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Relatedness between the Creative Industries and the wider economy: A primer

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Abstract

The Creative Industries are seen as an archetypal part of the knowledge economy, and policymakers invest considerable resources into developing new specialisms in the sector. The literature on local economic development highlights the importance of relatedness – having industries which use similar skills and/or technology – in developing new sectoral specialisms. This paper provides a primer on the idea of relatedness, with a focus on implications for economic development policy and the Creative Industries. It presents new descriptive analysis on relatedness to the Creative Industries in Great Britain, and highlights the strengths and limitations of relatedness as a concept for policy. While relatedness is relevant for developing new specialisms in the Creative Industries, our descriptive results show that while relatedness does matter, it is not destiny.

1. Introduction

The Creative Industries are among the archetypal industries of the knowledge economy. They are commonly defined as those which “have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property” (DCMS, 2001). Within this broad definition sits a diverse set of industries – according to the UK government definition these are Advertising; Architecture; Art and Antiques; Designer Fashion; Video, Film and Photography; Music and the Arts; Publishing; Software, Computer Games and Electronic Publishing; Radio and TV; Craft, and; Design. These skill-intensive industries are seen as vital to economic competitiveness and growth (Stam et al., 2008; Huggins and Clifton 2011).

Policymakers devote considerable resources into attracting and growing the Creative Industries. There is good evidence to support this focus: the sector has experienced strong recent growth – employment in the UK's Creative Industries has increased by around a third since 2011 (Tether, 2019); they are seen as driving innovation in the wider local economy (Bakhshi and McVittie, 2009), and; it may have knock-on effects driving growth in other local sectors (Lee, 2014). Numerous local economic development agencies have targeted the Creative Industries (e.g. South East LEP, 2018)¹ and the UK government has launched a Creative Industries sector deal, with the commitment to invest “to create world-class creative clusters” (HM Government, 2018: 14).

How do local economies diversify into new specialisms within the Creative Industries? One area of literature helpful in answering this question is the literature on relatedness and related variety, which suggests that it is easier for regions to develop new specialisations in industries in which they have pre-existing concentrations of related industries (Boschma, 2017). The main implication of this literature is that it is easier to diversify a local economy by growing industries which use similar skills, competencies, or knowledge bases as exist in the local economy: it is easier to make 'small leaps' from one industry into a related one than to make large jumps into an entirely new one. Yet, while there is good evidence on the importance of relatedness overall (see Boschma, 2017, for a review), there is little evidence specifically focused on the Creative Industries.

¹ For example, the South East Local Enterprise Partnership focused on the industry: <https://www.southeastlep.com/selep-backs-growth-of-creative-industries/>

This paper provides a primer on the idea of relatedness and its use for local economic development policy in the Creative Industries. It does this through three activities. First, it reviews the existing literature on relatedness and what it implies for policy. Second, it presents new evidence on patterns of relatedness between Great Britain's Creative Industries and sectors in the wider economy and undertakes descriptive regressions on the link between relatedness and the growth of Creative Industries in different places. Finally, it considers the policy implications from the analysis.

The paper finds suggestive evidence that relatedness has mattered for Creative Industries growth in the recovery period from the 2008 financial crisis, with three important caveats. First, there is considerable diversity amongst the different creative sub-sectors. Second, many of the industries which are 'related' to the Creative Industries are, in themselves, the objects of considerable economic development efforts and so hard to target. Third, and most important, is that while relatedness matters, it only explains a small share of growth in the Creative Industries in this period. Other firm- or location-specific factors play a more important role in driving growth in the sector.

The remainder of the paper is structured as follows. Section two summarises the academic literature on the Creative Industries and location. Section three outlines what the relatedness literature finds and how it might apply to the Creative Industries. Section four presents new evidence on relatedness to the Creative Industries in Great Britain, and section five concludes with implications for theory and practice.

2. The Creative Industries

The Creative Industries are considered an important part of the modern economy (Evans, 2009). Academic work on the sector draws on a wider consideration of the importance of 'creativity' in the economy. Scott (2006), for example, suggests that technological change and globalisation have changed labour markets in many developed economies, meaning that cognitive-cultural production is increasingly important. Rather than compete on the basis of low-cost production, the focus is increasingly on differentiated, symbolic goods which are produced by creative workers. Similarly, Florida's (2005; 2014) controversial concept of the 'creative class' highlights the economic importance of a group of skilled workers in occupations which rely on creativity, a group which includes workers in obviously 'creative' occupations such as artists but also in others, such as engineering. While this has been criticised on many grounds, not least as simply one way of illustrating human capital (Markusen, 2006), it remains an influential way of illustrating the importance of creativity across much of the modern economy. Academic work has highlighted the importance of creativity in the economy - the Creative Industries are seen as some of the exemplar industries of that trend.

Research has shown that the Creative Industries are predominantly urban and geographically unevenly distributed (Stam et al., 2008; Huggins and Clifton, 2011; Kemeny et al., 2019). This is because certain local economies are considered to have the conditions required for creative activity to thrive (Hall, 2000; Möller and Tubadji, 2009; Vorley et al, 2008). They can provide the focal points of creative processes, offering social relationships and the exchanges of tacit knowledge which are required (Scott, 2014). The 'buzz' of urban environments allows the rapid and

efficient exchange of new ideas, particularly where they cannot be exchanged through codified knowledge, and the dense networks of creative individuals allow innovation and creativity to spread (Storper and Venables, 2004). Cities may have ample visual stimuli (Chapain and Comunian, 2010; Drake, 2003). They may also be diverse, with large numbers of migrants (Nathan and Lee, 2014), or ample wealth to support the creative arts (Hall, 2000). Even at a relatively micro-level, evidence shows that creative activity clusters in relatively small areas, with strong creative and cultural economies developing self-reinforcing reputations which may attract new such activity (Currid and Williams, 2009).

These local interactions are particularly important for Creative Industries economic activity, much of which is based on fast-changing intangible knowledge. Because of this, some have argued that Creative Industries benefit from local 'buzz' – with face-to-face contact facilitating the rapid and diverse stimuli which enables creative work (Storper and Venables, 2004). Wojan et al. (2007: 711) argue that creative workers are likely to move to "places able to support rich opportunities for social and cultural interaction", a hypothesis they test using US data. They estimate the residual in a regression which predicts the share of workers in creative occupations in US counties, arguing that this residual can be considered a 'creative milieu' which accounts for unmeasured (or unmeasurable) creative factors. They then show that helps explain economic dynamism in the subsequent decade.

The Creative Industries, as defined by the UK government, are partially distinct from the wider notion of creativity. But their location will also, in part, be determined by these 'milieu' factors. Boix et al. (2016) map the geography of the Creative Industries across France, Great Britain, Italy, and Spain. They find a pattern of spatial

concentration in the Creative Industries (defined using the UNESCO definition), with a predominantly urban location which they relate to the “richness and thickness of personal networks” and other local endowments. But they also find considerable co-location within the sector, particularly in cities. While they do not hypothesise about why this might be the case, the revealed patterns suggest a sort of creative milieu in which benefits to one type of Creative Industry also provide benefits to the others.

3. Relatedness as a tool for understanding local economies

There is now a wide literature on regional diversification, at the heart of which is a single stylised fact: that it is easier for local economies to diversify into new industries or technologies if they are related to those which are already present (Essletzbichler, 2009; Boschma, 2016). There is abundant evidence for this stylised fact, including econometric studies and qualitative case studies, which shows it applies for technological innovation (Breschi et al., 2003) and regional industrial diversification (Neffke et al., 2011). The mechanisms underpinning this simple relationship can include diversification of existing firms, labour mobility between firms/sectors, social networking between proximate agents, and entrepreneurship (Boschma and Frenken, 2011).

Underpinning this simple fact, however, are a range of potential means of diversification. Boschma et al. (2017) set out a theory of regional diversification, at the heart of which is the idea that there are four possible ways of diversifying an economy:

- **Replication** – in which a region develops a new specialism in an industry which, while common elsewhere, is new to the region itself but related to its existing industrial base.
- **Transplantation** – in which a region develops a new specialism in a industry which is common outside, but which is unrelated to its existing industrial specialism.
- **Exaptation** – in which a region builds on existing strengths, but creates a niche which is new to the system (i.e. in a previously new to the world industry)

- **Saltation** – in which a region develops a new specialisation in a new industry which does not exist elsewhere.

The Creative Industries are a particularly interesting case of these processes. First of all, one of their key features is their permeability with other sectors of the economy. Strong supply-chain links with other parts of the economy can lead to the creation of innovation in various forms (Bakhshi and McVittie, 2009). Creative occupations are often in other parts of the economy too, with some evidence showing their importance in creating new products and processes in these 'non-creative' parts of the economy (Lee and Drever, 2013; Lee and Rodríguez-Pose, 2014). From the point of view of relatedness, the Creative Industries may therefore have an important role in stimulating growth in other local sectors (Lee, 2014).

The classic studies of relatedness suggest that new industries develop out of the knowledge and competencies in existing industries. For example, the British automobile industry was seen to have developed from a combination of cycle manufacture and coach making (Boschma and Wenting, 2007). The creation of new industries is unlikely to be captured in existing sectoral statistics, but the creation of new products might lead to employment growth which might be. For example, new processes in the design industry might develop from processes in nearby management consultancies or vice versa (see Tether and Tajar, 2008).

Second, many parts of the Creative Industries are likely to draw on local demand. For some industries, this will be demand from other businesses: for example, design companies might work for other local firms. While some of the Creative Industries are tradeable sectors which produce goods which can be consumed elsewhere (for example, IT – see Lee and Clark, 2019, for more on this distinction), the sector's

dynamics mean much of it could be seen as having strong non-tradeable elements: IT includes firms servicing international markets, but also firms serving local demand for IT in schools, hospitals, and other public services where they are required to regularly come and work on site.

Third, many have internal clustering dynamics with other parts of the same industry. The advertising industry is a tradeable industry which could, theoretically, be conducted anywhere. Yet it is famously highly spatially concentrated and requires sharing of information (Arzaghi and Henderson, 2008).

To date, there have only been a few studies to date on relatedness and the Creative Industries. The sole study identified for this primer is Innocenti and Lazeretti (2019) who consider relatedness between the Creative Industries and other sectors of the Italian economy, examining employment growth from 2006-2015. They estimate the conditional probability of co-presence of two industries to identify relatedness, and then estimate employment growth models, finding that local economies with higher relatedness to the Creative Industries are associated with higher employment growth rates in the Creative Industries.

4. Measuring relatedness in UK local economies

The academic literature on relatedness has developed a set of metrics to identify which activities are 'related' to which others. These measures often drawn from the literature on economic complexity (Hausman and Klinger, 2007). This paper uses these metrics to develop preliminary evidence on relatedness between other sectors and the Creative Industries in British local economies.

4.1 Data and units of analysis

The unit of analysis used here is the Travel-to-Work-Area (TTWA). The Creative Industries are highly localised (Currid-Halkett and Williams, 2009), with labour market networks important to their geographical extent. Local economies are “leaky buckets” with people commuting across different areas (Gordon, 1999), but TTWAs are relatively self-contained, mitigating against this problem. They are defined according to Coombes and the Office of National Statistics (2015) as largely self-contained local labour markets with at least 3,500 residents around 75% self-containment: that is, three quarters of the local workforce must live in the TTWA in which they work. Unfortunately, because of lack of available data we cannot construct models for Northern Ireland. The final sample is 212 TTWAs in Great Britain.

The industry data comes from the Business Register and Employment Survey (BRES). This is collected from around 80,000 firms each year, a 4% sample of all UK businesses. This gives information on the number of employees and business owners in each sector, so includes some sole proprietors. However, it misses the self-employed who are not registered for Value Added Tax (VAT) or Pay as You Earn

(PAYE) taxation. Because of this, it omits a large number of self-employed creative businesses; in total, self-employment accounts for around a third of all employment in the Creative Industries (Tether, 2019). Furthermore, because industrial classifications have changed over time (and in particular the change from SIC03 to SIC07 in 2008), we use this dataset for the period 2009-2014. This means that the context is highly important – this period covers the recovery from the global financial crisis and recession.

We use the widely-used DCMS classification of the Creative Industries. This includes the following sub-sectors: Advertising & Marketing; Architecture; Crafts; Design; Film, TV, video, etc; IT, software, etc; Publishing; Museums etc; Music and arts. These form the basis of the analysis, although small sample sizes at the local level limit the data analysis. We identify the Creative Industries using four-digit SIC codes, but consider all other industries at the three-digit level to avoid the large number of zero values which would otherwise result. Most studies in this field also make another distinction, between tradeables and non-tradeables. Tradeables are industries such as automobile manufacturing where production occurs in one place and consumption in another. Non-tradeables are industries such as face-to-face retail or restaurants where production takes place at (or close to) the place of consumption. Because the geography of non-tradeables tends to be determined more by the distribution of the population than the rest of the local economic structure, we exclude these industries.²

² This is common practice in the literature on relatedness. Details on our definitions of tradeables and non-tradeables can be found in Lee and Clark (2019).

4.2 Constructing an indicator for 'relatedness'

The basic methodology to identify relatedness follows three stages, closely following the model set out in Cortinovis et al., (2017: 1186-1188) who themselves adapt Hausman and Klinger's (2007) basic methodology. More detail on these stages is given in the appendix, but the intuitive process is given as follows:

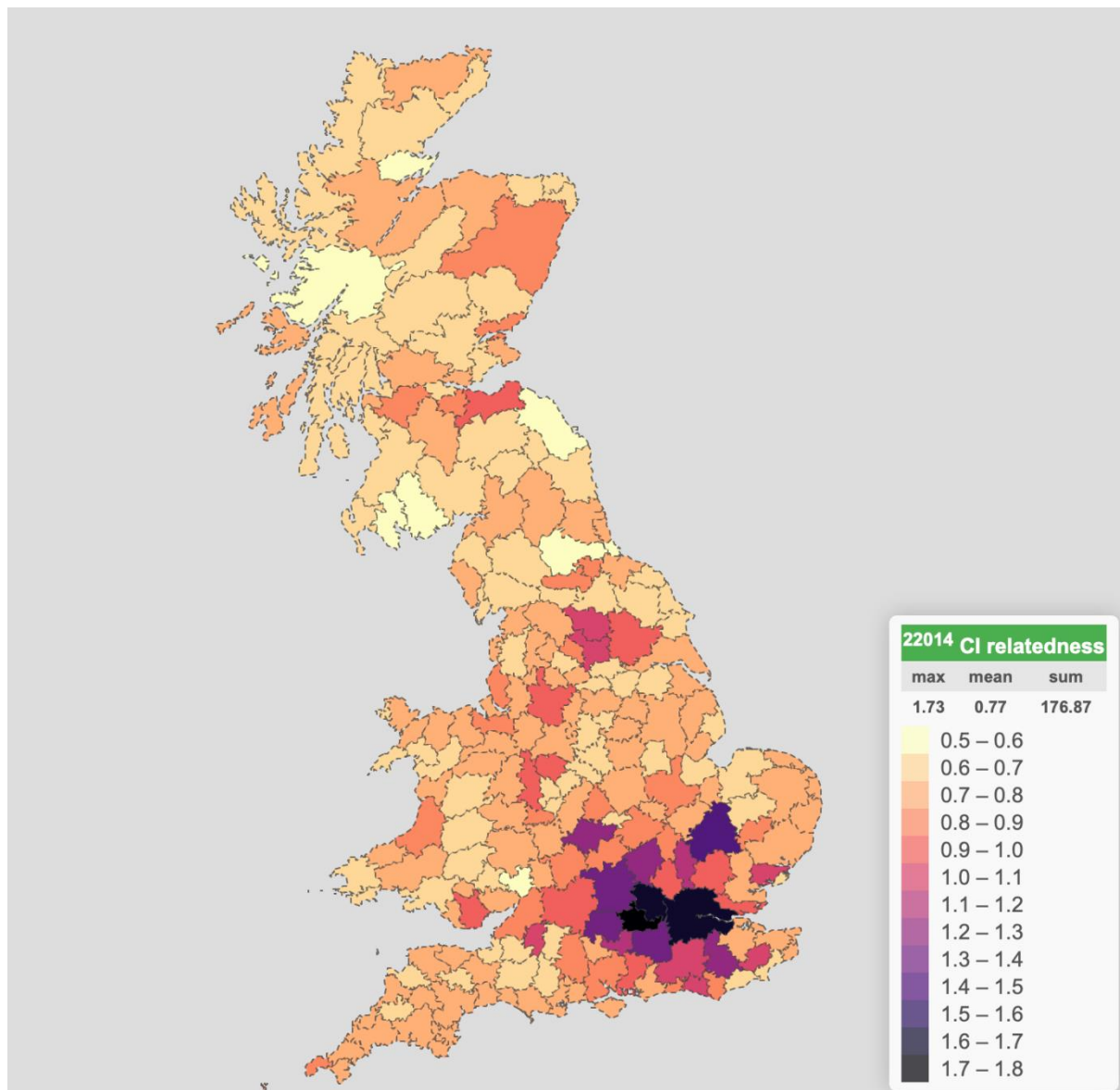
1. **Identifying patterns of specialisation.** The first stage is to work out a measure of specialisation of local economies. The intuition of this phase is that it uses location quotients, a measure of local economic specialisation (see Tether, 2019), to estimate whether each local economy is specialised in each industry.
2. **Relating specialisations in the Creative Industries to those in the wider economy.** The next stage looks at the probability of specialisation in each of the Creative Industries if each local economy is specialised in another industry, i.e. if a local economy is specialised in Hedge Funds how likely is it also to be specialised in Advertising? This gives a measure of relatedness between each other industry in the wider economy and each part of the Creative Industries.
3. **Constructing local 'relatedness' scores to the Creative Industries.** Finally, the indicator calculated in phase two is used to construct an overall measure of 'relatedness' between a local area's current economic specialism and the creative industries, a value which is higher if there is a higher probability that, based on the current industrial specialisms, the local economy would also be specialised in each Creative Industry. This is the measure of local relatedness.

The process above ignores much of the detail (see Cortinovis et al., 2017, for an excellent and much more detailed description of the process). Moreover, the relatedness literature varies in the construction of relatedness, with studies based on patents often using more advanced methodologies than those using local data.

5. Relatedness to the Creative Industries

The map of relatedness to the Creative Industries is given in Figure 1 which – for obvious reasons – closely matches the actual geography of Great Britain. There are concentrations of related activity in Edinburgh, areas of Yorkshire such as Harrogate, and some major cities such as Birmingham.

Figure 1. Relatedness to the Creative Industries in TTWAs, 2014



As we would expect, the measure of relatedness has a close relationship with employment in the Creative Industries. Figure 2 shows this basic relationship – a clear and positive relationship between the two variables. In a simple regression between share of Creative Industries employment and relatedness the R^2 is just over 0.7, showing that around 70% of variation in employment levels in TTWAs are “explained by” relatedness to other industries.

Figure 2. Relationship between Creative Industries relatedness and employment

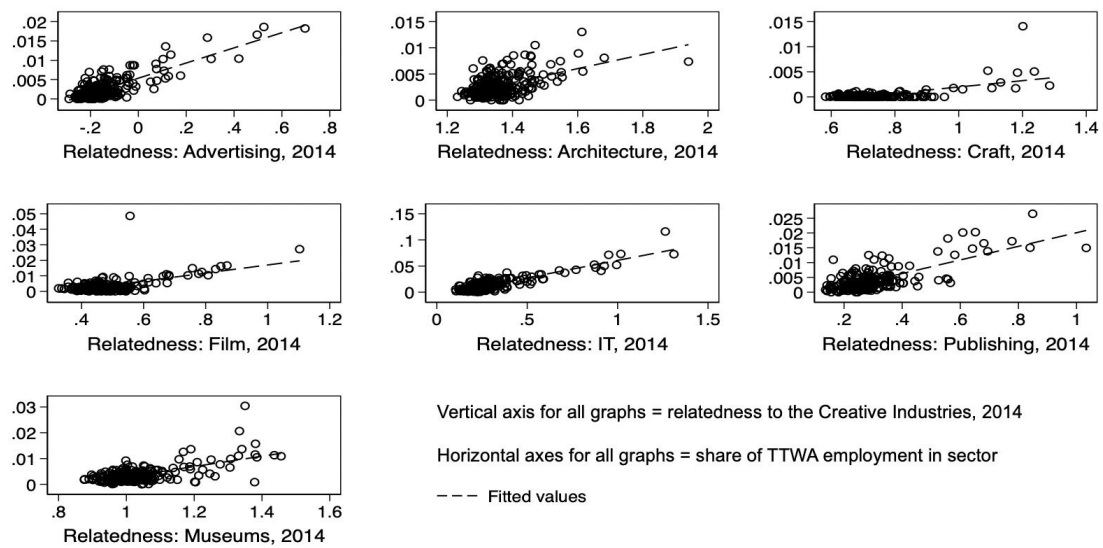


Source: BRES. A higher level of relatedness = more related to the Creative Industries

Figure 3 presents this relationship for each of the different sub-sectors of the Creative Industries (Design employment has some extreme outliers over this period, so it isn't included in this analysis). While there is a positive trend in each case, there are numerous outliers and the strength of the relationship varies significantly across models. In short, relatedness matters more for some industries than others. Simply comparing these R^2 values, we find that it explains around 0.76 of employment share in IT and 0.67 in Advertising and Marketing, but only 0.25 in Architecture or 0.32 in

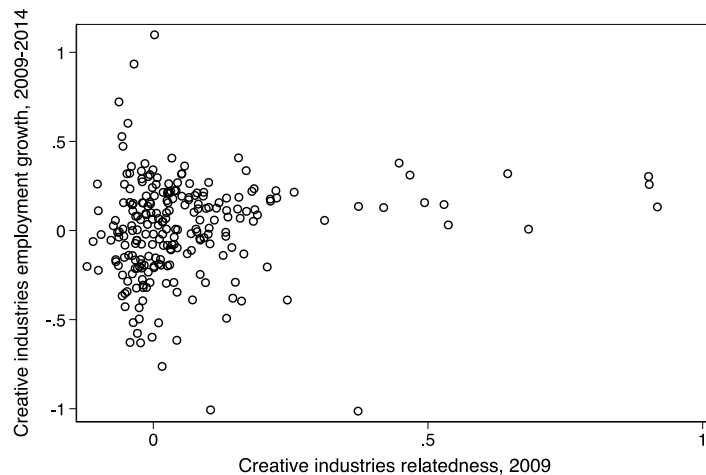
Film, Radio and Television. In short, relatedness matters more for some industries than for others.

Figure 3. Relatedness and employment, different variables



Relatedness seems to have a weaker relationship with employment growth, however. Figure 4 plots this relationship. While the relationship is, overall, positive, there is significant noise. Other factors are likely to be affecting growth processes in the creative industries.

Figure 4. Relatedness and employment growth, 2009-14



To test this relationship, we use a series of descriptive regressions which allow us to control for potential confounding factors such as initial employment in Creative Industries. Our basic model is as given below:

$$\Delta y_{i2009-2014} = \alpha + \beta_1 \text{Relatedness}_{i2009} + \beta_2 \text{Employment\%}_{i2009} + \varepsilon \quad (1)$$

Where $\Delta y_{i2009-2014}$ is the difference between the log of total employment in each ITWA between 2009 and 2014 (the growth rate of total Creative Industries employment). Our principle variable of interest is relatedness, which we calculate using 2009 data. Because this is largely determined by the existing presence of Creative Industries, in tables 2 and 3 we also include a measure of pre-existing specialisation (the share of Creative Industries in total employment). Our models essentially ask if, given initial specialisation, growth in the industries was faster where there was less employment in the sector beforehand.

Table 2. Relatedness and employment growth in Creative Industries, 2009-14

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	CI Overall	Advertising	Architecture	Craft	Film	IT	Publishing	Museums	Music
Relatedness, 2009	0.971*** (0.166)	2.345*** (0.313)	1.886*** (0.530)	0.966 (0.888)	0.792 (0.599)	1.110*** (0.197)	1.626*** (0.344)	2.744*** (0.587)	0.531 (0.952)
Initial employment %	-7.247*** (1.639)	-162.1*** (22.56)	-116.1*** (26.00)	-129.4 (89.99)	-19.38 (14.08)	-22.28*** (4.130)	-37.91*** (3.959)	-88.47*** (18.26)	-78.61*** (23.71)
Constant	0.211*** (0.0525)	-1.212*** (0.192)	-1.137*** (0.388)	-0.478 (0.442)	-0.0954* (0.0557)	-0.356*** (0.120)	-0.529*** (0.107)	-1.052*** (0.237)	-0.714 (1.646)
Observations	232	216	223	136	222	232	226	230	228
R-squared	0.130	0.191	0.112	0.019	0.021	0.103	0.192	0.139	0.135

Source: BRES, authors calculations

The results show that relatedness had a positive and statistically significant effect in each case, with the coefficients of the standardised variables relatively similar in magnitude. We note that, with the exception of crafts which has a very small sample size in each case, recent growth in the Creative Industries has been stronger in places where that particular Creative Industry was already relatively strong in 2009.

Table 3. Relatedness and employment growth in Creative Industries, 2009-14

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	CI Overall	Advertising	Architecture	Craft	Film	IT	Publishing	Museums	Music
Relatedness, 2009	0.853*** (0.169)	2.040*** (0.305)	2.093*** (0.553)	0.121 (0.962)	0.812 (0.575)	0.984*** (0.198)	1.484*** (0.334)	2.140*** (0.684)	0.806 (0.901)
Initial employment in each CI %	-7.455*** (1.598)	-166.8*** (23.82)	-116.0*** (25.41)	-135.1 (95.09)	-19.75 (14.64)	-26.99*** (4.750)	-37.15*** (3.667)	-85.26*** (18.18)	-81.47*** (24.62)
Total employment (ln)	0.0349** (0.0165)	0.0945* (0.0498)	-0.0557 (0.0345)	-0.165** (0.0718)	0.0111 (0.0379)	0.123*** (0.0303)	0.0221 (0.0345)	-0.0601* (0.0340)	0.0880** (0.0399)
Constant	-0.139 (0.181)	-1.986*** (0.507)	-0.717* (0.393)	1.774* (1.036)	-0.213 (0.405)	-1.495*** (0.347)	-0.723** (0.356)	-0.162 (0.582)	-2.123 (1.534)
Observations	232	216	223	136	222	232	226	230	228
R-squared	0.150	0.207	0.126	0.046	0.021	0.201	0.194	0.149	0.151

The Creative Industries are often seen as an urban sector, and one hypothesis is that the model in equation one is biased because post-crisis growth in the sector has disproportionately focused on cities. To account for this, in table 3 we repeat these simple regressions with an additional independent variable, the log of total employment. The results here are more mixed – relatedness is important for all sub-sectors except Craft and Music, with the sign of the coefficient being smallest for Music. While overall, Creative Industries employment grew faster in the larger cities, the result is not universal across Creative Industries sub-sectors.

Overall, these descriptive regressions show three main findings. First, relatedness does seem to matter overall for the Creative Industries. However, the second finding is that it only explains a relatively small share of the variation in the growth rate of the Creative Industries. Moreover, there is considerable variation in the extent to which it explains growth.³

³ Other studies have suggested that relatedness only matters under certain conditions, such as Xiao et al. (2018) who show relatedness matters more in regions with lower levels of innovation.

6. Conclusions and implications

The Creative Industries are a key area of local economic development policy, featuring heavily in Local Industrial Strategies (Todd, 2020). This paper has considered how useful the concept of relatedness is to the Creative Industries. One of the claims made by the relatedness literature is that it can help guide public policy towards particular industries, yet studies have tended to operate at a general level of abstraction. This paper addresses this gap, reviewing the literature on relatedness and presenting new evidence on the role of relatedness in industrial growth.

At the core of the idea of relatedness is the notion that it is easier to grow specialisms which are related technologically to pre-existing industrial concentrations (Frenken et al., 2007). Related technological fields draw upon related skills, or related knowledge, which facilitates entry into them. This means it is easier for a local economy to make short jumps into related industries than long-leaps into new ones. Understanding relatedness can help local economies target sectors in which they may be able to develop advantages. This is an important observation for a sector such as the Creative Industries, which may prove the target of economic development efforts simply because they are high-profile, fashionable and politically attractive. Relatedness can be used to identify areas of 'potential' where it might be that the Creative Industries have favourable conditions to grow (Balland et al., 2019). But relatedness is a mechanism rather than a universal law and other places might still be able to maintain some strengths in these sub-sectors.

An important caveat to this finding is required; in the descriptive regressions presented here three basic factors – industrial relatedness, Creative Industries employment share, and TTWA size – between them explain only around 10% of the post-crisis growth in the Creative Industries, with some differences between sub-sectors. This estimate seems low, but is actually higher than in other regressions which control for time-invariant fixed effects (Cortinovis et al., 2017). Relatedness matters, but it is far from the only determinant of local growth. This matters because it implies there is some scope to develop new specialisms – while it is harder to do so, local economies do have some ability to “fight against the flow”.

While it is important to be careful drawing conclusions from a limited empirical exercise on a limited data set, it does highlight the need for relatedness to be considered alongside other potential locational advantages and disadvantages. While relatedness is a useful concept here, other factors – in particular local endowments – are also likely to be important, and these will themselves be co-determined with the local relatedness. For example, presence of a university may increase growth in the Creative Industries but also sectors related to it. Second, while relatedness may have an overall effect on economic development in these areas, it does not seem to apply evenly across all of the Creative Industries sub-sectors. While some Creative Industries sectors, such as IT, appear strongly determined by relatedness to the rest of the local economy, others, such as Museums, are less so. In some respects, this is unsurprising, as activities such as Museums are likely to be spread geographically, grow slowly, and also have a strong element of non-tradeable production (in that they must be produced at the point of consumption). But the elements of the Creative Industries which appear most influenced by local relatedness seem to be those which are the most productive. The more productive,

tradeable parts of the Creative Industries can, by definition, be produced in one place and transported elsewhere. Their location is less determined by the size of the population of any local economy and more determined by the other firms which might provide complementary inputs – skills, specialist inputs and outputs which require face to face interaction, and localised knowledge spillovers. This leads to a problem for policy – the most economically dynamic parts of the industry will be hardest to spread geographically, at least in part, because they are most determined by the pre-existing specialisations of the local area.

This paper has presented a primer on the relatedness literature, but opens up potential future follow up research. In particular, the descriptive regressions presented here will be influenced by the economic context of the time, which saw a weak and unusual recovery from a major crisis. The other problem here is that we use a parsimonious model, without fixed effects, and with limited controls. Future work may wish to develop more complex model when data becomes available.

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Appendix: Calculating relatedness

We begin by considering the determinants of specialisation in the Creative Industries. We do this in a two-step process. First, we define specialisation using location quotients (LQ). Specifically, we begin by calculating location quotients (LQ) as the ratio of the share of employment in a particular industry in the regional economy to the share of that industry in the whole (national) economy. An LQ of one indicates a share of employment exactly matching that in the national economy; an LQ greater than one indicates a higher share than in the national economy, and an LQ significantly higher than one indicates a greater degree of local economic specialisation in that industry, relative to the national economy. More formally:

$$LQ_{ic} = (E_{ic} / E_c) / (E_i / E) \quad (1)$$

Where:

LQ_{ic} is the location quotient for industry 'i' in TTWA 'c'

E_{ic} is employment in industry 'i' in TTWA 'c'

E_c is total TTWA employment

E_i is national level employment in industry 'i'

E is total national employment.

We then calculate the standardised location quotient following Cortinovis et al. (2017: 1186) as:

$$SLQ_{ic} = \frac{LQ_{ic} - \overline{LQ_i}}{Std(LQ_i)}$$

(2)

Where LQ_{ic} is the location quotient for industry 'i' in TTWA 'c', \underline{LQ}_i is the mean LQ for industry 'i'. $Std(LQ_i)$ gives the standard deviation.⁴ We use the measure above to calculate the 95th percentile of employment required for a TTWA to be considered 'specialised' in that industry, with each TTWA considered specialised if the SLQ identified above is higher than the cut-off values identified in a bootstrap sampling process.

We then use this to calculate the conditional probability of any particular sector being co-specialised with another sector, estimated as the minimum between conditional probabilities of specialisation in industry 'i' if specialised in 'j' and vice versa.

$$\phi_{i,c,t} = \min\{P(x_{i,t} | x_{j,t}), P(x_{j,t} | x_{i,t})\} \quad (2)$$

This yields a matrix between different industries, with our focus being on relatedness to the Creative Industries specifically. We then use this to calculate a density indicator – as in the original Hausmann and Klinger (2007) paper, as follows.

$$d_{i,c,t} = \left(\frac{\sum_k \phi_{i,k,t} x_{k,c,t}}{\sum_k \phi_{i,k,t}} \right) \quad (3)$$

Given that our focus is on the Creative Industries, the density indicator can be seen as the proximity between industry 'k' and 'i' in each year 't', where $x_{k,c,t}$ gives the

⁴ Jing Xiao at Lund very kindly provided syntax for this stage. We use Tian's (2013) bootstrap method which is also used by Cortinovis et al. (2017) and Cicerone (2019).

specialism (or not) of a travel-to-work area in industry k at time t . If this density indicator is 1, this indicates that a TTWA has a highly related industrial base; if the value is 0 the industrial base is less related.

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