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Entrepreneurship Culture, Knowledge Spillovers, and the Growth of Regions

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Abstract
An extensive literature has emerged in regional studies linking organization-based measures of entrepreneurship (e.g., self-employment, new start-ups) to regional economic performance. A limitation of the extant literature is that the measurement of entrepreneurship is not able to incorporate broader conceptual views, such as behaviour, of what actually constitutes entrepreneurship. This paper fills this gap by linking the underlying and also more fundamental and encompassing entrepreneurship culture of regions to regional economic performance. The empirical evidence suggests that those regions exhibiting higher levels of entrepreneurship culture tend to have higher employment growth. Robustness checks using causal methods confirm this finding.
Keywords: Entrepreneurship; Entrepreneurship Culture; Regional Development; Economic Growth
JEL-classifications: L26, R11, M13

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Introduction

A large and compelling literature has found that not only do regions matter for entrepreneurship, but also, perhaps more importantly, entrepreneurship matters for regions. Systematic empirical evidence across a broad spectrum of national and temporal contexts suggests that those regions exhibiting a greater degree of entrepreneurial activity enjoy a superior economic performance (for a review, see VAN PRAAG and VERSLOOT, 2008). However, there is a considerable disparity between the conceptualization of entrepreneurship in the literature and how it is actually operationalized and measured in virtually every study providing an empirical link between entrepreneurship and growth. In their measures of entrepreneurship activity at the spatial level, most studies have restricted themselves to what AUDRETSCH et al. (2015) term as the "organizational view" of entrepreneurship, which is measured in terms of organizational status, such as the age of the firm (e.g., a startup), size of the firm (e.g., small), or governance of the firm (e.g., self-employed) (ANDERSSON and KOSTER, 2011; REYNOLDS and MILLER, 1992; LEE, 2016). The distinctive feature of this view is that entrepreneurship is recognized, defined and measured on the basis of organizational status.

Such measures reflect only one view to entrepreneurship – the organizational view. As AUDRETSCH et al. (2015) point out, there are also two other contrasting views of entrepreneurship. The behavioural view has a focus on the behaviour of individuals, teams and organizations to recognize, create and act upon opportunities as the distinguishing characteristic of entrepreneurship. The behavioural view is actually organization free in that it can take place in any type of organizational context (AUDRETSCH et al., 2015; SHANE and VENKATAMARAN, 2000; IRELAND et al., 2009). Similarly, the performance view classifies entrepreneurship on the basis of outcomes or performance, such as innovation or growth (AUDRETSCH et al., 2015; MCKELVIE and

WIKLUND, 2010; ACS and GIFFORD, 1996). The second two strands in the literature would question the claim from the first strand that while something might be linked to economic performance in the spatial context, it is hardly representative of or reflecting the broad meaning of entrepreneurship.

The purpose of this paper is to overcome this measurement and methodological limitation of the extant studies claiming to link entrepreneurship to the growth of regions. We do this by using a more fundamental measure of entrepreneurship specific to each region: entrepreneurship culture (OBSCHONKA et al., 2013; 2015; STUETZER et al., 2016). While each of the three views of entrepreneurship is decidedly unique and different, in terms of both conceptualization and measurement, what they have in common are that all represent a different manifestation of the same underlying entrepreneurship culture. Our novel contribution to the literature is therefore providing empirical evidence for the link of a recently developed indicator of entrepreneurship culture and economic growth. Our paper stands in the tradition of a few others also linking entrepreneurship culture to growth (e.g., BEUGELSDIJK, 2007; DAVIDSSON and WIKLUND, 1997). Using unique personality data to proxy entrepreneurship culture, we find in our empirical analysis that US regions with higher entrepreneurship culture enjoy higher economic growth. Causal methods using instrumental variable (IV) regressions confirm these findings.

Entrepreneurship Culture, Knowledge Spillovers and Economic Growth

What is culture? A widely adopted definition of culture is by HOFSTEDE (2001, p. 1) who views culture as a "collective programming of the mind". In that sense an entrepreneurship culture is a collective programming of the mind toward entrepreneurial values and norms such as proactiveness, risk taking, accepting failure, openness to new ideas, individualism, independence

and achievement, to name a few. In a similar vein, FREYTAG and THURIK (2007) argue that entrepreneurship culture is an aggregate psychological trait of the population (MCCLELLAND, 1961; HOFSTEDE and MCCRAE, 2008). Institutional theory helps applying these concepts to economics. Institutional theory is interested in the development, persistence and effects of man-made institutions on economic development. Although much research focuses on formal institutions (ACEMOGLU et al., 2002), informal institutions such as norms and values strongly affect human action too (NORTH, 1994; BAUMOL, 1996). An entrepreneurship culture can be seen as such an informal institution shaping the legitimacy of entrepreneurship as an economic behaviour (e.g., earning a living as an entrepreneur is an accepted career choice versus is not accepted (KIBLER et al., 2014) and facilitating the development of shared meaning (e.g., entrepreneurs create jobs vs. exploit labour) in a population (DENZAU and NORTH, 1994).

This is not limited to the organizational view of entrepreneurship but also relevant for the behavioural view and the performance based view. Regarding the behavioural view, entrepreneurial behaviour in a corporate context like developing a new product within a firm is arguably also shaped by the same informal institutions. For example, fear of failure as a manifestation of a low entrepreneurship culture will probably lead to 1) fewer people starting their own firm (WYRWICH et al., 2016), 2) less risk taking and less proactiveness within existing firms (KREISER et al., 2010), and 3) reduced ambitions to grow existing firms (HAMBRICK and CROZIER, 1985).

Another theoretical piece in linking entrepreneurship culture or what they termed as *entrepreneurship capital* to the economic growth of regions comes from AUDRETSCH et al. (2006). They argue that those regions with a greater endowment of entrepreneurship culture would have a greater propensity for not just discovering and generating entrepreneurial opportunities but also

acting upon them as well. In their approach, an entrepreneurship culture served as the crucial mechanism facilitating the spillover of knowledge and ideas from organizations where they were created to where those opportunities were actualized, ultimately generating a superior economic performance for individuals, organizations, and the entire region. Despite advancement in theory, AUDRETSCH et al. (2006) did not, however, actually observe or measure the underlying entrepreneurship culture, so they inferred the role of entrepreneurship capital from one of its manifestations – the regional start-up rate.

Entrepreneurship culture tends to persist over time (ANDERSSON and KOSTER, 2011; FRITSCH and WYRWICH, 2014) – therefore, having the potential to influence the economic trajectories of regions over a long period of time. In her widely acclaimed study, *Regional Advantage*, Anna Lee SAXENIEN (1994) attributed the long-term superior economic performance of Silicon Valley in California vis-à-vis Route 128 in Massachusetts to an entrepreneurship culture. A recent study by FRITSCH and WYRWICH (2017) uses an IV approach to measure the effect of entrepreneurship on economic growth. They identify a regional entrepreneurship culture in German regions by means of *historic* self-employment rates. Higher historic self-employment rates in 1925 relate to higher entrepreneurship in 1976 which is related to subsequent growth between 1976 and 2008. In a related study analyzing growth in US regions, GLAESER et al. (2015) instrument entrepreneurship by local proximity to coal mines. Despite their efforts to circumvent endogeneity issues, both studies again rely on organizational measure of entrepreneurship and do not directly measure entrepreneurship culture.

There is also empirical evidence that an entrepreneurship culture affects indicators related to the behavioural and performance view of entrepreneurship and ultimately economic growth. KREISER et al. (2010) finds that managers in small firms in countries with high uncertainty

avoidance and high power distance, two cultural characteristics according to HOFSTEDE (2001), have less proactiveness and risk taking. In turn, proactiveness and risk taking are key dimensions of an entrepreneurial orientation of a firm (LUMPKIN and DESS, 1996) and low entrepreneurial orientation is directly related to less innovations (PEREZ-LUNO et al., 2011) as well as firm growth (RAUCH et al., 2009). At the regional level, BEUGELSDIJK (2007) finds that an entrepreneurship culture relates to more patents at the regional level and ultimately higher employment growth between 1950 and 1998. More recently, CARAGLIU et al. (2016) show at the regional level that European cities with more positive risk attitude have a higher innovative performance in terms of patenting which in turn predicts economic growth in the long run (BEUGELSDIJK, 2007).

Summarizing the above, we argue that entrepreneurship culture as a theoretical construct encompasses all three views of entrepreneurship (organizational, behavioural and performance). We hypothesize that regions with higher entrepreneurship culture will have higher economic growth.

Measuring Entrepreneurship Culture

There are two ways of directly measuring entrepreneurship culture. A first group of studies compares aggregated scores of values and beliefs of entrepreneurs with non-entrepreneurs. From these differences composite indices are derived that discriminate regions with an entrepreneurship culture from those lacking such a culture (BEUGELSDIJK, 2007; BEUGELSDIJK and NOORDERHAVEN, 2004). A second group of studies applies the aggregate psychological trait explanation of entrepreneurship described above (FREYTAG and THURIK, 2007; DAVIDSSON and WIKLUND, 1997; DAVIDSSON, 1995). They use established psychological constructs for measuring an entrepreneurship culture that have been shown to be associated either with entrepreneurship or

with its economic consequences such as growth. For example, DAVIDSSON and WIKLUND (1997) use MCCLELLAND'S (1961) need for achievement trait, need for autonomy trait and aspects of self-efficacy (BANDURA, 1986) in explaining regional differences in entrepreneurship.

In the present study we follow this second approach. More precisely we adopt the Big Five personality approach, the most widely used contemporary model of personality (JOHN et al., 2008). At the individual level, there is clear empirical evidence that individuals scoring high in extraversion (E), conscientiousness (C), openness (O), and low in agreeableness (A) as well in neuroticism (N) are more likely to become entrepreneurs and succeed in entrepreneurship (ZHAO and SEIBERT, 2006; BRANDSTÄTTER, 2011). Beyond direct relations, an entrepreneurial constellation of the Big Five traits (high in E, C and O, low in A as well as N) is an even stronger predictor for entrepreneurial behaviour at the individual level (for an overview, see OBSCHONKA et al., 2013).

The Big Five approach to personality is well suited for the present research for several reasons. Most importantly, the approach is the most cross-culturally validated model of personality (SCHMITT et al., 2007; MCCRAE and COSTA, 1997). Another reason to use the Big Five model is that the constituent traits all demonstrate a strong genetic base (LOEHLIN, 1992; PLOMIN and CASPI, 1999) and are relatively stable over the course of life (COSTA and MCCRAE, 1992; ROBERTS et al., 2006). This implies that the regional prevalence of the Big Five traits is also relatively stable over time, which is in line with the assumption that regional culture is rather stable over time and therefore persistent (e.g., GUISO et al., 2006). Undeniably, the regional prevalence of the Big Five traits is suspect to change due to migration, changing environmental conditions, and changing social patterns but these processes arguably take decades or centuries (RENTFROW et al., 2008).

The regional distribution of the Big Five traits was mapped by RENTFROW (2010). OBSCHONKA et al. (2013) mapped its entrepreneurial constellation across U.S. regions and found that this entrepreneurial personality profile is correlated with some organizational measures of entrepreneurship (start-up rate). This entrepreneurial personality profile also predicted a lesser decline of start-up rates across US and UK regions in the Great Recession (OBSCHONKA et al. (2016). Beside a direct relationship with entrepreneurship indicators, OBSCHONKA et al. (2015) find empirical evidence for moderated effects. Specifically, regional knowledge resources in the US and UK have a stronger correlation with entrepreneurship indicators in regions with higher levels of the regional entrepreneurial personality profile. Finally, STUETZER et al. (2016) trace back the origins of an entrepreneurial personality profile in Great Britain to the Industrial Revolution. In regions with historically high concentration of employment in large-scale industries such as steel and textiles, the regional population has, on average, lower levels of an entrepreneurial personality profile. Summarizing the above, there is growing and converging empirical evidence for the validity of the entrepreneurial personality profile as a measure of an entrepreneurship culture.

Data and Estimation Model

We are interested in the relationship between entrepreneurship culture and regional economic performance. As regional units for our analysis we use US Metropolitan Statistical Areas (hereinafter referred to as "MSA"). As of 2009, there were 366 MSAs in the United States.

We use employment growth as our indicator of economic growth over other alternative measures for two reasons. Firstly, it is the most often used indicator of regional economic performance that can be compared across regional, national and temporal contexts (e.g. ACS and

STOREY, 2004; FRITSCH and WYRWICH, 2014; GLAESER et al., 2015). Secondly, employment growth registers as the highest policy priority in developed countries (MORETTI, 2012). Data on employment come from the US Bureau of Labor Statistics, which provides a time series for US counties from 1990 to 2015. We compute employment growth (%) over several time periods to test for sensitivity and robustness with respect to the time period. Nevertheless, we use the growth of the annual payroll as an alternative dependent variable in a robustness check. We use the new measure of entrepreneurship culture that was described above. The individual-level data for the personality traits come from the Gosling-Potter Internet project, which collects personality data in the United States (RENTFROW et al., 2008, has details of the construction of the database). The database consists of 935,858 survey respondents in the United States from 2003 to 2009. Individual respondents were allocated to an MSA based on their current residence via ZIP code. The mean number of respondents in an MSA in the US is 2,557. Self-ratings were collected using the Big Five Inventory (JOHN et al., 1991). Respondents indicated the extent to which they agreed or disagreed with 44 statements using a five-point Likert-style rating scale.

The five dimensions E, C, O, A and N were used to create an entrepreneurial personality profile for each respondent (e.g., OBSCHONKA et al., 2013). Using the CRONBACH and GLESER'S (1953) D^2 approach, which quantifies the similarity between two profiles, the Big Five profile of each respondent is compared with the fixed reference profile to derive scores in terms of each Big Five dimension. The individual entrepreneurial Big Five profile was aggregated to a spatial mean score, resulting in our measure of regional *entrepreneurship culture*. The variable was finally z-standardized – a value of 0 indicates an average degree of entrepreneurship culture, a value of 1 (-1) is 1 standard deviation (SD) above (below) regional average. Note that the time span of the personality data ranging from 2003 to 2009 does not, and does not need to match the time span of

the employment data from 1990 to 2015. This is because Big Five traits and our measure of an entrepreneurial culture are theorized to be relatively time-invariant.

The spatial variation of entrepreneurship culture across US MSAs is shown in Figure 1. Many MSAs in Florida, California and Texas as well as the Mountain regions have a strong entrepreneurship culture. MSAs along the Mississippi and in what is now known as the Rust Belt have a weak entrepreneurship culture. There is a promising overlap with Figure 2 showing the employment growth (%) across MSA region in the United States between 1990 and 2015. The correlation between entrepreneurship culture and 1990-2015 employment growth is 0.35 (Table 1).

In addition to entrepreneurship (culture), the extant literature has identified other potential determinants of regional economic performance, which need to be controlled for. Unless otherwise stated, the respective data are taken from the 2010 ACS five-year estimates. The descriptive statistics, including the mean and SD, and the simple correlations for all variables are provided in Table 1.

The first variable is the extent of *human capital* in a particular region. *Human capital* is typically measured in terms of education (STUETZER et al., 2014; LEE, 2016). The measure used in this paper is the share of the adult population in the region having attained a bachelor's degree or higher.

Most studies find a positive and statistically significant relationship between the extent of *knowledge* in a region and regional economic performance (FRITSCH, 2013). As in many other studies we proxy *knowledge* by the employment share in research and development (R&D) occupations (engineers and natural scientists) (e.g., FRITSCH and SLAVTCHEV, 2007).

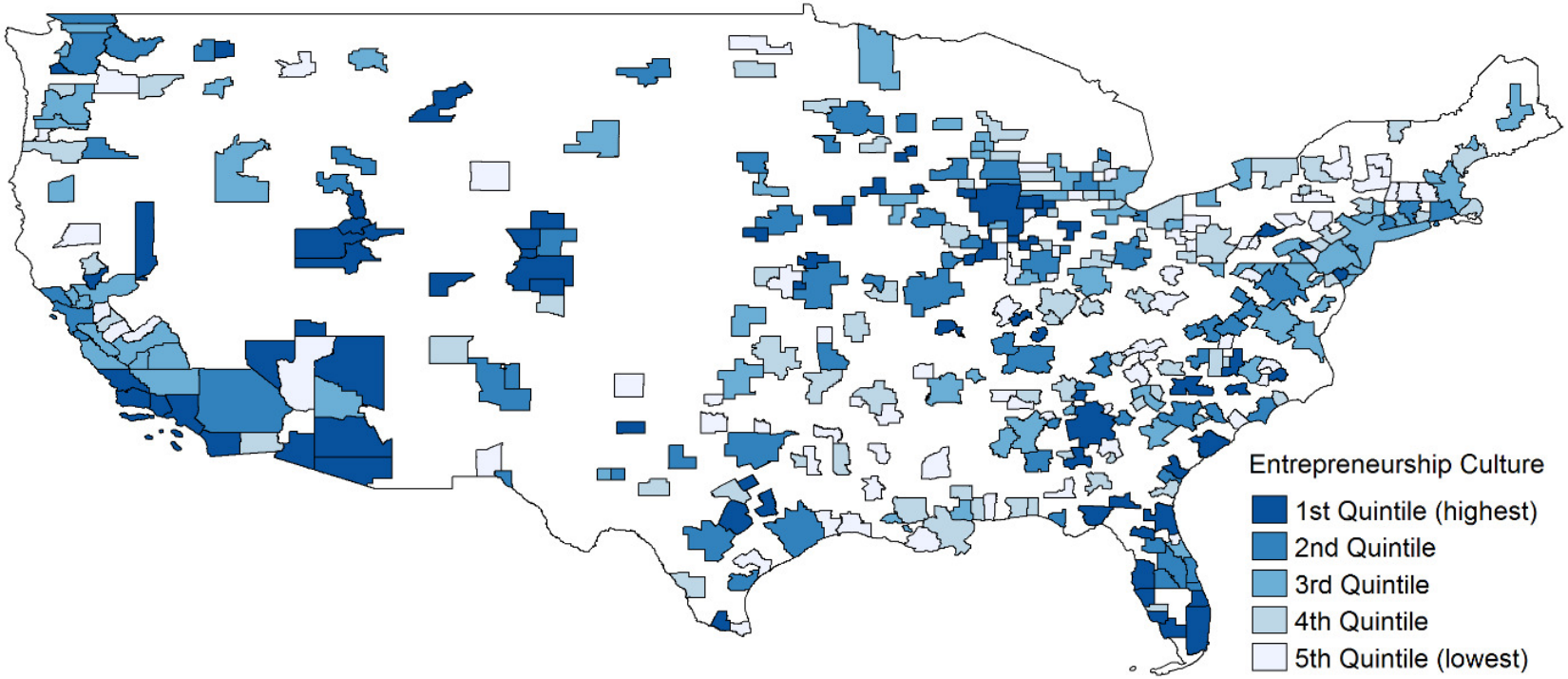

Figure 1: Regional Entrepreneurship Culture (Contiguous United States)

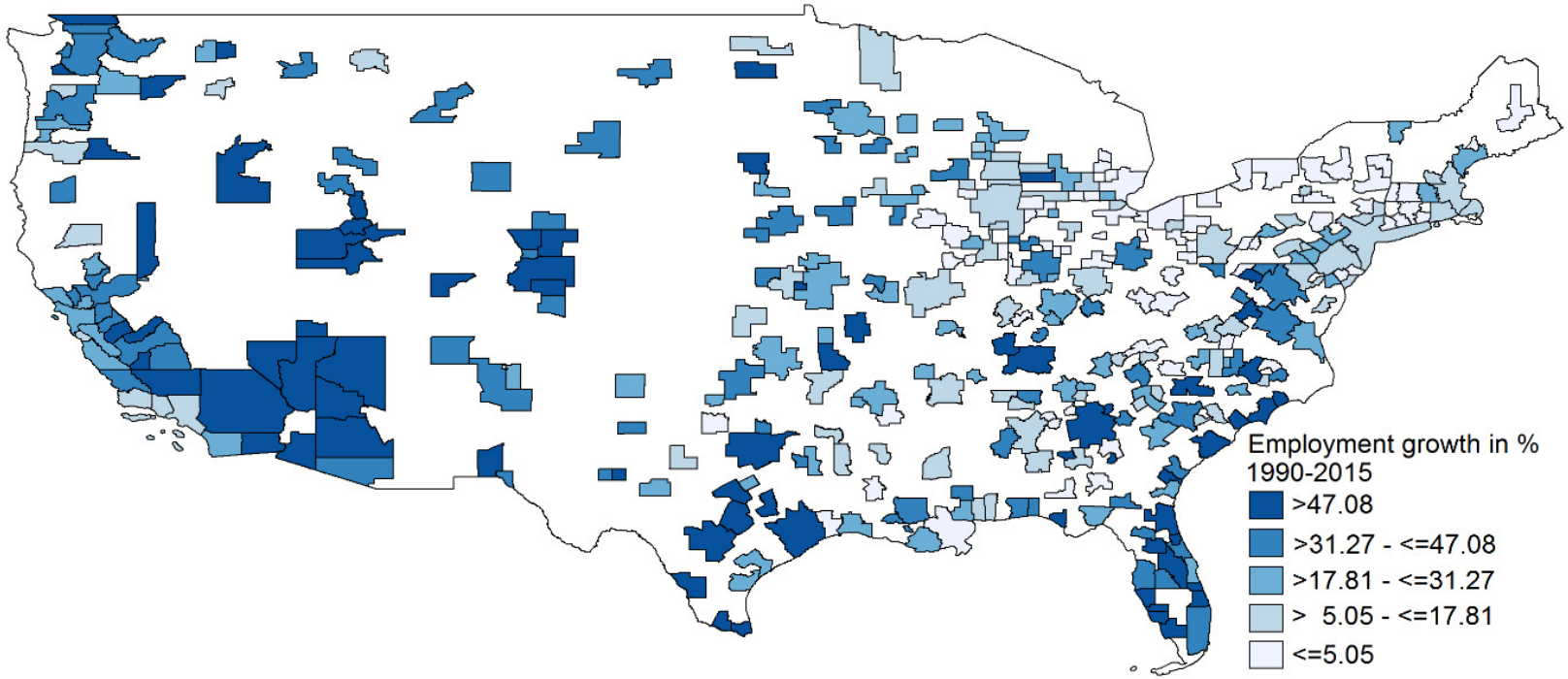

Figure 2: Regional Employment Growth, 1990-2015 (Contiguous United States)

Table 1: Descriptive Statistics and Correlations

Variables		Mean	SD	1	2	3	4	5	6	7	8	9
1	Employment growth 1990-2015	30.06	32.88	1.00								
2	Entrepreneurship culture	0.00	1.00	0.35	1.00							
3	Human capital	25.36	7.81	0.14	0.36	1.00						
4	Knowledge	1.54	0.91	-0.03	0.16	0.61	1.00					
5	Financial capital	19.86	23.32	0.16	0.15	0.18	0.01	1.00				
6	Industry diversity	7.23	0.81	0.25	0.13	-0.11	-0.10	0.15	1.00			
7	Migration	0.57	0.45	0.29	0.25	0.30	0.16	-0.01	-0.12	1.00		
8	Demographic composition	25.96	2.13	0.18	0.17	0.24	0.22	0.20	0.29	0.29	1.00	
9	Population density	263.83	310.13	-0.16	0.11	0.30	0.21	0.09	0.17	0.11	0.23	1.00

Notes: Correlations above |0.1| are significant at the 5% level

Table 2: OLS Regressions for Employment Growth and Robustness Checks

	I: Main model		II: Culture indicator based on youth residence		III: IV regression using historical coalfields				IV: Lewbel IV regression	
	DV: Employment growth 1990-2015		DV: Employment growth 1990-2015		1st stage DV: Entrepreneurship culture		2nd stage DV: Employment growth 1990-2015		DV: Employment growth 1990-2015	
Variables	Coef	β	Coef	β	Coef	β	Coef	β	Coef	β
Entrepreneurship culture	7.274***	0.221	5.205***	0.158	----		23.06**	0.701	6.374*	0.194
	(1.604)		(1.536)				(9.342)		(3.443)	
Distance to nearest coalfield	----		----		0.0004***	0.146	----		----	
					(0.000117)					
Human capital	0.604**	0.144	0.771***	0.183	0.0489***	0.382	-0.145	-0.034	0.646**	0.154
	(0.267)		(0.264)		(0.00862)		(0.512)		(0.285)	
Knowledge	-3.991*	-0.111	-4.233**	-0.117	-0.0994	-0.091	-2.673	-0.074	-4.053**	-0.112
	(2.055)		(2.079)		(0.0677)		(2.367)		(1.645)	
Financial capital	0.126*	0.089	0.125*	0.089	0.00266**	0.062	0.0835	0.059	0.128	0.091
	(0.0652)		(0.0661)		(0.00127)		(0.0692)		(0.079)	
Industry diversity	11.30***	0.280	11.88***	0.294	0.216***	0.176	7.428**	0.184	11.519***	0.285
	(2.020)		(2.037)		(0.0766)		(3.265)		(2.458)	
Migration	19.65***	0.269	22.09***	0.302	0.392***	0.176	12.99**	0.178	20.027***	0.274
	(3.604)		(3.590)		(0.113)		(5.126)		(3.319)	
Demographic composition	0.109	0.007	0.140	0.009	-0.00399	-0.008	0.299	0.019	0.100	0.006
	(0.808)		(0.818)		(0.0289)		(1.480)		(1.413)	
Population density	-0.0371***	-0.350	-0.0373***	-0.352	-8.94e-05	0.028	-0.0368***	-0.347	-0.037***	-0.349
	(0.00746)		(0.00755)		(0.000191)		(0.00658)		(0.006)	
Initial employment 1990	3.905	0.077	3.547	0.070	-0.0120	-0.008	4.427	0.087	3.917	0.078
	(3.697)		(3.745)		(0.0709)		(3.403)		(2.799)	
Constant	-68.51***	.	-78.55***	.	-2.924***		-24.06		-71.026***	
	(22.30)		(22.32)		(0.675)		(43.91)		(29.841)	
Observations	366		366		363		363		366	
Adjusted R^2	0.300		0.283		0.198		0.133		0.317	

Notes: Standard errors are given in parentheses

β=standardized regression coefficient; *** p<0.01, ** p<0.05, * p<0.1

The availability of *financial capital* is another variable we need to control for. Sufficient *financial capital* is important for new and existing companies to finance growth and innovation activities (BLACK and STRAHAN, 2002; HANLEY et al., 2015). We proxy the availability of *financial capital* with the deposits in financial institutions per capita (average between 2006 and 2010). The deposits data stem from the Federal Deposit Insurance Corporation's Summary of Deposits.

Industry structure has also been included in most studies of regional economic performance. In this paper we consider whether economic activity is specialized in few industries or spread across diverse industries (GLAESER et al., 1992). Diversity is generally hypothesized to be conducive to knowledge spillovers because it is different industry contexts that create the potential for combining different technologies to generate new innovations, which should ultimately spur economic growth. The empirical evidence has generally found that *industry diversity* and not specialization is positively related to regional economic growth (GLAESER et al., 1992; FELDMAN and AUDRETSCH, 1999). The measure of *industry diversity* in a region is measured by the inverse Hirschman-Hefindahl index (IHHI):

$$IHHI = \frac{1}{\sum_{i=1}^{N} s_i^2}$$

where s_i depicts the share of employment share in the specific industry i at the large one-digit industries.

The extent to which a region is open to ideas, information, people, and businesses outside the region has been posited to be conducive to innovative activity and empirically found to be positively related to regional economic growth. We measure a region being open to external influences with net *migration* as a percentage of the total population. We also consider the

demographic composition of the population. To control for the *demographic composition* of the region, the share of the population between 25 and 44 years old is included. Finally, *population density* has generally been posited to reflect the potential for agglomeration economies (FRITSCH, 2013) and knowledge spillovers and is measured as the population density in 2000.

Empirical Results

The results from ordinary least square (OLS) estimation for regional employment growth (%) between 1990 and 2015 are provided in Table 2 (Model I). For the control variables, we find positive and significant relationships with employment growth regarding human capital, financial capital, industry diversity and migration. Contrary to expectations, knowledge and population density are negatively related to employment growth, while the demographic composition shows no relationship with employment growth. Regarding our main variable of interest, we find positive and statistically significant coefficient of entrepreneurship culture, suggesting that those regions exhibiting a higher degree of entrepreneurship culture tend to enjoy higher rates of employment growth. Table A1 in the Appendix A in the supplemental data online presents empirical results using employment growth over shorter time periods. Across all time periods, entrepreneurship culture predicts employment growth. Comparing the size of the coefficient of entrepreneurship culture reveals that the effect is strongest over longer periods of time, which is in line with other empirical findings (FRITSCH, 2013).

There are several potential issues with our analytic strategy. Table A2 in the Appendix A in the supplemental data online presents robustness checks regarding the non-representativeness of our personality sample. There we also present results using payroll growth as an alternative

dependent variable. The results are robust to any of these modifications. In this main paper we continue by providing robustness checks regarding potential endogeneity.

Endogeneity can arise as people with certain entrepreneurial personality traits migrate to MSAs with good economic development in order to take advantage of this good economic development by founding a business. To account for this endogeneity we run a robustness check computing the entrepreneurship culture measure based on the residence of the respondent in their youth – before any occupational and migration decisions are made. Table 2 (Model II) presents the results using this alternative indicator of entrepreneurship culture. The coefficient is somewhat smaller in size but significant. This finding suggests that selective migration does not drive our results.

Another robustness check tackles the issue of endogeneity with an IV approach. We use historical coal mining as an instrument for entrepreneurship culture. More precisely, we digitized a map showing the historical coalfield for the contiguous United States in 1909 (TARR and MCCURRY, 1910). Based on this map, we computed the minimum distance of each MSA to a coalfield.[1]

The reasoning for using coal as an instrument is that coal was necessary to fuel the steam engines in large-scale industries such as textile and steel (STUETZER et al., 2016; GLAESER et al. 2015). The presence of large-scale industries negatively affects entrepreneurship and entrepreneurship culture via several pathways such as 1) institutions that might be tuned to the needs of firms in large-scale industries and not the needs of smaller and younger firms, 2) a lack of entrepreneurial activity and thus entrepreneurial role models, 3) a lack of entrepreneurial spirit due to monotonic and repetitive tasks at the assembly line; and 4) less skill variety of the workers

because of a high division of labour in large-scale industries. (DAVIDSSON, 1995; STUETZER et al. 2016; GLAESER et al. 2015).

Table 2 (Model III) presents the results of the IV regression. In the first stage, we regress entrepreneurship culture on the minimum distance to the nearest coalfield and the vector of controls employed in the previous regressions. As expected, a longer distance to the nearest coalfield is related with stronger entrepreneurship culture and vice versa. In the second stage, we use the coal-related share of entrepreneurship culture to explain variation in regional economic growth. As in the main regression, a stronger entrepreneurship culture is positively related to employment growth between 1990 and 2015. We conducted several tests regarding the appropriateness of the IV model. Regarding potential under-identification of the IV model, we conduct the Kleinbergen-Paap under-identification test. The chi-square test statistic of 11.32 rejects the null hypothesis of under-identification ($p < 0.01$). The first-stage F-statistic of above 10 signals the relevance of the instrument. We do not need to conduct a test regarding over-identification because our model has one instrument for one endogenous regressor and over-identification can only occur if one has more instruments than endogenous regressors.

The above IV regression confirms the initial finding that entrepreneurship culture promotes regional economic growth. However, some might be worried about other channels beside entrepreneurship culture (such as human capital) how coal affects economic growth which would violate the exclusion restriction. Recently, LEWBEL (2012) suggested an identification procedure that relaxes the exclusion restriction and is based on the regressors that are not correlated with the product of the heteroskedastic errors. The results of the LEWBEL'S IV test are presented in Table 2 (Model IV) and they again indicate the entrepreneurship culture is positively related to economic growth, although the level of significance is somewhat reduced. Again, we checked the

appropriateness of this IV approach. We conduct the Kleinbergen-Paap under-identification test to check for under-identification. The chi-square test statistic of 41.01 rejects the null hypothesis of under-identification (p-value < 0.01). The Hansen-Sargan test statistic of the over-identifying restriction is 6.03 with seven degrees of freedom ($p > 0.10$) indicating no over-identification problem.

Taken together, the empirical results provide evidence suggesting that, even after controlling for a broad range of spatial characteristics and influences and running several robustness checks, regional economic growth remains positively associated with entrepreneurship culture.

Conclusions

Theory links entrepreneurship to regional economic performance, and especially economic growth, because of the key role played by entrepreneurship as a conduit for the spillover of knowledge. Entrepreneurial activity provides a plausible mechanism by which new ideas and knowledge created in one context result in innovation in a very different context. However, in trying to link entrepreneurship to regional economic performance the vast majority of studies has been limited to measuring entrepreneurship only in terms of the organizational dimension, such as new firms, self-employment, small firms and business ownership. While the behaviour and perspective views are cornerstones of the literature, measurement constraints have limited many to relying solely on organizational based measures of entrepreneurship.

This paper has introduced regional entrepreneurship culture as a more fundamental concept and measure of entrepreneurship, which encompasses all three views of entrepreneurship. The empirical evidence supports the idea that those regions bestowed with a greater amount of

entrepreneurship culture enjoy a higher employment growth. Using several robustness checks and applying causal methods strengthens our interpretation of the results.

The implications for regional policy may be to reconcile some of the more disappointing experiments and results from targeting just one aspect of entrepreneurship (i.e. promoting self-employment or small business). Policy to promote entrepreneurship that ignores or is obvious of key cultural dimensions may incur the risk of counter-intuitive results and disappointing stakeholders.

Recent attempts at regional policy to enhance economic growth, such as the European smart specialization of regions (McCann and Ortega-Argiles, 2016), may be on track by attempting to embed policies within the local and regional cultural contexts. The "specialization" actually involves a strategy focusing on a set of complementary economic activities, and does not imply producing a sole product or service. As the results of this paper suggest, regional policies that can influence underlying entrepreneurship culture may pay rich dividends in terms of subsequent regional economic performance.

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[1] The map shows only the coalfields in the contiguous United States excluding Alaska and Hawaii. We do not have data for three MSAs in Alaska and Hawaii (Anchorage, Fairbanks and Honolulu) which reduces the number of observations in the regression to 363.

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Appendix

Entrepreneurship Culture, Knowledge Spillovers, and the Growth of Regions

Stuetzer, M., Audretsch, D.B., Obschonka, M., Gosling, S.D., Rentfrow, P.J., Potter, J. in Regional Studies

In this Appendix we present additional results and robustness checks.

In the main paper, we presented in Table 2 the results regarding regional employment growth between 1990 and 2015 which are again shown in Table A1 in column I. Additional estimates for the time periods 1995-2015, 2000-2015, 2005-2015, and 2010-2015 are shown in columns II to V. The positive and statistically significant relationship between entrepreneurship culture and regional employment growth holds for all of the time periods examined, suggesting that this relationship is remarkably robust over time. This is in line with other empirical research suggesting positive effects of entrepreneurship on economic growth in the middle and longer run (FRITSCH and MUELLER, 2004). For the control variables, the results are robust with respect to the time period for human capital, industry diversity and migration. By contrast, they are somewhat more nuanced and ambiguous for financial capital, knowledge, the regional population density, the demographic composition, and population density.

In the main paper we presented robustness checks regarding the causality of the observed relationship. Here we present robustness checks regarding other potential concerns. One potential issue of our regression analysis is that the personality data is collected via an Internet website and therefore are not representative of the local populace in terms of age and gender (see OBSCHONKA et al., 2015 for details). Therefore, we ran a robustness check, in which we weighted the individual entrepreneurial personality profile by age and gender when computing the entrepreneurship culture indicator.[1] The results remain unchanged (Table A2, Model I).

Another issue is that employment growth – although the most commonly used and comparable across time and countries – is not the only indicator of economic expansion. We therefore additionally used payroll growth as an alternative dependent variable. Annual payroll includes wages, salaries and all other benefits and bonuses paid to employees in an MSA. The data stem from the Statistics of U.S. Businesses (SUSB Annual Data Sets) and cover the time period 1990 to 2013. Annual payroll data for 2014 and 2015 – to match the longest time period of the employment data – were not yet published. Payroll data are conceptually related to the income approach of measuring GDP because according to theory the payroll should be equal to the marginal revenue product of labor. In that sense, only the value added by the workforce is paid as wages. The income approach of measuring GDP decomposes GDP into wages (payroll), profits and payments to all other production factors in the production process. Wages are thereby the most important component of GDP (>50%). Note that payroll data have been successfully used in previous studies on economic growth (LEE, 2016). The results presented in Model II in Table A2 indicate that entrepreneurship culture also predicts payroll growth.

A last issue is that entrepreneurship culture measured on base of Big Five traits is argued to be relatively time invariant. If this is violated it can bias the regression results. Psychology theory argues and has showed that the Big Five traits are relatively stable at the individual level and therefore also our regional aggregation should be relatively stable. Nevertheless interaction with the environment and migration can change our measure of entrepreneurship culture over time which can lead to biased regression results. Two of our previously conducted regressions dampens such concerns. Our proxy for entrepreneurship culture measure is based on personality data from 2003-2009. In Table A1 Model V we use as DV the employment growth from a later period, 2010 and 2015. In this setting, entrepreneurial culture also predicts employment growth. Moreover, as

mentioned in the main text, we use the entrepreneurship culture measure based on the residence of the respondent in their *youth* as independent variable in the robustness check presented in Model II of Table 3 (main paper). Using youth residence eliminates the migration part of the bias of a slightly time variant entrepreneurship culture.

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Table A1: OLS Regressions for Employment Growth over Different Time Periods

	I: Employment growth 1990-2015		II: Employment growth 1995-2015		III: Employment growth 2000-2015		IV: Employment growth 2005-2015		V: Employment growth 2010-2015	
Variables	Coef	β	Coef	β	Coef	β	Coef	β	Coef	β
Entrepreneurship culture	7.274***	0.221	4.620***	0.204	3.051***	0.205	1.302***	0.138	1.245***	0.161
	(1.604)		(1.081)		(0.718)		(0.452)		(0.416)	
Human capital	0.604**	0.144	0.474***	0.164	0.295**	0.155	0.245***	0.202	0.140**	0.141
	(0.267)		(0.180)		(0.120)		(0.0753)		(0.0693)	
Knowledge	-3.991*	-0.111	-3.179**	-0.128	-1.484	-0.091	-0.302	-0.029	-0.179	-0.021
	(2.055)		(1.385)		(0.920)		(0.579)		(0.533)	
Financial capital	0.126*	0.089	0.0853*	0.088	0.0544*	0.085	0.0349*	0.086	0.0249	0.075
	(0.0652)		(0.0439)		(0.0292)		(0.0184)		(0.0169)	
Industry diversity	11.30***	0.280	8.736***	0.315	5.005***	0.274	2.270***	0.196	1.285**	0.135
	(2.020)		(1.366)		(0.908)		(0.572)		(0.527)	
Migration	19.65***	0.269	16.28***	0.324	9.637***	0.291	4.163***	0.198	-0.0510	-0.003
	(3.604)		(2.429)		(1.612)		(1.015)		(0.933)	
Demographic composition	0.109	0.007	0.0772	0.007	0.421	0.060	1.123***	0.253	0.656***	0.180
	(0.808)		(0.547)		(0.364)		(0.229)		(0.211)	
Population density	-0.037***	-0.350	-0.0182***	-0.250	-0.0147***	-0.306	-0.00739***	-0.243	-0.000686	-0.028
	(0.00746)		(0.00492)		(0.00325)		(0.00202)		(0.00183)	
Initial employment 1990	3.905	0.077	1.647	0.047	1.732	0.083	1.020	0.079	0.342	0.032
	(3.697)		(2.462)		(1.483)		(0.904)		(0.837)	
Constant	-68.51***		-60.29***		-46.58***		-48.86***		-25.11***	
	(22.30)		(15.20)		(10.13)		(6.390)		(5.907)	
Observations	366		366		366		366		366	
Adjusted R^2	0.300		0.328		0.317		0.329		0.150	

Notes: Standard errors are given in parentheses
β=standardized regression coefficient
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Robustness Checks for OLS Regressions for Employment Growth 1990-2015

	I: Culture indicator weighted by age x gender		II: Regression with DV: Payroll growth 1990-2013	
Variables	Coef	β	Coef	β
Entrepreneurship culture	7.639***	0.232	12.87***	0.153
	(1.545)		(3.859)	
Human capital	0.750***	0.178	2.123***	0.197
	(0.258)		(0.640)	
Knowledge	-4.580**	-0.127	-2.030	-0.022
	(2.041)		(4.936)	
Financial capital	0.124*	0.088	0.262*	0.073
	(0.0649)		(0.157)	
Industry diversity	10.33***	0.256	30.99***	0.300
	(2.048)		(4.827)	
Migration	20.13***	0.276	59.34***	0.318
	(3.561)		(8.670)	
Demographic composition	0.208	0.013	3.203*	0.081
	(0.804)		(1.930)	
Population density	-0.0392***	-0.370	-0.125***	-0.460
	(0.00742)		(0.0178)	
Initial employment 1990	4.460	0.088	----	
	(3.679)			
Initial payroll 1990	----		6.82e-07*	0.126
			(3.60e-07)	
Constant	-66.66***	.	-196.5***	.
	(22.19)		(52.60)	
Observations	366		366	
Adjusted R^2	0.308		0.380	

Notes: Standard errors are given in parentheses
β=standardized regression coefficient; *** p<0.01, ** p<0.05, * p<0.1

[1] As each Internet based dataset, the Personality dataset we use is somewhat skewed towards female and younger respondents. The process of weighting shall correct for this. We know from the respondents in the personality data set their age, gender and the MSA they live in. So we know for each MSA the percentage of the respondents in several age x gender categories (e.g. male in the 18-24 age group). Taking the New York MSA as an example, we know that that 11.3% of the respondents in New York belong to this category (male x 18-24). However, the actual 2010 ACS 5yr estimates show that 14.1% of the population in New York belong to this category. This suggests that this category (male x 18-24) is underrepresented in the Personality data set. In order to create a correcting weight, one simply divides the share of the respondents in this category from ACS data by the share of the respondents in this category from the Personality data set. In this assumed case all respondents in the category (male x 18-24) would receive a weight of 1.25. When aggregating the entrepreneurial personality profile of the individual respondents to the MSA level, respondents from this category matter more compared to other respondents from different age x gender categories with smaller weights. We compute the age x gender weights for each MSA and thereby reduce the issue of non-representativeness of the Personality data.