeply embedded and resilient to disruption in high birth rate regions. This may be related to factors such as serial entrepreneurship and locational inertia. Several empirical studies that have examined failed entrepreneurs have found that the majority start new businesses (Stokes and Blackburn, 2002; Nielsen and Sarasvathy, 2011; Stam, Audretsch and Meijaard, 2008). Thus, the owners of businesses that close in response to an economic shock are highly likely to restart new ventures and, as has already been noted, most new ventures are established in the area in which the entrepreneur resides due to locational inertia. These factors combine to provide a mechanism that enables regions with a strong entrepreneurial culture to be adaptable to economic shocks.

Third, recent research has demonstrated a positive link between the diversity of an area's knowledge stock and entrepreneurship (Bishop, 2012). This arises from the ability of a diverse knowledge base to increase the volume of potential new development opportunities available to entrepreneurs as it enhances cross-sector spillovers of knowledge. Thus, areas with high birth rates tend to have a more diverse knowledge stock that can be exploited to generate new opportunities in the face on an exogenous shock. Hence high birth rate economies are well placed to renew and revitalise in the presence of a recessionary shock.

To summarise: a path dependency framework posits that 'history matters' to regional entrepreneurship, as past entrepreneurial activity creates the current context in which

entrepreneurial activity takes place. A combination of spatial stickiness in heterogenous, slowly evolving, regional characteristics and institutions, together with self-reinforcing positive feedback mechanisms creates persistent spatial variations in entrepreneurship; interdependencies across local areas may also create entrepreneurial clusters of areas with high or low birth rates. Shocks may disrupt the economic and social relations that support entrepreneurship; however, the impact will tend to be felt less in regions with strongly embedded entrepreneurial cultures. Moreover, these regions will tend to be adaptable and resilient due to the flexibility and innovation of entrepreneurs, favourable industrial structures and a diverse knowledge base.

3. Data and method

The data used in this study cover the 380 district and unitary local authority districts (LADs) in Great Britain (England, Scotland and Wales) as defined following the 2009 changes to local government. The data on firm births are derived from the Business Demography statistics produced by the Office for National Statistics (ONS). A firm is defined as a new birth if is registered for VAT (Value Added Tax) or PAYE (Pay As You Earn) in a particular year but was not registered in the previous two years. Prior to the introduction of these new statistics, UK studies of firm births and deaths were primarily based on VAT registrations only (e.g. Bishop, 2012, Anyadike-Danes and Hart, 2006). The new data have a wider coverage but still have some limitations. First, the data exclude the smallest businesses which have no employees and/or are not VAT registered; second, there may be a time delay between founding the business and registration - and third, the public sector and agriculture are excluded from the data. Despite these limitations, the data are the most comprehensive

to be published at the sub-regional level and represent an important step forward from the previous data. The new data are available from 2004; however, most of the analysis focuses on the period following the first signs of the financial crisis in 2007. It is also important to recognise that the study focuses solely on firm births rather than deaths or churn rates. The extent to which patterns in these alternative indicators mirror those for firm births would be a useful subject for further research (a recent study by Simon-Moya, Revuelto-Taboada and Ribeiro-Soriano (2016) considers some of the issues for new firm survival in a Spanish context).

LADs differ considerably in size and, to control for this, it is necessary to express births as a proportion of a measure of regional size. Two alternative denominators are typically used: the working age population or the business stock (Fotopoulos, 2013; Bishop, 2012). The first approach is consistent with the view that new businesses are established by individuals involved in the local labour market and hence the rate of entrepreneurship is most appropriately indicated by the propensity of the population to generate new businesses. The second approach implicitly views new firms as emerging from the existing business stock and measures the rate at which this stock is being replenished (Derbyshire and Haywood, 2009). The arguments for and against these definitions have been well-rehearsed in the literature with most recent studies opting for the labour market approach (for further discussion see e.g. Fotopoulos, 2013; Derbyshire and Haywood, 2009). This option has the advantage of being grounded in an underlying theory of entrepreneurship in which individuals make labour market choices based on the costs and benefits of these alternatives (Evans and Jovanovic, 1989). A major weakness of the alternative 'ecological approach' is that it effectively ignores the propensity of the unemployed to generate new

businesses as they are not employed in the current business stock. Consequently, this paper adopts the labour market approach and defines the birth rate as new births per 1,000 members of the working age population.

The methodological perspective taken in this paper primarily involves Exploratory Spatial Data Analysis (ESDA) (Anselin, 1993). This involves a set of methods that describe and map the spatial distribution of a dataset with the aim of identifying spatial patterns (e.g. geographical clusters, spatial regimes), atypical locations (outliers), the evolution of the distribution over time and the mobility of locations within the distribution (Bishop, 2013; Celebioglu and Dall'erba, 2009). The focus is on understanding the complex spatial processes underlying the data and suggesting hypotheses rather than testing hypotheses concerning the behaviour of the representative region as is typical in standard econometric approaches. This is particularly important for spatial data which often exhibit patterns of heterogeneity and clusters rather than uniformity. It is also particularly pertinent for a relatively new dataset such as the present one in which there is limited availability of time series information.

The ESDA approach has been used increasingly in recent years for studies of regional inequalities in income and other measures of regional performance (e.g. Bishop, 2013; Celebioglu and Dall'erba, 2009; Ezcurra, Pascual and Rapún, 2007; Dall'erba 2005; Bishop and Gripaios, 2005). These papers have often revealed complex spatial patterns of persistence, divergence and spatial clusters that are difficult to characterise in simple terms. For example, in a study of GDP per head across GB counties, Bishop and Gripaios (2005) find

that whilst the shape of the overall income distribution is persistent over time, this conceals significant movement within the distribution and long run divergence between groups of regions within the dataset. From the perspective of the current paper, ESDA allows a focus on the extent to which the persistence identified by previous studies is a generic feature of the data or if it obscures more complex underlying spatial patterns. It also facilitates an examination of the importance of spatial scale - thus, the analysis examines the data at the level of broad administrative regions, regional clusters of LADs and the disaggregated LAD level. A detailed discussion of many of the measures utilised in the next section is provided in Bishop (2013).

4. Global analysis

The analysis begins with an overview of the main features of the evolution of firm births using global measures of dispersion and inequality across the sample as a whole. One initial issue that has been noted in previous studies is the existence of a strong outlier - the City of London - a small area covering the central financial district of the capital (Gleave and Mitra, 2010). This area has historically exhibited an extremely high rate of new firm formation for a small working population, reflecting the importance of the City as a financial centre and high levels of inward commuting (Bishop, 2012). An initial analysis indicated that this is an issue with the current dataset, with the City being a strong outlier in every year. Some studies have tackled this problem by omitting the City from the analysis (Gleave and Mitra, 2010), whilst others have utilised strategies such as logarithmic transformation of the data or dummy variables for econometric analysis (Bishop, 2012). For the present study, the impact

of the exclusion or inclusion of the City varies depending on the measure used and the issue is discussed alongside the individual measures. It is also worth noting that initial analysis revealed a second potentially important outlier (Westminster) - however, inclusion or exclusion of this area had no substantive impact on the conclusions and hence it is retained throughout.

Table 1 details basic descriptive statistics with and without the City. Prior to the financial crisis the data reveal a modest fall in the mean birth rate from 2004-6 and then a rise in 2007. The economic shock associated with the financial crisis impacted on GDP towards the end of 2007 and the UK entered a recession in 2008 and 2009 before embarking on a patchy recovery during 2010-12. There is some evidence of a shock effect with a fall in the mean birth rate from 2007 – 2010. At a national level, the impact of the shock may have been temporary, as the birth rate recovers during 2011-2012. The inclusion or exclusion of the City slightly increases mean birth rates but does not affect this overall pattern. However, the inclusion of the City has a major impact on the size of the measures of dispersion (the standard deviation and coefficient of variation) as these are highly sensitive to outliers. Excluding the City, the data indicate that there has been some increase in dispersion (i.e. divergence) since 2007 although the change is not consistent over time. The movement in the overall distribution can be most easily demonstrated by the kernel density plots (using an epanechenikov kernel) in figure 1. To facilitate comparison of the shape of the distribution across time, the data are normalised by the annual mean. The plots suggest that, whilst there is some evidence of a move of the mode of the distribution to the left over time, the overall shape of the global distribution remains relatively persistent across the period of recession and recovery.

Whilst the Coefficient of Variation is often used as a measure of dispersion, there are other measures of inequality available and these may potentially yield different conclusions (Litchfield, 1999). In order to address this issue, the paper presents two additional measures. The first is the GINI Index (G) which indicates the extent to which the distribution of birth rates deviates from a perfectly equal distribution and varies from 0 to 1 as inequality increases. The second is the Theil Index (T). This index belongs to the generalised entropy class of measures which are derived from information theory, where entropy is a measure of the randomness in a given set of information (Bishop, 2013). This index gives equal weight to differences between values at all parts of the distribution and varies from 0 to an upper limit of ln(n) (where n is the number of regions) as inequality increases.

Unfortunately, outliers can have a major impact on measures of inequality. Two alternative strategies for dealing with this were examined - first, leaving out the City and, second, constructing a weighted value of the index, weighing areas by the relative size of their working population. This latter method reduces the impact of the City as the area has a small working population. In practice, both methods produce similar results. This is illustrated in Figures 2 and 3 which show the G and T indices for the entire unweighted and weighted sample and the unweighted sample excluding the City. (Given the City's small relative size, the weighted sample without the City produces almost identical inequality values to those with the City included and hence this time series is omitted).

The inequality indices provide some evidence of an increase in inequality of birth rates across regions since the recessionary shock of 2007. Significance tests of the difference

between the inequality coefficients of 2007 (excluding the City) and subsequent years are presented in Table 2 and indicate that all subsequent coefficients are significantly different from 2007 ($p < 0.01$ in all cases). Thus, there is a significant, albeit small, increase in inequality that occurs immediately after the recessionary shock and is maintained in subsequent years, providing some initial evidence that the recessionary shock may have had an uneven impact. The jump in the indices when the City is included raises the interesting issue as to whether this is just an effect related to this outlier or is (at least partially) part of a wider spatial phenomenon throughout the capital city: this is investigated in detail during the subsequent analysis.

5. Regional analysis

Global indices may mask changes at a lower spatial scale and hence this section examines data on the standard regions of Great Britain. The focus is on the period post-2007 in order to assess the impact of the financial shock and all calculations exclude the City. Table 3 indicates that London is the most entrepreneurial region having a consistently higher birth rate than other regions. There is a general pattern of a fall in regional birth rates after the recession followed by a modest recovery but with rates still remaining below their pre-recession level in 2012. The only exception is London, in which the birth rate exceeded pre-recession levels by 2011. The spatial distribution of births across regions is also persistent, again with the notable exception of London which appears to be diverging from other regions. This pattern can be seen clearly in Figure 4 which plots the evolution of birth rates in London compared to the average, upper and lower regional bounds of the rest of GB. Interestingly, the strong performance of London is widespread throughout the capital city.

Indeed, in terms of the growth of birth rates over the period 2007-12, 15 out of the top 25 LADs are in London and only 5 out of the 33 London boroughs have seen a fall in births. This provides some support for the notion that the region with the highest level of births at the onset of the financial shock (London) has been relatively resilient to the financial crisis and best able to adapt and generate new births. Thus, whilst the City may be an outlier, it is at the centre of a wider spatial phenomenon in which a cluster of areas are generating a dynamic entrepreneurial response to the economic shock.

To examine regional patterns in more detail, it is useful to decompose regional inequality measures into component groups. The Theil decomposition is used as this is easier to interpret than decompositions of the Gini Index (Litchfield, 1999). The Theil Index can be decomposed into two components, the first of which measures inequality within regions and the second which measures inequality between regions. Table 4 presents the decomposition using the eleven standard GB regions. The decomposition shows that the within-region component is more important than the between-region component in all years. This suggests that standard regions are heterogeneous entities, reflecting the fact that they are primarily administrative rather than economic entities and contain areas with widely varying characteristics. However, the importance of the between-region component has risen since 2007 from 33.8% to 44.5% of total inequality confirming evidence of regional divergence.

Given the difference between London and other GB regions, the Theil index was also decomposed into two groups - London and the rest of GB (Table 5). As would be expected, given the heterogeneous nature of the second group, within-region inequality strongly

dominates. However, there is a notable upwards trend in the proportion of inequality attributed to between regions, with the proportion rising from 14% to 27% over the period. This further reinforces the notion of a divergence between London and the rest of GB following the recessionary shock. Thus, whilst the overall global distribution of birth rates is relatively persistent, this masks an important underlying spatial dynamic at the regional level in which London (the most entrepreneurial region) is behaving differently from other regions.

6. Local analysis

The theoretical discussion in section 2 suggested that spatial stickiness and self-reinforcing mechanisms may operate across the boundaries of administrative units. Thus, clusters of areas with high or low birth rates may exist across standard regional boundaries or be contained in limited areas within these boundaries. To investigate this issue, it is instructive to analyse data at the most disaggregated (LAD) level by analysing spatial autocorrelation statistics. Spatial autocorrelation arises if the distribution of a variable is non-random across space (Anselin 1999). In the present context, positive autocorrelation implies that areas with high or low births tend to be located in proximity to areas with similar rates of births. Conversely, negative correlation implies the spatial proximity of areas with different birth rates. Spatial autocorrelation statistics can be computed across the sample as a whole (global spatial autocorrelation) or decomposed to a local level by calculating local indicators of spatial autocorrelation (LISA) (Anselin, 1995). Global indicators summarise the degree of spatial dependence in a single indicator, with the obvious limitation that this may mask

spatial patterns at a lower level. Accordingly, one of the main advantages of ESDA lies in visualising local patterns to identify spatial heterogeneity (Anselin, 1999).

The global indicator of spatial autocorrelation utilised in this study is Moran's *I,* which is defined as: $I = (n/s)\ [\Sigma_i \Sigma_j w_{ij} z_i z_j / \Sigma_i z_i^2]$ - where n is the number of observations, z_i is the deviation of the value of the birth rate from the mean in location *i*, w_{ij} is the weight attached to the *ij*th pair of regions and $s = \sum_i \sum_j w_{ij}$. The weights reflect a measure of the distance between regions and may take a variety of forms (Bishop, 2013). For the present analysis, first order contiguity weights were used with the weight equal to one if the regions are geographically adjacent, and zero otherwise. The decomposition of *I* into local components (with data standardised with a mean of 0 and a variance of 1) can be defined for the *i*th location as: $I_i = z_i \Sigma_i w_{ij} z_j$.

Table 6 shows the Moran statistics using both the original data and a log transformation, as a significant outlier can influence the statistic but it is desirable to retain the City to avoid a 'hole' in spatial coverage. To test for significance against the null of no spatial autocorrelation, a permutation approach with 999 permutations was used in which a reference distribution was generated for random layouts with identical values to the observed data (Anselin, 2003; Bishop, 2013). The null of no spatial autocorrelation was rejected for all years (at the 0.001 level) using both the original and transformed data. Thus, firm births are not randomly distributed across sub-regions and the positive values of the statistic suggest the presence of positive global spatial autocorrelation.

LISA statistics can be computed for individual areas in every year and, consequently, are best presented via summary maps which highlight spatial clusters and outliers. Figures 5, 6 and 7 show cluster maps using a 0.05% significance level, for 2004, 2008, and 2012 – representative of periods of stability, crisis and recovery. In 2004, there is evidence of several small clusters of sub-regions that exhibit high firm start-up rates across parts of London, the South East, and a small part of the North West. There are also four fairly noticeable clusters that exhibit low firm start-up rates, which cover areas of central and southern Wales, large conurbations in the North West, smaller clusters in southern Yorkshire and the East Midlands, and, finally, a wide area of the North East of England and Scotland. It is important to note that these clusters are not coterminous with the boundaries of standard regions, highlighting the importance of a disaggregated analysis.

In 2008, during the recessionary period, the high-high cluster in the south east appears to become more concentrated around London. The cluster of low firm start-up rates in the North West becomes much reduced, as does the cluster in Scotland, whereas the low-low cluster in southern Yorkshire appears to have expanded to include more sub-regions of both Yorkshire and East Midlands. In 2012, there is a noticeable increase in the size of the low-low cluster to include most of Wales. Elsewhere, the most notable feature is the persistence of the London cluster: indeed, in 2012, the London area (including some areas outside the capital) is the only remaining cluster of high birth rates. Clearly, proximity to London mattered when it came to sub-regions developing a dynamic and adaptive approach to the economic crisis. Conversely, areas with traditionally low birth rates (e.g. in Wales and

Scotland) remained locked into less entrepreneurial regimes and found it difficult to develop a dynamic response.

An additional perspective on this evolutionary process can be garnered by analysing the cross-sectional distribution over time through the use of Markov Chain techniques (Bishop and Gripaios, 2005; Magrini, 2004; Quah, 1993). If b_t denotes the distribution of firm births across LADs at time *t* and it is assumed that the evolution of births follows a first order autoregressive process, then b_{t+1} only depends on b_t. If *M* is an operator that maps the distribution from *t* to *t+1*, then $b_{t+1} = M(b_t)$. In a discrete interpretation of this process, the distribution of firm births can be divided into *i* classes, and b_t represents a vector of the probabilities of being in class *i* at time *t*. The mapping operator M can be regarded as a transition probability matrix, the elements of which contain the probabilities of moving from class *i* to class *j* during the transition from one time period to the next. If these transition probabilities are constant over time, then the evolutionary process constitutes a discrete, time homogenous Markov Chain. As the Markov process tends to infinity, the process converges to an ergodic (limiting) distribution of probabilities δ such that $\delta = \delta M$. The transition probability matrix, ergodic distribution and class boundaries can be examined to assess the extent to which the initial distribution persists or convergences towards one or more classes and the movement of individual areas can be examined. Inclusion of the City has no significant effect on the analysis as the area is immobile - it simply persists in the top class in every time period. (An alternative continuous approach (Quah, 1997) supported the conclusions of the discrete analysis; hence, for parsimony of presentation, only the results of the discrete interpretation are presented.)

The first stage in implementing the approach is to divide the data in the base year into equal sized classes based on birth rates. In subsequent years, the boundaries between classes can either be held constant or allowed to vary to maintain equal observations in every class (Quah, 1993). The two approaches often yield similar transition matrices (see e.g. Bishop and Gripaios, 2005; Bishop, 2013) and this proved to be the case in the present paper; hence, the analysis presents the results of the first approach. As the choice of the number of classes is somewhat arbitrary, it is prudent to examine the sensitivity of conclusions to varying the number of classes (Schluter, 1997). In all of the tables, the data on firm births are normalised by the annual mean to control for a changing mean and the transition period is set equal to one year.

Table 7 presents the transition probabilities for an illustrative four class, constant boundary case for the 2004-12 period. A Likelihood ratio test of the Markov property (Collins, 1975) rejects the null that the probability of ending in a class does not depend on the starting class at the 0.01% level, implying that there is at least a first order Markov chain (chi-square = 267.0 with 9 degrees of freedom). The diagonal probabilities can be interpreted as an indication of the extent of persistence in the distribution as they show the probability of remaining in the same class in *t* and *t + 1*. These probabilities show high levels of persistence in the top and bottom quartile with respective probabilities of remaining in the class of 0.83 and 0.85. However, there is some churning in the middle of the distribution where the diagonal probabilities are much lower, although the probability of moving two classes is

extremely low. The probability of moving out of the top class is greater than moving in, suggesting a fall in the size of the top class; however, the lowest class is growing with more LADs moving in than out.

To examine whether there has been a significant change in mobility following the recessionary shock, the time period was divided into two sub-periods 2004-7 and 2007-12 and M was estimated for both of these periods. The two matrices proved to be very similar (Table 8). Indeed, a test of time homogeneity which tests whether the probabilities in the two sub-periods differ from the whole period (Bickenbach and Bode, 2003) accepts the null of equal probabilities (chi-square = 10.993 with 10 degrees of freedom). Thus, there is no evidence of a significant change in mobility across the distribution as a whole after 2007. In other words, the broad evolutionary process presented in the overall transition matrix was already underway prior to the recession.

The impact of the evolutionary process that has occurred since 2007 can be seen in the ergodic distribution for the four class case which is presented in Table 9. This indicates that a continuation of this process would, in the limit, result in an expansion of the lowest class (from 25% to 44.6%) and a reduction in size of the top class (from 25% to 12%). The table also presents the ergodic distribution for other class sizes, facilitating an analysis of the sensitivity of the conclusions to the number of classes. The results broadly confirm the analysis of the four class case reinforcing the idea of some hollowing out at top of the distribution and greater concentration at the lower end. This accords with the previous discussion of the LISA statistics in which the high-high cluster centred in London was the only remaining high-high cluster in 2012. To examine whether London is behaving

differently from other regions, separate transition matrices were estimated for London and the rest of the sample. A chi-square test of the four class case rejects the null of equal transition probabilities (chi-square = 26.34, 10 degrees of freedom) suggesting that London is different from the rest of the sample. This can be seen in the transition matrix for London in Table 10, where the probabilities are very different from those for the sample as a whole (and the rest of GB which is similar to the sample as a whole).

A more detailed picture of London can be gained from examining the mobility of LADs within the four quartiles of the distribution. In 2004, 21 of the 33 London LADs were in the top quartile of firm birth rates. All these areas were still in the top quartile in 2012 with only three experiencing temporary drops in individual years during this period of time. Moreover, four of the seven London LADs that began in the second highest quartile had moved to the top quartile by 2012 whilst the rest remained in the second highest quartile. Four of the five areas in the lowest two quartiles had moved up to the second quartile by 2012. Consequently, by 2012 only one LAD in the capital was in the lower half of the distribution of birth rates. This constitutes a clear pattern in which the capital city is maintaining and strengthening its position in the distribution. Conversely, only one area from the three regions with the lowest average birth rates - Scotland, Wales and the North East - was in the top quartile in 2012 (the special case of Aberdeen - which is the hub for the North Sea oil industry). Moreover, 13 Welsh areas which started above the lowest quartile had fallen into the lowest quartile by 2012.

The analysis of the disaggregated data confirms the patterns identified in previous sections and provides compelling evidence of the presence of different spatial regimes across GB.

London (and some surrounding areas of the South East) appear to exhibit what might be considered an 'entrepreneurial regime'. These areas are characterised by persistently high firm birth rates that have been resilient to the economic crisis; areas within this cluster have typically developed an entrepreneurial response to the shock with birth rates that have risen to higher levels than prior to the crisis. The Markov analysis suggests that the increasing advantage of London was a process that was underway prior to the recession but the impact of the recession may have reinforced the dominance of the capital. On the contrary, areas with traditionally low levels of firm births appear to have become "locked-in" to these low birth rate regimes and have struggled to adapt to the crisis by generating high level of new firm births. Moreover, some of these clusters (notably in Wales) have expanded into adjacent areas.

7. Conclusion

Adopting a path dependency perspective, this paper has argued that spatial stickiness and self-reinforcing positive feedback mechanisms create persistent spatial variations in entrepreneurship; whilst shocks may disrupt these dependencies, those regions with strongly embedded entrepreneurial regimes tend to be adaptable and resilient due to the flexibility and innovation of entrepreneurs, favourable industrial structures and diverse knowledge bases. These contentions have been examined empirically by applying a range of ESDA techniques to the evolving spatial distribution of new firm births across GB during the period 2004-2012, covering a period of growth, shock and recovery. The central aims were to ascertain the extent to which the persistent spatial variations in regional

entrepreneurship had been affected by the global financial crisis and whether regions with high levels of entrepreneurship had been resilient to the impact of the recession.

The empirical results suggest that the overall shape of the global spatial distribution of firm birth rates remained relatively stable during an acute economic shock. However, at a more disaggregated spatial level, there is evidence of an increase in inequality amongst regions; this appears to be associated primarily with a divergence between London (and some of its environs) and the rest of the distribution. Areas within this cluster have tended to have persistently high birth rates throughout the period of the study and by 2012, the London based cluster was the dominant high birth rate cluster. A more detailed analysis suggests that this phenomenon is widespread across London LADs and is not simply confined to the more central areas of the capital city. Moreover, there is evidence that the gap between London and other areas is widening: indeed, 60% of the LADs with the highest growth in birth rates since 2007 are in London. In terms of the theoretical framework advanced in this paper, this suggests that London and the surrounding area constitute a resilient 'entrepreneurial regime' that has generated a dynamic, adaptive response to the crisis. This provides some evidence that regional entrepreneurship is indeed a path dependent process, where history matters when it comes to the entrepreneurial response to an exogenous shock.

It is important to recognise that this paper has only presented an exploratory analysis of the data on firm births and it is outside its remit to fully explain the specific regional patterns uncovered. Nevertheless, it is likely that the sources of London's strong entrepreneurial

performance are related to the path dependency framework outlined at the start of this paper. Thus, spatial stickiness may be associated with a favourable industrial structure based on a strong service sector characterised by significant self-employment and dominated by small firms in sectors with low entry barriers. In addition, London's historical position as a prominent financial centre makes it an attractive place to start a firm and access start-up capital. This prominence has been cemented though institutional hysteresis: important financial institutions such as the Bank of England and London Stock Exchange have remained located in the region for many years. The integration of the financial services sector with other commercial institutions could also be seen a source of the dynamic increasing returns that has fostered the development of a time persistent entrepreneurial culture. This culture has also made London attractive to entrepreneurially-oriented in-migrants. In addition, London benefits from high levels of knowledge capital with Inner London having by far the highest proportion of employment in Knowledge Intensive Services in the UK (Outer London and the South East come second and third).

At the opposite end of the spectrum, many areas characterised by persistently low birth rates lie within regions that Birch, MacKinnon and Cumbers (2010) refer to as 'old industrial regions' (OIRS). These areas have historically exhibited a greater than average employment in coal mining and related activities that were heavily dependent on coal, such as steel and metal processing (Birch, MacKinnon and Cumbers, 2010). Path dependence may be an important factor in explaining the persistence of low rates of entrepreneurship in these OIRs. In particular, the industrial structure has historically involved sectors characterised by large production plants, with significant scale economies, a highly unionised labour force

and significant state involvement through ownership and/or regulation. These characteristics have created severe barriers to entry and limited entrepreneurial opportunities. Moreover, this might have led to the development of institutions and organisations that reflected this industrial structure, which may also additionally influence the cultural and social tendencies of the local labour force. These social institutions and organisations may be resistant to processes of change and the reorganisation of the means of production, two fundamental manifestations of the entrepreneurial process. This has resulted in a weak local entrepreneurial culture that has persisted over time. Furthermore, the process of de-industrialisation that has characterised many OIRs in recent years has created an environment that makes these regions less desirable in which to conduct business and start a firm.

Whilst it may be difficult for regions with a weak entrepreneurial culture to overcome the barriers that re-inforce a persistently low rate of new firm births, appropriate policy intervention may assist the adaptive process. Drawing on the lessons derived from a case study of Sheffield, Williams and Vorley (2014) argue that the key role for the public sector is to facilitate the long-term conditions required for creation of an entrepreneurial culture rather than simply focusing on increasing the number of start-ups in the short to medium term. This argument is supported by the analysis of the present paper – if the factors deterring entrepreneurship are subject to long-term spatial stickiness, then a long term strategy to "unglue" this stickiness is required. Policy interventions should focus on the wider socio-economic conditions that impede entrepreneurship rather than rely on specific

policies (e.g. financial incentives) that may provide a short-term boost business births but fail to tackle the underlying barriers to entrepreneurship.

In conclusion, the preceding analysis provides evidence of the heterogeneity of entrepreneurial activity across regions and the time persistent nature of this heterogeneity through periods of economic stability, crisis and recovery. In addition, it suggests that regions with high birth rates are more resilient and adaptable to exogenous shocks. What remains to be fully explored is how this persistent heterogeneity and observed divergence has impacted on regional economic performance. If entrepreneurial activity is an important source of growth, regions with considerable entrepreneurial vigour might be expected to have experienced lower unemployment and/or faster rates of job creation during the economic recovery. Interestingly, London has significantly outperformed other regions in terms of economic growth and employment creation since 2007 (Riggs and Prothero, 2013). Future research might explore the link between this phenomenon and entrepreneurship in more detail.

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Table 1: Descriptive statistics - firm births 2004-12

	Birth Rate without City			Birth Rate with City		
Year	Mean	Std. Dev.	CV	Mean	Std. Dev.	CV
2004	7.460	2.629	0.352	7.992	10.708	1.340
2005	7.178	2.284	0.318	7.772	11.809	1.519
2006	6.606	2.102	0.318	7.154	10.890	1.522
2007	7.125	2.347	0.329	7.679	11.044	1.438
2008	6.645	2.738	0.412	7.537	17.606	2.336
2009	5.850	2.381	0.407	6.633	15.448	2.329
2010	5.729	2.589	0.452	6.513	15.493	2.379
2011	6.355	2.826	0.445	7.160	15.945	2.227
2012	6.521	2.946	0.452	7.366	16.731	2.272

Table 2: Change in Inequality 2007-12

	Gini Index			Theil Index		
	Change	St. error	p value	Change	St. error	p value
2007-8	0.023283	0.004272	0.00	0.017769	0.006176	0.0042
2007-9	0.020525	0.004364	0.00	0.016206	0.00593	0.0066
2007-10	0.041184	0.005097	0.00	0.029406	0.008172	0.0004
2007-11	0.039484	0.005052	0.00	0.027771	0.007397	0.0002
2007-12	0.040711	0.005809	0.00	0.029619	0.007849	0.0002

Table 3: Regional birth rates

	NE	NW	YH	EM	WM	SW	E	SE	L	SC	W
2007	5.368	6.853	6.561	6.727	6.882	7.163	7.723	7.986	9.841	5.092	5.206
2008	4.612	6.133	5.990	6.002	6.193	6.490	7.199	7.564	10.512	4.521	4.817
2009	3.971	5.265	5.334	5.277	5.299	5.554	6.472	6.835	9.056	4.061	4.305
2010	3.583	4.891	5.148	5.093	5.315	5.412	6.173	6.846	9.390	4.146	3.821
2011	4.272	5.519	5.302	5.686	5.799	6.015	6.765	7.551	10.730	4.583	4.217
2012	4.435	5.713	5.546	5.882	5.734	6.279	6.872	7.647	11.218	4.734	4.246

Note: NE = North East; NW = North West; YH = Yorkshire and Humberside; EM = East Midlands; WM = West Midlands; SW = South West; E = East of England; SE = South East; L = London; SC = Scotland; W = Wales.

Table 4: Decomposition of Theil Index by standard region

	T	Within regions	Between regions	% between
2007	0.043828	0.029013	0.014815	0.338026
2008	0.061597	0.037159	0.024438	0.39674
2009	0.060034	0.035862	0.024171	0.402622
2010	0.073234	0.043	0.030234	0.412841
2011	0.071599	0.039757	0.031842	0.444727
2012	0.073447	0.04075	0.032697	0.445178

Table 5 Decomposition of Theil Index by London and rest of GB

	Total	Between regions	Within regions	% between
2007	0.043828	0.006048	0.03778	0.137998
2008	0.061597	0.01347	0.048127	0.21868
2009	0.060034	0.012032	0.048002	0.200423
2010	0.073234	0.016047	0.057187	0.219123
2011	0.071599	0.018435	0.053165	0.25747
2012	0.073447	0.020055	0.053392	0.273056

Table 6: Moran statistics for global spatial autocorrelation

	Firm Birth Rate			Ln Firm Birth Rate		
Year	Moran's *I*	μ	σ	Moran's *I*	μ	σ
2004	0.1105	-0.0018	0.0117	0.5352	-0.0009	0.0309
2005	0.0778	-0.0029	0.0089	0.4445	-0.0025	0.0309
2006	0.0796	-0.0026	0.0094	0.4585	-0.0033	0.0295
2007	0.0924	-0.0025	0.0102	0.4648	-0.0029	0.0316
2008	0.0706	-0.0028	0.0067	0.5387	-0.0031	0.0306
2009	0.0662	-0.0026	0.0069	0.5124	-0.0026	0.0301
2010	0.0745	-0.0029	0.0076	0.5512	-0.0026	0.0313
2011	0.0835	-0.0024	0.0077	0.5744	-0.003	0.0318
2012	0.0897	-0.0024	0.0086	0.5858	-0.0024	0.031

Table 7: Four class, constant boundary M matrix

	Class (t +1)			
Class (t)	1	2	3	4
1	0.83	0.16	0.01	0
2	0.21	0.62	0.16	0.01
3	0.01	0.23	0.65	0.1
4	0	0.01	0.15	0.85

Table 8: Four class, constant boundaries, sub-period, M matrix

		2004-2007		
		Class (t +1)		
Class (t)	1	2	3	4
1	0.79	0.18	0.02	0
2	0.18	0.62	0.19	0.01
3	0.01	0.27	0.6	0.13
4	0	0.01	0.18	0.81
		2007-2012		
1	0.81	0.18	0.01	0
2	0.19	0.65	0.16	0
3	0.01	0.16	0.71	0.12
4	0	0	0.12	0.88

Table 9: Ergodic distribution 2007-12

Number of classes	Initial Class size	Ergodic distribution
4	0.250	0.446, 0.272, 0.162, 0.120
5	0.200	0.404, 0.256, 0.144, 0.106, 0.090
6	0.166	0.376, 0.235, 0.155, 0.100, 0.072, 0.062
7	0.143	0.343, 0.228, 0.155, 0.094, 0.072, 0.059, 0.050
8	0.125	0.315, 0.216, 0.156, 0.101, 0.073, 0.054, 0.043, 0.042

Table 10: Four class, London only, M matrix

	Class (t +1)			
Class (t)	1	2	3	4
1	0.76	0.24	0.00	0
2	0.15	0.62	0.23	0.00
3	0.00	0.16	0.75	0.09
4	0	0.00	0..05	0.95

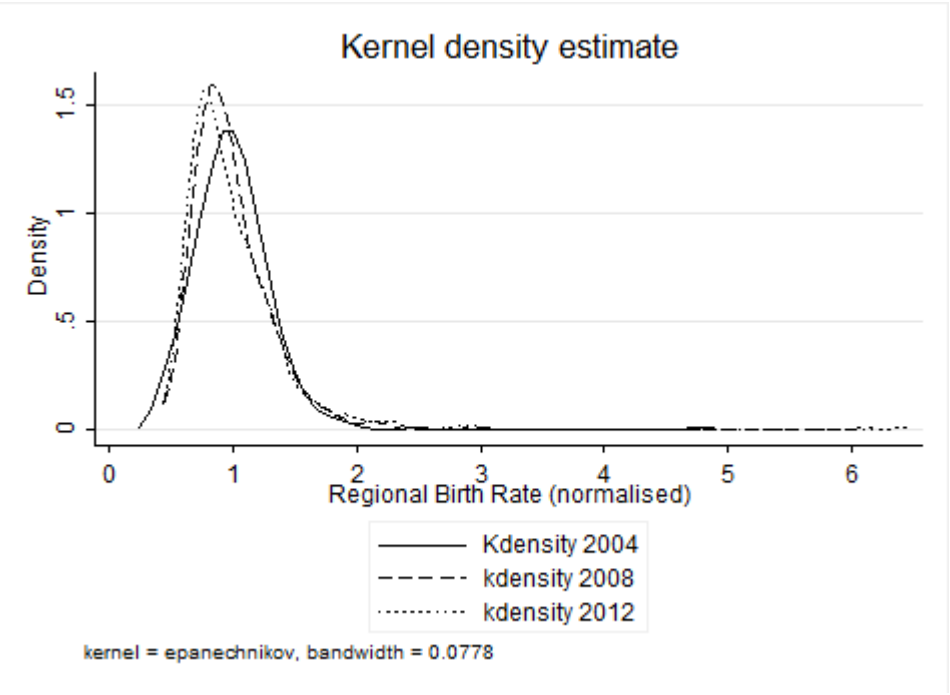

Figure 1: Kernel density estimates (normalised regional birth rates, 2004, 2008, 2012)

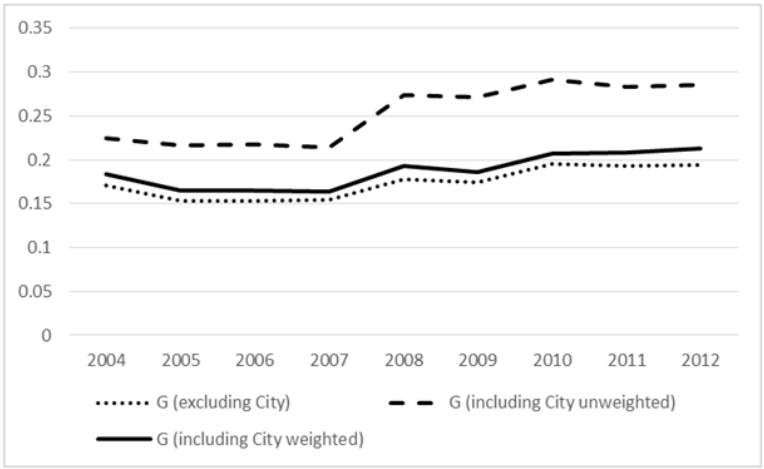

Figure 2: Gini Index 2004-12

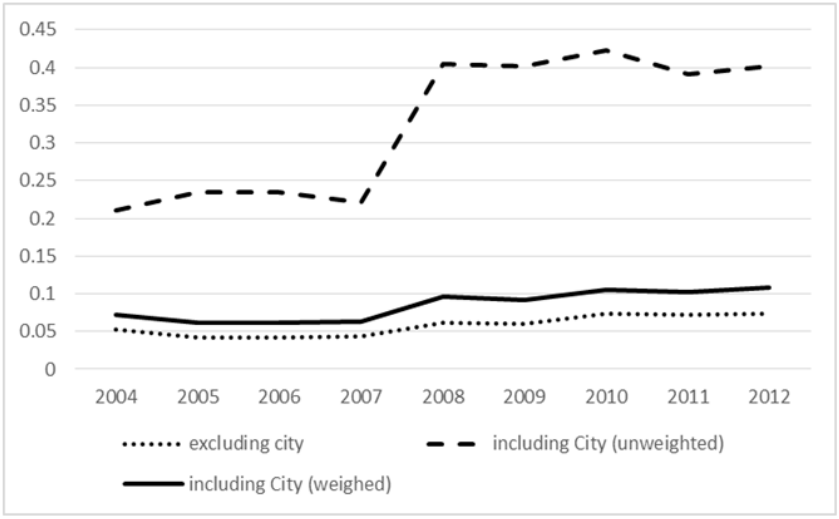

Figure 3: Theil Index 2004-12

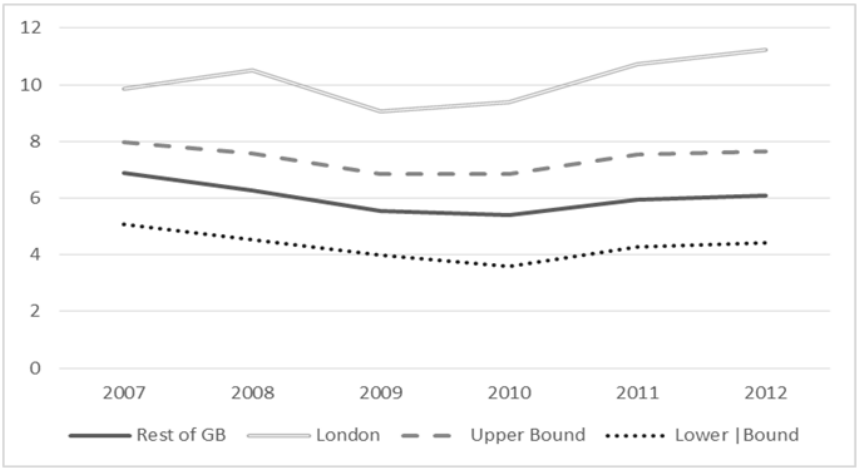

Figure 4: Birth Rates - London and Rest of GB, 2007-12

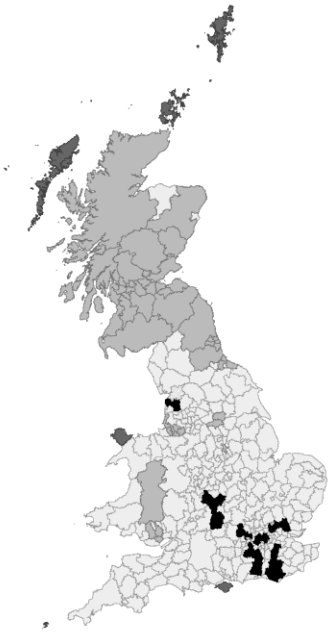

Figure 5: LISA clusters 2004: The Darkest shaded areas signify clusters of regions with high firm start-up rates, the lightest shaded areas signify clusters of regions with low firm start-up rates. Other shaded areas are islands with no neighbours.

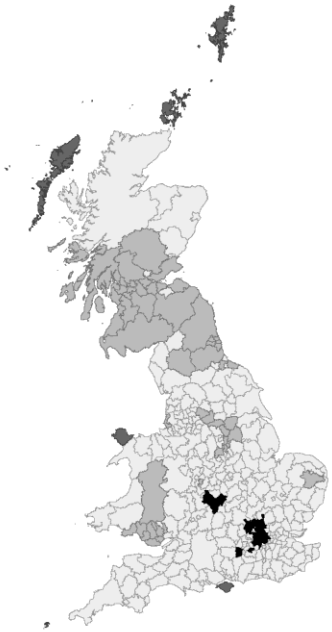

Figure 6: LISA clusters 2008: The Darkest shaded areas signify clusters of regions with high firm start-up rates, the lightest shaded areas signify clusters of regions with low firm start-up rates. Other shaded areas are islands with no neighbours.

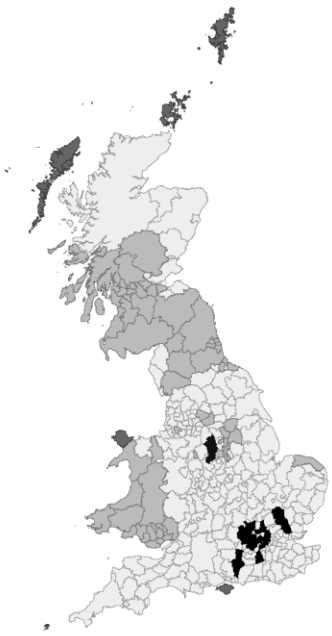

Figure 7: LISA clusters 2012: The Darkest shaded areas signify clusters of regions with high firm start-up rates, the lightest shaded areas signify clusters of regions with low firm start-up rates. Other shaded areas are islands with no neighbours.