What Differentiates Top Regions in the Field of Biotechnology?

An empirical Study of the Texture Characteristics of 101 Biotech Regions

in North-America, Europe and Asia-Pacific.

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Introduction

Biotechnology is often considered as one of the promising technologies that will bring economic growth and welfare to a region. Evidence indicates that regions that have developed into successful biotech clusters are very limited (Audretsch & Feldman, 1996; Feldman & Florida, 1994). Thriving clusters such as the San Francisco Bay Area, San Diego and Boston have therefore been widely studied by researchers and policy makers in order to identify the main factors behind the success of those biotech clusters. General consensus exists that well developed biotech regions, so-called clusters or hot spots, are characterized by the presence of world-class scientific research, high levels of entrepreneurial activity (both academic spin-offs and industrial ventures), high labour mobility and dense social networks, and the presence of venture capital and a dedicated support infrastructure (e.g. Casper, 2007; Cooke, 2006; Owen-Smith et al., 2002). About the respective role and importance of public knowledge institutes and private firms for the emergence and early development of biotech regions different perspectives are being advanced. Case study research provides evidence that universities and knowledge generating institutes have played a central and active role in the creation of biotech clusters in the region of Boston (Breznitz, O'Shea, & Allen, 2008) and San Francisco Bay area (Chiarone & Chiesa, 2006). In contrast, private firms have played a prominent role in the development of biotech activities in the regions of Milano, Italy and Uppsala, Sweden (Chiarone & Chiesa, 2006) as well as in Japan (Bartholomew, 1997).

While case study research provided valuable insights on the characteristics and the dynamics within individual (biotech) clusters, so far large-scale empirical studies addressing the texture characteristics of regions in a quantitative way, are absent. Building on patent and publication-based indicators, we engage in such a study in the field of biotechnology. Our analyses cover 101 regions from North-America, Europe and Asia-Pacific that developed substantial technological activities in the field of biotechnology over the period 1992-1997. The period of analysis corresponds with an era of rapid growth in biotech industry (Lecocq & Van Looy, 2009).

Data

To identify the worldwide leading clusters in terms of biotech technology development and study the texture characteristics of biotech regions in a quantitative way, we draw on the dataset with EPO patent applications and Web of Science publications in the field of biotechnology created by Glänzel et al. (2004). All patents and publications have been allocated to their respective regions based on the address information of applicants (patents) and authors (publications) following the "*patent allocation methodology*" developed by Lecocq et al. (2011). Only those regions that developed a substantial amount of biotech activity over the time period 1992-1997[1] are retained for the analyses. The "*sector allocation methodology*" developed by Du Plessis, et al. (2011) allows to identify by which type of actor (private firms, public universities and research centres, research hospitals and/or persons) a patent has been applied. Table 1 provides an overview of the texture variables used in the paper.

[1] Minimum 18 EPO patent applications, i.e. on average three patents/year.

Table 1 Texture variables

Variable	**Description**
Number of firms	Number of companies active in biotech patent applications in the region.
Company concentration index	Ratio of the number of biotech patents of the leading firm in the region and the total number of company biotech patents in the region.
Science-intensity of the region	Number of biotech publications in the region per 1000 population.
Entrepreneurial orientation of knowledge institutes	Ratio of the total number of biotech patents applied by public knowledge generating institutes in the region and the total number of biotech publications in the region
International collaboration with firms	Number of biotech co-patents in the region with a firm from outside the country
International collaboration with knowledge institutes	Number of biotech co-patents in the region with a knowledge generating institute from outside the country

Analyses

In line with previous research, our findings confirm that biotech technology development activities (measured by the number of patent applications), are concentrated in a few top regions or clusters: over the period 1992-1997, the 15 leading regions in terms of biotech technology development account for 56% of all biotech patent activity worldwide[2].

An analysis of the texture characteristics of the top biotech regions provides evidence for the presence of two types of biotech regions: regions in which technology development is mainly situated or concentrated within private firms – hereafter called "concentrated regions" - and

[2] The top 15 leading regions in biotech technology development over the period 1992-1997 are North California, US; Tokyo-TO, Japan; Massachusetts, US; South California, US; New Jersey, US; New York, US; Maryland, US; Île de France, France; Osaka-FU, Japan; Pennsylvania, US; Denmark, Denmark; Inner London, UK; Illinois, US; Karlsruhe, Germany; and Nordwestschweiz, Switzerland.

regions where technology development is more equally distributed between private firms, entrepreneurial universities and/or research centres/hospitals hereafter referred to as “distributed regions”.

During the growth phase of biotech, we find evidence of regions catching up and regions falling back in the ranking of leading biotech regions. Using Logit Regressions models with Random Effects controlling for the panel structure of the data, we further look into the texture characteristics that distinguish the top 15 biotech regions from the other biotech regions for the years 1992 to 1997. The Logit Regression models in our study take the following functional form:

$P(y_{it} = 1 \ / \ x_{it})$ with t = 1-7, x_{it} contains the explanatory and the control variables
y_{it} takes the value 1 if a region is among the top 15 regions in year t, or else the value 0

Table 2 shows the results of the logit regression models. In Model 1, analyses are run for all 101 biotech regions. Separate analyses are also run for the regions with a “distributed” texture (n= 64, Model 2) and the regions with a “concentrated” texture (n=37, Model 3) [3].

[3] In the separate analyses, “concentrated” regions have been defined as those regions in which technology development activities is predominantly situated within private firms (share of company patents >= 0.75) and the lead player in the region (period 1992-1997) is an established firm.

Table 2 Random Effect Logit models

	Model 1 All Regions	Model 2 Regions with distributed texture	Model 3 Regions with concentrated texture
Science-intensity of the region	17.56**	86.18***	52.39***
	(7.89)	(25.07)	(17.34)
Number of firms	0.69***	2.17**	0.92**
	(0.18)	(0.87)	(0.41)
Company concentration index	6.14**	-22.77	25.34***
	(3.02)	(23.41)	(9.56)
Entrepreneurial orientation of knowledge institutes	201.14**	1479.37***	504.07
	(102.21)	(557.68)	(329.23)
International collaboration with knowledge institutes	1.28**	3.36	4.32***
	(0.60)	(5.24)	(1.25)
International collaboration with firms	-0.41	-1.98	-0.31
	(0.57)	(3.08)	(0.99)
Population	0.0005	0.0007	0.0032***
	(0.0003)	(0.0006)	(0.0012)
US dummy	-0.23	14.24*	-6.07
	(1.96)	(7.57)	(6.38)
Time	-0.78***	-0.87	-2.52***
	(0.29)	(1.16)	(0.76)
Constant	-19.06***	-75.49***	-51.66***
	(5.03)	(18.35)	(10.34)
Observations	606	384	222
Loglikelihood	-525.07	-9.86	-27.23
P	0.0086	0.0021	0.0004

*, **, *** indicate significance at the 10% 5% and 1%. Standard deviation between brackets.

The results in Table 2 reveal that leading biotech regions are more science-intensive and count a higher number of firms active in biotech technology development. These results hold for both “distributed” and “concentrated” regions. The regression analyses further reveal that leading biotech regions with a “concentrated” texture are not only characterized by the presence of numerous firms active in biotech technology development; technology development activities of firms appears to be also more concentrated within the leading firm in the region as compared to other non-top regions. Next, the regressions show that top “distributed” regions are characterized by a stronger entrepreneurial orientation of the knowledge institutes in the region, while no significant impact is found for the “concentrated” regions. Finally, the analyses reveal that “concentrated” regions, in which a positive impact of entrepreneurial-oriented institutes is largely absent, do benefit from international technology collaborations with knowledge institutes. For the “distributed” regions, no similar effect is found in terms of international collaboration. The results also reveal no significant impact from international technology collaborations with firms.

Conclusions

In this paper, we study the texture characteristics of regions that are instrumental for becoming a top region during the first growth phase of the biotech industry (period 1992 – 1997). Our study provides evidence for the presence of two types of leading biotech regions: “*concentrated*” regions in which technology development is mainly situated within private firms and “*distributed*” regions where technology development is more equally shouldered by private firms, entrepreneurial universities and/or research centres/hospitals.

Our analyses further indicate that regions with “concentrated” texture characteristics benefit, in terms of overall technological activity, from increased levels of concentration of technology development activities within a leading firm, thereby supporting the anchor-tenant hypothesis proposed by Agrawal & Cockburn (2003). Our results also indicate that regions with a “concentrated” texture benefit from engaging in international technology collaborations with scientific actors. In science-based industries such as biotechnology, developing relevant and highly-specialized scientific knowledge within the region also remains essential (see also Anderssen, 2001; Glänzel et al., 2004).

While the role of science and entrepreneurial-orientated universities and research centres is widely acknowledged for the early, incubation phase of new, science-based technologies, our study shows that in the growth phase of the biotech industry, the orientation and contribution of scientific actors in terms of technology development is positively influencing whether or not regions with more “distributed” texture characteristics evolve to become top regions. Indeed, our results show that top “distributed” regions benefit, along with an excellent science base, from a more entrepreneurial orientation of their knowledge institutes. To become a leading region, regions with a “distributed” texture also have to create sufficient industrial activities in the field of biotechnology, by generating new entrepreneurial activities in the field of biotechnology or attracting new firms in the region. Also the continuous investment in a strong science base remains important in the growth phase of science-based industries.

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