UNIVERSIDAD POLITÉCNICA DE MADRID
ESCUELA TÉCNICA SUPERIOR DE INGENIEROS INDUSTRIALES

Departamento de Ingeniería de Organización, Administración de Empresas y Estadística

**ENTREPRENEURIAL ECOSYSTEMS:
THEORY REVISITED, RESEARCH AGENDA AND POLICIES**

TESIS DOCTORAL

AUTOR:

Alberto Arenal Cabello

Ingeniero de Telecomunicación y Diplomado en Ciencias
Empresariales

DIRECTORES:

Dr. Claudio Feijóo González

Doctor Ingeniero de Telecomunicación y Licenciado en
Economía

Dra. Ana Moreno Romero

Ingeniera Industrial y Doctora en Psicología

2020

Tribunal nombrado por el Magfco. y Excmo. Sr. Rector de la Universidad Politécnica de Madrid, el día

Presidente:

Secretaria:

Vocal:

Vocal:

Vocal:

Suplente:

Suplente:

Realizado el acto de defensa y lectura de la tesis el día _____ en la E.T.S. Ingenieros Industriales de la Universidad Politécnica de Madrid.

CALIFICACIÓN:

EL PRESIDENTE

LOS VOCALES

EL SECRETARIO

AGRADECIMIENTOS

Desde la oportunidad que representan estos agradecimientos, quiero aprovechar para hacer balance y devolver el cariño y soporte a todos aquellos que directa o indirectamente han contribuido en el camino recorrido hasta llegar a completar esta tesis doctoral.

En primer lugar, quiero agradecer el tiempo y la paciencia que me han dedicado mis directores, Ana y Claudio. Gracias por vuestra inspiración, que siempre me ha permitido ampliar miras y tener una visión de conjunto en cada uno de los pasos. Claudio, agradecimiento especial por tu dedicación más allá de lo razonable. Has sido un full-stack supervisor. De lo general a lo concreto, has cubierto todos los ángulos de ayuda posibles: tirando de mí cuando el camino se empinaba, abriéndome nuevos horizontes cuando la cosa se nublaba y entrando al detalle siempre que lo he necesitado. Y todo con el pequeño matiz de estar a 10.000 kilómetros de distancia. Desde revisiones interminables en trenes mientras recorrías Asia, a conversaciones Shanghai-Las Vegas para resolver detalles o momentos inspiradores al calor de un honey pomelo, agradecimiento y admiración eterna. En estas líneas, incluyo también a Sergio y Cris, equipo y familia, grandes soportes durante todo el proceso a nivel profesional y a nivel humano. Miro hacia atrás y el camino me parece inverosímil. Y sin duda imposible haberlo superado sin vosotros. Agradecer también a la Comisión de Doctorado del DIO, personalizada en María Jesús, Teresa y Ruth, por su soporte y ayuda en toda la parte administrativa durante todo el proceso. Soy consciente de que vuestro trabajo es muchas veces ingrato y siempre habéis puesto las soluciones delante de los problemas.

Por otro lado, no quiero dejar pasar la oportunidad de agradecerlos a todos vosotros, familia y amigos, porque gran parte de lo que soy hoy es la suma de lo que todos vosotros me habéis aportado. Y a todos os he robado momentos que nunca volverán durante este periodo doctoral. Imposible mencionar a todos los amigos que desde la infancia y colegio hasta el paso por teleco y Getafe han estado ahí siempre, alegrándose por mis éxitos y acompañándome en mis momentos menos buenos. Mi sincero homenaje y agradecimiento. Por supuesto, unas breves líneas de reconocimiento y gratitud para mi familia, que tanto me ha dado y me sigue dando. A la ‘familia de nacimiento’, porque sois los principales responsables de la persona que soy; y también a la familia ‘de papeles’, porque sin duda os siento y quiero como propios.

Y por supuesto, las últimas palabras están dedicadas a mi equipo más cercano, Natalia y Pablo, por haber sido y ser el pilar fundamental que me ha permitido llegar a tierra. Especialmente a ti, Natalia, gracias por la generosidad con la que has interpretado esta etapa y la paciencia para sobrellevar las ausencias.

Termino estos agradecimientos agotado por la intensidad de los últimos 5 años, pero muy contento por la experiencia acumulada y por haber podido disfrutar del camino en una etapa que siempre recordaré y que, sin duda, me ha ayudado a evolucionar y progresar a todos los niveles.

TABLE OF CONTENTS

1	INTRODUCTION AND OVERVIEW	1
1.1	Prelude	1
1.2	Entrepreneurship history in a nutshell: origin, evolution and current state of the field	2
1.3	Research context.....	5
	From managed economy to entrepreneurial economy	5
	Entrepreneurship as a policy subject / The emergence of an entrepreneurship policy	8
	The emergence of an entrepreneurship policy as a research field.....	9
1.4	Overview of the research	11
	1.4.1 Research aim and objectives.....	11
	1.4.2 Research method.....	12
1.5	Thesis structure and outline	12
2	THEORETICAL FRAMEWORK.....	15
2.1	The ecosystem metaphor in business and management studies: the antecedents of the entrepreneurial ecosystems.....	15
2.2	Innovation ecosystems.....	17
2.3	Entrepreneurial ecosystems	19
2.4	The need for more analysis and a new theory	23
3	METHODOLOGY	27
3.1	Methodology overview.....	27
3.2	Research philosophy	28
3.3	Research design, approach and methods	29
3.4	Data collection and analysis	30
	Phase 1 – Academia (sample – data collection – data analysis)	30
	Phase 2 – EU policy (sample – data collection – data analysis)	36
	Phase 3 – AI (and EdTech) ecosystem in China (sample – data collection – data analysis)	40
4	RESULTS.....	55
4.1	Phase 1 – Results of the text mining analysis for the corpus Academia	55
	Descriptive statistics.....	57

	Preprocessing and preliminary analysis	60
	Cluster analysis	75
4.2	Phase 2 – Results of the text mining analysis for the corpus EU Policy	84
	Preprocessing and preliminary analysis	86
	Cluster analysis	94
4.3	Phase 3 – AI (and EdTech) ecosystem in China.....	99
	Government.....	100
	Industry	104
	Universities and research-oriented institutions	106
	Triple helix dynamics.....	109
	ATH results: case studies within the AI ecosystem	112
5	FURTHER DISCUSSION.....	123
5.1	The ongoing debate about relationships between research and policy	123
5.2	Entrepreneurship research and policy: the case of EU	124
5.3	Are research and policy priorities related? The case of entrepreneurship policy in the EU as a realization for the discussion	127
6	CONCLUSIONS, LIMITATIONS AND FURTHER WORKS	139
6.1	Thesis contributions: answering the research questions	139
6.2	Implications	147
6.3	Limitations	148
6.4	Avenues for future research.....	149
6.5	Last thoughts / Epilogue	151
7	REFERENCES	153
8	ANNEXES.....	175
	Annex 1 - Scientific impact & dissemination resulting from this thesis.....	177
	Annex 2 – Cluster analysis: other inputs and results (phase 1 and phase 2).....	181
	Annex 3 - EU Regional Results	197
	Annex 4 – Extended summary of some main case studies	203

FIGURES

Fig. 1 - Results from the search ‘entrepreneurship policy’ in Google Books ngram viewer (retrieved 13 th September 2017).	11
Fig. 2 – Thesis structure. Source: own elaboration.	13
Fig. 3 - Triple helix model: Industry – Government – University. Own elaboration based on the original model from (Etzkowitz and Leydesdorff, 2000).	18
Fig. 4 - The OECD/EUROSTAT framework for Entrepreneurships Indicators. Source: own elaboration based on OECD-EIP.	21
Fig. 5 - Common framework based on the entrepreneurial model of BEEP (fine border) and EIP (thick border). Own elaboration.	22
Fig. 6 - This thesis under the glasses of the research onion model. Source: own elaboration adapted from Saunders et. al (2009)	28
Fig. 7 - General workflow of text mining. Own elaboration from Miner et al. (2012).	31
Fig. 8 - Evolution of the total number of articles related to entrepreneurship policy within the ten journals analysed. Source: own elaboration.	33
Fig. 9 - Evolution of the total number of EC communications related to entrepreneurship and start-ups per year within the period 1990–2016. Source: own elaboration.	39
Fig. 10 - Percentage of EC communications related to entrepreneurship per year with respect to the total number of EC communications. Source: own elaboration.	39
Fig. 11 - Asymmetric Triple Helix (ATH) model for the AI ecosystem in China. Source: Own elaboration adapted from Cai (2013) and Cai and Liu (2014).	46
Fig. 12 - Regional distribution of papers in SE Asia, the EU and US sub-corpus per five-year term (1990–2016)	58
Fig. 13 - Regional distribution of papers per type of affiliation within SE Asian, EU and US sub-corpora (1990–2016)	59
Fig. 14 - Top 50 frequent word stems within the Corpus Academia by absolute number of occurrences (1990–2016)	62
Fig. 15 - 50 most frequent word stems for the corpus Academia in 1990-1994	64
Fig. 16 - 50 most frequent word stems for the corpus Academia in 1995-1999	65
Fig. 17 - 50 most frequent word stems for the corpus Academia in 2000-2004	66
Fig. 18 - 50 most frequent word stems for the corpus Academia in 2005-2009	67
Fig. 19 - 50 most frequent word stems for the corpus Academia in 2010-2014	68
Fig. 20 - 50 most frequent word stems for the corpus Academia in 2015-16	69
Fig. 21 - Top 50 frequent word stems within the SE Asia Academia sub-corpus by absolute number of occurrences	71
Fig. 22 - Top 50 frequent word stems within the corpus EU Academia sub-corpus by absolute number of occurrences	73
Fig. 23 - Top 50 frequent word stems within the corpus US Academia sub-corpus by absolute number of occurrences	75

Fig. 24 - Distribution of papers for the twelve-cluster taxonomy (Corpus Academia, 1990–2016). Source: own elaboration.	77
Fig. 25 - Evolution of the relative weight of number of papers in the twelve-cluster taxonomy for each five-year period (Corpus Academia, 1990–2016). Source: own elaboration.....	78
Fig. 26 - Distribution/Percentage of papers per cluster within the global Corpus Academia and the SE Asia, EU and US sub-corpora	81
Fig. 27 - Conceptualization of the policy cycle process and its link to research focus on entrepreneurship policy. The paper focuses on the dark shaded area. Source: Own elaboration.....	85
Fig. 28 - Top 50 most frequent word stems within the corpus EU Policy by absolute number of occurrences (1990–2016)	87
Fig. 29 - 50 most frequent word stems for the corpus EU Policy in 1990-1994	90
Fig. 30 - 50 most frequent word stems for the corpus EU Policy in 1995-1999	90
Fig. 31 - 50 most frequent word stems for the corpus EU Policy in 2000-2004	91
Fig. 32 - 50 most frequent word stems for the corpus EU Policy in 2005-2009	92
Fig. 33 - 50 most frequent word stems for the corpus EU Policy in 2010-2014	93
Fig. 34 - 50 most frequent word stems for the corpus EU Policy in 2015-2016	94
Fig. 35 Distribution of EC Communications (Corpus EU Policy) related to entrepreneurship for the thirteen-cluster taxonomy (1990–2016).....	96
Fig. 36 - Evolution of the relative weight of EC communications related to entrepreneurship in the thirteen-cluster taxonomy for each five-year period (corpus EU Policy, 1990–2016).....	97
Fig. 37 – Key national initiatives that touch upon AI in China (2015–2019). Source: own elaboration.	102
Fig. 38 – Areas of specialization of the main large companies in China’s AI innovation ecosystem (2017-18). Source: own elaboration.	105
Fig. 39 - Evolution of the Entrepreneurship policy main themes (1990–2016)	135
Fig. 40 - Common framework based on the entrepreneurial model of BEEP (fine border) and EIP (thick border). Own elaboration.....	140
Fig. 41 - Asymmetric Triple Helix (ATH) model for the AI ecosystem in China. Source: Own elaboration adapted from Cai (2013) and Cai and Liu (2014).	141

TABLES

Table 1 - Journals included in the sample (1990–2016). Source: own elaboration.....	32
Table 2 - Questionnaire sent to AI experts. Source: own elaboration.	48
Table 3 - Distribution (%) of SE Asia, EU and US affiliated papers by type of collaboration, in five-year terms.....	59
Table 4 - Top 20 relevant word stems for the twelve-cluster analysis of the Corpus Academia (1990–2016).....	79
Table 5 - Percentage of SE Asia/ EU /US-affiliated papers per cluster.	80
Table 6. Number of SE Asia/EU/US co-authored papers per cluster.....	82
Table 7 - Top 20 relevant word stems for the thirteen-cluster analysis of the corpus EU Policy (1990–2016).....	98
Table 8 – AI policy-related initiatives at the national level in China (2015-18). Source: Own compilation from document analysis.....	100
Table 9 – Main regional/local initiatives related to AI in China (2017-18). Source: Own compilation from document analysis.....	103
Table 10 – Valuation and headquarters of AI-related unicorns in China as of January 2019. Source: own elaboration based on market analysts’ data.	105
Table 11 – Main AI initiatives in China in top universities and research institutions (2017-18). Source: own compilation.	107
Table 12 - Analysis of papers from top AI journals in 2017. Source: own analysis.	111
Table 13 – Relevant ongoing AI company case studies in China (2017-18). Source: own compilation.	117
Table 14 - Stages of evolution of the entrepreneurship policy in the EU (1990–2016).....	136
Table 15 - Top 5 more relevant papers per cluster according to Scopus ranking.....	181
Table 16 -Top 20 more relevant words for four cluster analysis in the corpus Academia (1990-2016).....	184
Table 17 - Top 20 more relevant words for five cluster analysis in the corpus Academia (1990-2016)	184
Table 18 - Top 20 more relevant words for six cluster analysis in the corpus Academia (1990-2016).....	185
Table 19 - Top 20 more relevant words for seven cluster analysis in the corpus Academia (1990-2016)	186
Table 20 - Top 20 more relevant words for eight cluster analysis in the corpus Academia (1990-2016).....	186
Table 21 - Top 20 more relevant words for nine cluster analysis in the corpus Academia (1990-2016).....	187
Table 22 - Top 20 more relevant words for ten cluster analysis in the corpus Academia (1990-2016).....	187
Table 23 - Top 20 more relevant words for eleven cluster analysis in the corpus Academia (1990-2016).....	189
Table 24 - Top 20 more relevant words for thirteen cluster analysis in the corpus Academia (1990-2016)	190
Table 25 -Top 20 more relevant words for four cluster analysis in the corpus EU Policy (1990-2016).....	191
Table 26 - Top 20 more relevant words for five cluster analysis in the corpus EU Policy (1990-2016).....	191
Table 27 - Top 20 more relevant words for six cluster analysis in the corpus EU Policy (1990-2016).....	192
Table 28 -Top 20 more relevant words for seven cluster analysis in the corpus EU Policy (1990-2016).	192
Table 29 - Top 20 more relevant words for eight cluster analysis in the corpus EU Policy (1990-2016).	193
Table 30 -Top 20 more relevant words for nine cluster analysis in the corpus EU Policy (1990-2016).	193
Table 31 -Top 20 more relevant words for ten cluster analysis in the corpus EU Policy (1990-2016).	194

Table 32 -Top 20 more relevant words for eleven cluster analysis in the corpus EU Policy (1990-2016).....	195
Table 33 - Top 20 more relevant words for twelve cluster analysis in the corpus EU Policy (1990-2016).....	195

GLOSSARY

AI	Artificial intelligence
ANDE	Aspen Network of Development Entrepreneurs
EC	European Commission
EIP	Eurostat Entrepreneurship Indicators Programme
EU	European Union
ICT	Information and communications technology
IPP	Innovation Policy Platform (IPP)
OECD	Organization for Economic co-Operation and Development
SME	Small and medium-sized enterprises
TH	Triple Helix
UNCTAD	United Nations Conference on Trade and Development

RESUMEN

Esta tesis tiene el objetivo de ampliar el conocimiento existente en relación a la adopción de la teoría de ecosistemas para explicar la actividad emprendedora y/o innovadora en distintos contextos.

La noción de ecosistema emprendedor a nivel local /regional/ nacional es un concepto que se ha estudiado de manera creciente, sobre todo durante la última década. Un gran número de investigadores procedentes de distintas disciplinas, así como organizaciones internacionales de distinta índole, han estudiado como las interacciones entre agentes que compiten y/o cooperan contribuyen a establecer las condiciones que a su vez influyen en la aparición y desarrollo de actividades emprendedoras en un determinado lugar.

A pesar de las diferencias entre las distintas aproximaciones, existen algunas características comunes que sirven para acotar el concepto ‘ecosistema emprendedor’. Entre ellas, las más destacadas son (i) la compleja interdependencia entre los distintos agentes y factores del ecosistema; (ii) sus relaciones y como éstas evolucionan de forma dinámica; (iii) la noción del emprendedor y la actividad emprendedora no sólo como un resultado sino también como un elemento central del sistema; y, como consecuencia, (iv) la necesidad de una aproximación holística para analizar su evolución y desempeño en el sistema. A pesar de que existe acuerdo sobre estas cuestiones de alto nivel, la mayor parte de la discusión sobre los ecosistemas emprendedores no ha considerado la dimensión temporal y, por tanto, los marcos actuales se han demostrado útiles para representar al conjunto de agentes y dominios, pero no como representación del impacto de/en la actividad emprendedora en un determinado lugar a lo largo del tiempo.

Por otro lado, también existe un amplio consenso en la relevancia de las políticas públicas como uno de los principales contextos para la actividad emprendedora, es decir, en relación a todas las condiciones que influyen en su desarrollo. Sin embargo, a pesar de que el estudio de este dominio y su influencia en la actividad emprendedora ha atraído el interés de académicos, organizaciones internacionales y profesionales, aún se encuentra en sus etapas iniciales, lejos de alcanzar un estado de madurez. Existen dos razones fundamentales para explicar esta situación. En primer lugar, las múltiples controversias no sólo sobre la configuración de la intervención pública en este ámbito, sino también sobre su propia existencia/necesidad y justificación. Ligado a ello, no existe un análisis lo suficientemente granular sobre la evolución de las políticas públicas en este ámbito que determine cuáles han sido los principales temas y conceptos. Y tampoco existen análisis entre distintas geografías y aproximaciones.

Con estas premisas, el principal objetivo de esta tesis es responder a la pregunta: ‘¿Cómo impacta el dominio de las políticas públicas en el desarrollo de ecosistemas emprendedores?’.

Metodológicamente, esta tesis adopta una filosofía de investigación pragmática, partiendo de la base de que los ecosistemas emprendedores y de innovación representan múltiples realidades. Ligado a ello, la aproximación de la investigación es deductiva y exploratoria y el diseño está basado en métodos de investigación mixtos, tanto cualitativos (caso de estudio) como cuantitativo (minería de textos).

La estructura de la tesis se muestra en la figura 1 (p. 13, capítulo 1). Tras el capítulo introductorio en el que se resumen los principales aspectos del documento y se detallan los objetivos de la investigación, el segundo capítulo recoge una revisión de literatura sobre los ecosistemas emprendedores e innovadores, concluyendo con los principales gaps en este ámbito, ligándolos con los objetivos de la tesis y estableciendo la base del resto de la tesis. Adicionalmente y como contribución teórica, se propone un modelo conceptual consolidado para representar los principales dominios de los ecosistemas emprendedores partiendo de los modelos desarrollados por el Babson College y la OCDE.

A partir de ahí, los capítulos 3 y 4 detallan la metodología y resultados de la tesis, que se estructuran en tres fases.

- La fase 1 del análisis utiliza minería de textos para explorar los principales temas, déficits, tendencias y cambios que han marcado la agenda de investigación en políticas públicas de emprendimiento. Para ello, se analiza una muestra de 1,048 artículos relacionados con la cuestión publicados durante el periodo 1990 – 2016 en diez de las revistas más relevantes del ámbito del emprendimiento. Los resultados de este análisis muestran que el dominio de investigación ha estado dominado por los artículos relacionados con la inclusión, el empleo y la regulación. El dominio ha evolucionado desde una aproximación inicial en la que ese liga el emprendimiento con el empleo hacia una perspectiva más multidisciplinar que incluye como temas relevantes la gestión empresarial, la dimensión geográfica y temas más específicos como las relacionadas con la concentración de la actividad productiva o la internacionalización, frente a aproximaciones anteriores de un corte más general. De forma general, el análisis de los artículos de la muestra permite concluir que la investigación en políticas públicas y emprendimiento se ha hecho cada vez más abierta, con una creciente cooperación entre investigadores de distintas geografías/ afiliaciones, y también más sofisticada, con conceptos y temas cada vez más cercanos a las prioridades de implementación a nivel político.
- La fase 2 aplica el mismo procedimiento de minería de textos que la fase 1, en este caso con el objetivo de estudiar el dominio de las políticas públicas en emprendimiento en la Unión Europea. Es decir, el objetivo es identificar los conceptos y temas clave que han marcado la agenda política en emprendimiento en la Unión. Para ello, se analiza una muestra de 576 Comunicaciones de la Comisión Europea relacionadas con emprendimiento durante el mismo período que en la fase 1, 1990-2016. Como principal resultado del análisis, es posible afirmar

que la agenda política en emprendimiento de la UE empieza a comienzos de los 2000s con el lanzamiento de la Agenda de Lisboa; y a partir de ahí ha seguido una curva de aprendizaje desde el escaso apoyo inicial hasta una serie de medidas cada vez más numerosas y concretas durante los últimos años del análisis. Por otro lado, como el análisis considera la evolución del ciclo político de la UE, es posible afirmar que las prioridades de los gobiernos de la Unión han evolucionado coincidiendo con el ciclo político. Derivado de esto, puede inferirse que cada gobierno intenta establecer sus ideas en la agenda política. Otro resultado interesante es que la evolución de la agenda política no ha sido homogénea a lo largo del periodo bajo estudio: inicialmente, los temas aparecen desconectados pero en los últimos periodos se puede apreciar cierta continuidad con respecto a las etapas anteriores más próximas.

Adicionalmente, el capítulo 5 de la tesis recoge un análisis cualitativo sobre los resultados de las dos primeras fases con el objetivo de proporcionar una visión combinada de la emergencia y evolución de los dos corpus estudiados y, potencialmente, encontrar conexiones y/o diferencias entre ellos. Particularizando en el caso de las políticas públicas sobre emprendimiento, este análisis combinado tiene como objetivo contribuir a la creciente discusión existente en torno a las relaciones entre investigación académica y políticas públicas llevadas a cabo en la UE. El principal resultado de este análisis es la división del periodo bajo análisis en una línea temporal de tres etapas y seis sub-etapas en las que se comparan los temas de los dos corpus. Así, es posible concluir que los intereses de ambos corpus se han ido alineando según avanzaban los años, lo que se puede interpretar como un signo de madurez.

- La tercera y última fase del análisis adopta una metodología completamente distinta a las fases anteriores para estudiar el papel de las políticas públicas en el desarrollo de ecosistemas innovadores/emprendedores en China. Consecuentemente, el diseño y fuentes de datos utilizados durante la investigación también son distintas a las fases anteriores y en este caso se centran en el estudio del ecosistema de innovación alrededor del desarrollo de la inteligencia artificial. Para ello, se propone un modelo específico de Triple Hélice asimétrico como el indicado en la Figura 11, considerando las particularidades de China. Tomando como base este modelo, esta fase lleva a cabo un análisis cualitativo basado en una revisión de documentos y en entrevistas con expertos. Los resultados del análisis muestran como un contexto favorable desde el punto de vista político junto a una amplia tasa de adopción y la competencia entre regiones por las inversiones y el capital humano han convertido a China en uno de los ecosistemas líderes en el ámbito de la inteligencia artificial, sobre todo en el segmento b2c.

El último capítulo recoge las conclusiones de la investigación. A modo de resumen, los resultados de esta tesis permiten concluir que los ecosistemas emprendedores son un dominio de creciente relevancia,

especialmente durante la última década. Esta popularidad ha ido acompañada de un gran número de controversias sobre todo en lo relativo al papel que debe jugar el dominio de las políticas públicas. En este contexto, esta tesis proporciona una serie de contribuciones (teóricas, metodológicas y prácticas) que pretenden mejorar el conocimiento sobre esta cuestión y pueden ser utilizados por investigadores y legisladores en este ámbito.

Palabras clave: teoría de ecosistemas; políticas de emprendimiento; minería de textos; Unión Europea; China

ABSTRACT

The aim of this research is to expand the knowledge on entrepreneurial and innovation ecosystem theory as explanatory frameworks of different contexts.

The concept of a local, regional and national entrepreneurial ecosystem have been increasingly studied, especially during the last decade. From academic authors with rather disparate backgrounds to reports from international organizations and institutions, there is an increasing number of studies about the interactions of those agents that compete, cooperate and contribute to set the conditions that influence the emergence and development of entrepreneurial and/or innovative activities in a specific location.

Despite the nuances among their approaches, it is possible to observe some key shared features delimiting the notion of the entrepreneurial ecosystem regarding: (i) the complex interdependency among actors and factors and the dynamic evolution of their relationships; (ii) the conception of entrepreneurship not only as an outcome but also considering the entrepreneur as a fundamental part of the system; and (iii) the need for a holistic approach to analyze the evolution of the system and to evaluate its performance. In addition, much of the discussion of entrepreneurial ecosystems has lacked a time dimension and, as a consequence, the existing explanatory frameworks are useful as general taxonomies of domains but not as representations of the role and impact of the entrepreneurial activity of a given place over time.

Similarly, all the contributions on entrepreneurial ecosystems also agree on the critical role of the policy domain as a key context for entrepreneurship, that is, in setting the framework conditions for the development of entrepreneurial activities. The study of how public policies could enhance entrepreneurial ecosystems has attracted the attention of academia, international organizations and practitioners. However despite this interest, knowledge on the topic is still in its early stages from both the research and policy perspectives. Two main reasons explain this lack of maturity. First, there is still a range of controversies about how the policy interventions should be configured and also about what should be the policy rationales and justification. Related to this, there is not enough granular analysis on the evolution of the policy agenda able to identify main themes and foundational concepts, establishing patterns and finding temporal relations between different approaches and geographies.

Therefore, in summing the previous considerations, there is still room to improve the understanding of the dynamics of the entrepreneurial ecosystem from the perspective of public policies. Within this context, this thesis contributes to answer the following question: ‘How does the policy domain impact on the development of entrepreneurial ecosystems?’.

Methodologically, this thesis has adopted a pragmatic research philosophy, considering that entrepreneurial and innovation ecosystems represent not a single but multiple realities. Consequently,

the research requires a deductive and exploratory approach and the research design is based on mixed methods both qualitative (case study) and quantitative (text mining techniques).

The structure of the thesis is summarized in Figure 1 (p. 13, chapter 1). After the initial introductory chapter in which the main aspects and objectives of the thesis are delineated, the literature review (chapter 2) sets the context within the research on entrepreneurial and innovation ecosystems, concluding with the main research gaps in the field. Furthermore, building on previous developments by Babson College and the OECD, an advanced conceptual framework for the representation of the entrepreneurial ecosystems is proposed as a theoretical contribution.

Then, the investigation is divided into three consecutive phases, described in chapter 3 (methodology) and chapter 4 (results).

- Phase 1 explores the key topics, gaps, trends and shifts that have shaped the entrepreneurship policy research agenda to date by using a range of text mining and cluster analysis techniques. The sample under analysis is a corpus of 1,048 academic papers focused on entrepreneurship-related policies and published during the period 1990–2016 in ten relevant journals. The results of the analysis show that inclusion, employment and regulation-related papers have largely dominated the research in the field, evolving from an initial classical approach to the relationship between entrepreneurship and employment to a wider, multidisciplinary perspective, including the relevance of management, geographies and narrower topics such as agglomeration economics or internationalization instead of the previous generic sectorial approaches. Overall, the text mining analysis reveals how entrepreneurship policy research has gained increasing attention and has become both more open, with a growing cooperation among researchers from different affiliations, and more sophisticated, with concepts and themes that moved the research agenda forward, closer to the priorities of policy implementation.
- Phase 2 applies the same text mining workflow as in phase 1 to study the evolution of the policy domain in the EU. Particularly, this phase aims to identify the key topics and concepts in the EU policy agenda on entrepreneurship over time. The sample under analysis is a corpus of 576 selected EC communications related to entrepreneurship during the period 1990-2016. As main finding, the EU entrepreneurship policy agenda can be considered to have started in the early 2000s, coinciding with the launch of the Lisbon Agenda and has followed a learning curve during the last two decades, moving from vague and naïve support to increasingly targeted measures, and to early maturity during the last years under analysis. Furthermore, as the analysis considers the evolution of the EU policy cycle, it could be added that the focus of policymakers' discourse shifts every five years, coinciding precisely with the EU policy cycle. This suggests that every new College of Commissioners aims to bring their ideas to the agenda. Another

relevant insight is that this evolution has not been completely homogenous: initially, themes appeared disconnected in time and scope, but later displayed potential influences and continuity from previous stages.

The empirical findings of the first two phases permit to add an additional qualitative analysis to provide a retrospective view of the emergence and configuration of both EU policy and academic bodies looking for potential linkages and/or differences among them (chapter 5). This combined examination contributes to the discussion on the relationships between research and policy, specifically focusing on entrepreneurship policy in the EU. As main output, the analysis displays three main stages, each of them containing two further sub-stages for the period under study (1990 – 2016) in which main themes from the two corpora/perspectives are compared. This analysis shows that EU policy and the interests of academia are increasingly aligned over time, which could be interpreted as a symptom of early maturity as both can now rely on data to study the impact of different types of learning, increasing the speed and depth of the learning process.

- Phase 3 adopts a totally different methodology to study the role of policy when developing innovation and entrepreneurial economies in China, probably the most paradigmatic alternative non-Western socioeconomic model. The approach, time frame for development and availability of data sources are completely different from the case of the European Union, so this phase is based on a case study about the AI innovation ecosystem. The analysis proposes a revisited asymmetric Triple Helix (ATH) model, as shown in Fig. 11, and the qualitative analysis of the AI innovation ecosystem is based on both an in-depth document review and also on interviews with experts. The results show how a favourable context, the broad adoption rate and the competition for talent and capital among regional-specialized clusters are boosting the advance of AI in China, mainly in the business to customer arena.

All in all, the entrepreneurial ecosystem, that is, the wider area of entrepreneurial domains, agents, roles, and interactions, is a field that has been increasingly explored, especially during the last decade. Despite this popularity, a variety of controversies has emerged especially around the role of policy domain. Within this frame of reference, the last chapter in this thesis provides the conclusions of the investigation. As main output, it compiles a range of theoretical, empirical and methodological contributions for both researchers and policymakers in the field, aiming to improve the understanding of entrepreneurial (and innovation) ecosystems and the role of public policy on their formation, evolution and performance.

Keywords: ecosystem theory; entrepreneurship policy; text mining; Eur

1 INTRODUCTION AND OVERVIEW

1.1 Prelude

'[...] You have now to choose between the known and probably shorter path; or move to the unknown and surely longer way. This is your choice'. It was June 2014 and these were the final words of a very intense and constructive meeting with Claudio, Sergio and Cristina. After completing the Master in City Sciences during September 2014 and July 2015, Cristina and myself wanted to start our doctoral studies, in September 2015. Given our backgrounds and personal interests, two main options of potential research fields were open to us: the telecommunications/digital economy or entrepreneurship.

We have both studied telecommunications engineering with a speciality in ICT management. And we have been working in several positions focusing on the study of the regulatory framework of the digital economy and the relationship between the different stakeholders involved, both in the public and private domains. In addition, the research and professional backgrounds of both Claudio and Sergio were centred on the fields of telecommunications and the digital economy, mainly from the point of view of policy and techno-economic analysis. So this was the 'known and probably shorter' path.

On the other hand, our personal interest in entrepreneurship was growing. Personally, my last position in AMETIC, the Association of Electronics, Information and Communications Technologies, Telecommunications and Digital Content Companies in Spain, opened my mind to better understanding the ICT entrepreneurial ecosystem in Spain and Europe. In addition, the Master in City Sciences programme made me aware of the increasing relevance of cities as a key unit of decision making processes that impact individuals' lives. It provided me with a comprehensive vision of the urban phenomenon beyond the concept of smart cities, understanding that innovation and entrepreneurship could not be analysed in isolation. During those months before the PhD enrolment, I immersed myself more deeply in ecosystems theory. I was amazed to learn what this theory was about and how deepening my knowledge of this field could help me to better understand the world. On the other hand, neither I nor my supervisors had previous experience as researchers in the field. So this was the 'unknown and surely longer way'.

Almost six years after that initial meeting, I am really happy with the choice I made to follow the 'unknown'. Entrepreneurship and innovation, the relationships between them, their context, and how policy influences them are topics that are trending even more now than six years ago. Today, entrepreneurship is not just considered the result of a heroic individual pursuing great innovative projects. Nor is it just a way to solve unemployment issues as an output of certain policy initiatives; entrepreneurship is a way to approach and face complex realities in both the private and public sectors, beyond mere economics. In practical terms, my motivation for my research and for studying

entrepreneurship and ecosystems is even greater after this five-year doctoral path. And indeed, during this doctoral period I have grown ever more aware that my knowledge on ecosystems and policy related issues is far from complete.

In addition to my interests in this field, I had another intrinsic and personal motivation to start my doctoral studies: to develop my critical thinking. My feeling in 2014 was that reality was picking up speed, and I was becoming increasingly unable to handle it in an objective way. Contrary to the accelerating and short-term nature of every single activity in the ‘real world’, research forces you to pause and reflect. And then to rethink. After this five years, I think I am more able to address complexity and process news, events and thoughts. I have many more doubts and concerns than I did in September 2015. And these continue to be the best motivations for being a (entrepreneurial) researcher.

1.2 Entrepreneurship history in a nutshell: origin, evolution and current state of the field

There is no doubt that entrepreneurship is considered an activity of paramount importance in the current economic and social context. Although the concept ‘entrepreneurship’ is usually perceived as a new word linked to describing innovative activities, a review of the literature suggests it can be considered as a classic term in economic and social studies.

Etymologically, the word ‘entrepreneur’ originated in the thirteenth-century in France¹ (Sobel nd). It is commonly agreed that the French economist Richard Cantillon was the first academic who used the concept ‘entrepreneur’ as a term in economics to represent the general idea of speculating and financial risk-taking. Particularly, Cantillon considered entrepreneurship as the process of bearing the risk of buying something at a certain price at a certain moment, and selling it at an uncertain moment in the future (Cantillon 1755).

Henceforth, many renowned scholars introduced their own nuances to the concept contributing to its evolution. Just to mention some of the most relevant practitioners from Economics and Management, Jean-Batiste Say referred to the concept as a risk taking process, and John Stuart Mill remarked on the distinction between entrepreneur and other business owners in his book *Principles of Political Economy* (1848), based on the involvement or not in the daily management of the business. Frank Knight (1921) pointed out the difference between risk and uncertainty based on the notion of the unique nature and insurability of the uncertainty. And also defining the special feature of entrepreneurship as the ability to deal with this uninsurable risk.

¹ *Entreprendre*, meaning ‘to do something’ or ‘to undertake’.

Joseph Schumpeter (1934) represents a pivotal moment in the modern concept of entrepreneurship. His work *Theorie der Wirtschaftlichen Entwicklung* (1912), the second edition of which was published in English in 1934 entitled *The Theory of Economic Development*, considered for the first time the innovative role of the entrepreneur – ‘new combinations’ – and its influence on economic development as opposed to classical equilibrium. And later, Schumpeter also remarked on the disruptive function of the entrepreneur in the economy – ‘creative destruction is the essential fact about capitalism’ – (Schumpeter 1942).

As opposed to Schumpeter’s idea of entrepreneurial dynamism that breaks the equilibrium of the economy, economists from the Austrian School strongly based their concept of entrepreneurship on the premise that markets tend continuously towards the equilibrium, considering a static view of the entrepreneur role. Von Mises was probably the most recognized author in this vein – ‘the entrepreneur is always a speculator’ – (1949). Using Mises’ contribution, Kirzner argued that the role of entrepreneur can be considered as an ‘arbitrageur’ matching supply and demand (Kirzner 1973).

Nevertheless, the Schumpeterian notion of innovation as a key feature of entrepreneurship has directly influenced further research works (Shane and Venkataraman 2000a). Many authors have defended that in an entrepreneurial process the creation of new organizations is not mandatory, but it is related to the search for and exploitation of opportunities (Drucker 1985a; Gartner 1988). And even for those prominent scholars focused on the impact of entrepreneurship on economic growth, who understand that the creation of an organization is the distinguishing factor compared to other disciplines, innovation is an essential characteristic of the entrepreneur (Baumol 1996a; Acs *et al.* 2012a). In this sense, innovative entrepreneurship is mainly considered a key leverage of sustainable economic growth, and material and non-material welfare. Some authors have even remarked on the distinction between opportunity-based entrepreneurship, dominant in developed countries, and necessity-based entrepreneurship, prevailing in developing countries (Reynolds *et al.* 2002) and the difficulties in accurately measuring Schumpeterian entrepreneurship (Gartner 1989; Henrekson and Sanandaji 2014).

As a research field, the political economy consideration on the influence of entrepreneurship on economic development has turned around since the 1970s–1980s and entrepreneurs and the creation of ventures have gained increasing consideration (Thurik 2009a). Simultaneously, entrepreneurship started to grow significantly as a research field thanks to the creation and strengthening of the formal institutional infrastructure (conferences, scientific journals, educational programmes, etc.). Entrepreneurship is considered a specific discipline in economics and management while still searching for its maturity (Landström *et al.* 2012; Busenitz *et al.* 2014; Ferreira *et al.* 2015). However, the ‘body of knowledge’ of entrepreneurship as a discipline is considered as limited and fragmented until the early 2000s due to two main reasons: (i) the late attention by academia; and (ii) the permeable boundaries of

the fields (Busenitz 2003; Schildt et al. 2006). In addition, from a research view, some authors identify the individual perspective on the definition of entrepreneurship as the main obstacle to setting a proper conceptual framework (Shane and Venkataraman 2000a; Carlsson *et al.* 2013). Therefore their contribution to the debate addresses the importance of not only taking into account the person who starts an entrepreneurial activity (not necessarily the creation of a new firm because it can take place within an existing organization) but the sources of opportunities surrounding this and the process to discover, evaluate and exploit them.

There is therefore a wide range of features included in the term entrepreneurship. Furthermore, the concept of entrepreneur is used outside academia to describe a significant variety of economic agents such as startup founders, self-employed and freelance professionals, executives in charge of innovation within a company, contractors, investors in new ventures, etc. Similarly, most authors and researchers now consider that entrepreneurship is not restricted to a single agent, and entrepreneurial activity may be developed within different organizations according to the size (startups, SMEs, large firms, intrapreneurs²...), both in public or private domains (Baumol 1996b; Acs *et al.* 2012b). So what is important from the research perspective is to establish solid boundaries for the entrepreneur concept. In this sense, the combination of value generation, innovation and risk taking in the form of ownership are required features with the advantage of delimiting not only the entrepreneurs' activities but also their output.

Regarding the aim of value generation from entrepreneurial activity, this can be differentiated between pro-profit entrepreneurship or simply, entrepreneurship, where the main value is captured both by the entrepreneur and others, versus so-called social entrepreneurship, in which the largest value is captured by others (Parrish 2010). Both need economic sustainability for success, so the main difference is identified in the value proposition itself, based on a market motivation or on a transformational benefit for the wider society (Martin and Osberg 2007).

From an institutional perspective, the conceptual framework of the OECD-Eurostat Entrepreneurship Indicators Programme (EIP) is considered as a relevant reference to the concept of entrepreneurship (Ahmad and Hoffmann 2008). According to EIP, the following definitions apply:

² The concept of intrapreneur was cited in 1992 by the American Heritage Dictionary to define a person within a large corporation who takes direct responsibility for turning an idea into a profitable finished product through assertive risk-taking and innovation [intra(corporate) + (ENTRE)PRENEUR.]. The objective of intrapreneurs is to turn new technologies inside corporations into profitable new businesses, to reduce costs, create new features and competitive advantages, promoting corporate innovation (Pinchot 1987). As a consequence, intrapreneurs are people who innovate within companies and develop entrepreneurial activities.

- ‘Entrepreneurs are those persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- Entrepreneurial activity is the enterprising human action in pursuit of the generation of value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.
- Entrepreneurship is the phenomenon associated with entrepreneurial activity.’

In conclusion, in spite of its practical relevance, from a research perspective a single conceptual framework for entrepreneurship is still lacking. Two main relevant issues have been highlighted in this regard: first, the absence of a comprehensive and unanimous definition of the topic (Shane & Venkataraman 2000); and second, it is being addressed by scholars from diverse disciplines such as psychology, anthropology, social sciences, and, obviously, economics and management studies, all using diverging perspectives (Carlsson *et al.* 2013). From the author’s point of view, two additional difficulties should be highlighted. The first is the almost exclusive focus on the individual – the person or group of persons who starts an entrepreneurial activity – but not on the relationships woven around the entrepreneur and the process of discovering, evaluating and exploiting these relationships. The second is the absence of an explicit consideration of the time dimension in the entrepreneurial activity.

1.3 Research context

From managed economy to entrepreneurial economy

As introduced, in an economic context aimed at a renewed and innovation-based growth, entrepreneurship is considered a key constituent (Audretsch *et al.* 2008; Acs *et al.* 2012b; Ács *et al.* 2014). In fact, entrepreneurs are expected to create value in the shape of new businesses ventures and generate new jobs by mobilizing economic resources, which in combination has a positive impact in terms of increasing productivity and economic growth (IEG World Bank 2013). In this regard, international institutions such as the United Nations (United Nations Conference on Trade and Development 2011) or the Organization for Economic Cooperation and Development (OECD 2004, 2015a) have reported the relevance of innovation and entrepreneurship as key aspects to achieve not only sustainable economic growth but also the general welfare of society.

This was not always the case. The post II World War economic policy of governments around the world was primarily based on the premise that large firms were the core element which drives economic growth and job creation (Reynolds *et al.* 1999). In this respect, the research of Birch (1979) involved a significant shift in the consideration of the job generation paradigm. His research concluded that small businesses had been the main source of new jobs in the US in 1969–1976. Since then, incremental

evidence has shown the decreasing influence of big companies on employment, as demonstrated by Carlsson's studies on the employment share of the 500 largest American firms, noting that it had decreased from 20% of the total number of jobs in 1970 to only 8.5% in 1996 (Carlsson 1992, 1999).

Simultaneously, since the last quarter of the twentieth century, entrepreneurship has emerged as a pivotal theme on the policy agenda (Wennekers *et al.* 2002). The new paradigm characterized by the globalization process, the technological disruption of ICTs and the emergence of knowledge as a key factor for economic growth, implied that traditional policy approaches were no longer considered effective in supporting economic development and the maintenance of low unemployment rates in Western countries (Gilbert *et al.* 2004). In the early 1990s, entrepreneurship started to be considered 'at the heart of national advantage' (Porter 1990a) and public intervention in the field of entrepreneurship began to be included as a strategic priority and with a broad focus, not only addressing policies oriented to support those who have decided to start a business – the entrepreneurs as such – but also to the promotion of entrepreneurial culture throughout society (Verheul *et al.* 2001; Acs *et al.* 2012a). Some authors have gone even further noting that in the 21st century there has been a paradigm shift from the 'managed economy', based on large-scale and standardized production to the 'entrepreneurial economy', in which knowledge and innovation are the dominant elements (Audretsch and Thurik 2004; Thurik 2009b). After the financial crisis in 2007, interest and support for entrepreneurial activity gained momentum, as the conditions to foster innovation activities in connection with post-crisis recovery have acquired a prominent role on many political agendas (Warwick 2013).

Although this interaction of entrepreneurship and economic development has become a hot topic on the agenda of policymakers and private investors, there has been a deep lack of understanding about the field. This could mainly be due to the absence of a comprehensive framework that gathers and quantifies the agents and their relationships as a necessary step to measure and evaluate the different inputs and outputs of the entrepreneurship performance in a certain place. Until the 1990s, academic research on the entrepreneurship field had been traditionally focused on individual entrepreneurs and/or small firms, underestimating the complexity of their interactions and influence on the entrepreneurial outcome of an area (Van De Ven 1993; Spilling 1996). In this context, the entrepreneurship ecosystem approach appears as a possible solution to address this gap (Zacharakis *et al.* 2003; Neck *et al.* 2004). Taking into account that the performance of entrepreneurship strongly depends on its interaction with many different factors and the recognized influence of local aspects on entrepreneurial performance (Feldman 2001; Lee *et al.* 2004), the concept 'entrepreneurial ecosystem' includes cultural aspects and agents (individuals, firms, organizations and governments), among other relevant elements, and their relationships and evolution.

While these considerations apply to Western contexts, the previously mentioned shift from a ‘managed economy’ to an ‘entrepreneurial economy’ does not apply in the same way from a non-Western perspective.

In this regard, the case of China is especially relevant in the context of this thesis. With all due caution, China represents the most paradigmatic alternative reality that should be evaluated when reviewing the most recent economic history.

As a brief introduction to set the context, since Deng Xiaoping rose to power in the late-1970s, China exhibited a period of reforms and modernization and economic openness with a focus on agriculture, industry, science and technology, and the military, labelled as the ‘four modernizations’. Since then, China has become the largest factory in the world becoming a successful model in terms of economic development. This model began to show signs of exhaustion during the mid-2000s. China can no longer depend solely on capital and labour growth to drive the desired levels of sustainable economic growth. In fact, there has been a recent shift towards innovation as a panacea for increasing both product quality and productivity and, on this basis, expanding domestic consumption and thus decreasing the dependence on external markets whilst augmenting the economy’s added value.³ As stated by President Xi, China ‘... should unswervingly follow an independent innovation path featuring Chinese characteristics, stick to the guiding principles of independent innovation, leap-frogging development in key sectors and development supported by science and technology and oriented towards the future’ (Xi 2014).

As a result, China is already a leading global force in the digital economy, especially in AI. Digital technologies, particularly AI, are expected to lead to more efficient products and services, achieving large productivity gains and a more dynamic economy, with businesses able to compete globally and even export *Made in China* digital business models and solutions (Woetzel *et al.* 2017). It has also been argued that AI could contribute to overcoming the physical limitations of capital and labour and open up new sources of value and growth (Purdy *et al.* 2017). Some experts and analysts refer to it as a new industrial revolution in its capacity to change economy and society. It is poised to change not only the way in which we think about productivity or our relationship with our environment but also to transfer elements of national power. Just as past industrial revolutions transferred power to the more industrialized nations, AI could be a similar game changer at the international level (Bughin *et al.* 2018).

³ It is unclear how this productivity increase can be reconciled with high rates of employment while keeping the amount of debt under control and maintaining economic growth. See, for instance, Pettis (2018) for a critique.

From an ecosystem perspective, both planification and centralism⁴ are probably the two more salient economic particularities of China that should be considered (Feijóo 2020). As salient feature, the leadership of government at different levels, beyond the role of legislators and/or regulators, is more comprehensive than in the Western economies. In addition, while it has commonly been accepted that the ‘border’ of an ecosystem is not limited to national/regional contexts (Tsujimoto *et al.* 2018), this is not the case in China, where it is possible to establish national boundaries. As the main example, the combination of a huge internal market⁵ and the barriers to external competition⁶ is favouring the rapid development of domestic Internet companies by granting them almost exclusive access to this internal market.

Entrepreneurship as a policy subject / The emergence of an entrepreneurship policy

As previously introduced, entrepreneurship has become a pivotal theme in the policy agenda all over the world. Within this context, the emergence of entrepreneurship policy⁷ as a field is the logical consequence of the increasing attention on entrepreneurship as a strategic driver of progress during the last quarter of the twentieth century (Lundström and Stevenson 2002a; Gilbert *et al.* 2004).

Nevertheless, this new strategic consideration of entrepreneurship has not been homogenously adopted across jurisdictions, even among Western economies. The consequences that globalization produced on employment were evidenced earlier in the United States (1980s) than in Western Europe (1990s) and, as a result, economic diagnosis and policy approaches to face the new paradigm were not adopted at the same time on both sides of the Atlantic Ocean. While unemployment was a huge problem in the United States in the 1980s, it started to be a problem in Europe in the 1990s and, as a result, the transition from a managed economy to an entrepreneurial economy and new policy approaches occurred earlier in the United States than in Europe. In fact, in the early 1990s growth rates and unemployment figures between European Union countries and the US were diverging, mainly due to two factors: the weaknesses of the

⁴ China’s constitution defines its political system as a ‘people’s democratic dictatorship’ aiming to develop a ‘socialist market economy’. Available at http://www.npc.gov.cn/englishnpc/Constitution/2007-11/15/content_1372962.htm

⁵ China is the world’s most populous country, representing almost 20% of the total world population.

⁶ The main example is the Great Firewall, a subproject within the Golden Shield Project. It consists of a range of legislative and technical initiatives aiming to regulate the Internet at the domestic level in China and keep control of China cyberspace. It implies blocking access to a number of foreign websites and, as a consequence, a slowdown of cross-border Internet traffic.

⁷ One of the most common accepted definitions for entrepreneurship policy was that provided by Anders Lundström and Lois Stevenson, who defined it as ‘measures taken to stimulate entrepreneurship; that are aimed at the pre-startup, the startup and post-startup phases of the entrepreneurial process; designed and delivered to address the areas of motivation, opportunity and skills; with the primary objective of encouraging more people to start their own businesses’ (Lundström and Stevenson 2005).

industrial sector in Europe, where production was being transferred to countries with lower costs, and simultaneously, a slower transition of Europe to a more entrepreneurial economy (Audretsch *et al.* 2007; Audretsch and Thurik 2010). As previously mentioned, it was not until the second half of the 1990s when European policy makers started to agree that a policy shift was necessary to promote a knowledge-based economy as a means to stimulate economic growth. In this sense, the Lisbon Agenda⁸, drafted in the early 2000s, can be considered as a first milestone towards a common entrepreneurship policy. Since then, a review of the different EU policy documents and priorities shows an evolution of the priority policy targets ranging from the general approaches to the framework conditions in which European entrepreneurs can thrive to specific measures aimed at particular aspects of the entrepreneurial ecosystems.

Despite these developments, the policy and research field of entrepreneurship are still in their early stages and knowledge about their evolution is still limited. This is especially true in Europe, where there are insightful contributions about the period between the emergence to the initial steps of the field (Audretsch *et al.* 2002) but less is known about the subsequent period.

From the perspective of the ecosystem approach, public policies have been found to be one of the key elements of the ecosystem; and even considering that there are a range of factors influencing the health of an entrepreneurial ecosystem, understanding how policies have fostered and/or undermined its development has been considered as very relevant (Hechavarria and Ingram 2014). In addition, ecosystems have been determined as susceptible of being changed as a result of policy, but as an emerging topic controversies have appeared, not only about how the policy intervention should be configured (Minniti 2008; Lerner 2013) but also about what should be the policy rationale to justify it (Shane 2009; Acs *et al.* 2016) and even if specific policies should exist as such.

The emergence of an entrepreneurship policy as a research field

The interest of academia on entrepreneurship as a field of research also started to be relevant from the last two decades of the twentieth century. As introduced in section 1.3.1., Birch's research (1979) implied a shift on how the job generation process should be considered. Then, during the late 1980s and early 1990s, academics began to study and propose policy measures to favour SMEs, mainly focused on measures to improve the environment for existing small firms and levelling the playing field to compete fairly with big companies (Brock and Evans 1989; Loveman and Sengenberger 1991; Storey 1994). During the 1990s, unemployment continues to be an increasing problem in OECD countries and

⁸ Its aim was to make the EU 'the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion', by 2010.

there is increasing academic evidence about the linkage not only between entrepreneurship activity and growth but also between innovation and new firms. And, as a result, rising evidence about the need of new policy approaches to foster entrepreneurship as a way to create new jobs in the knowledge-based economy.

But up to the early 2000s there was no comprehensive academic description of entrepreneurship as a policy domain as such (Audretsch *et al.* 2007). In this regard, the work of Anders Lundström and Lois Stevenson could be emphasized during the first half of the 2000s, in providing one of the most commonly accepted definitions of entrepreneurship policy and also in establishing the differences between SME policy and entrepreneurship policy and a classification of different entrepreneurship policy typologies (Lundström and Stevenson 2002a).

Subsequently, during the second half of the 2000s, there was an increasing debate in academia about which policies are conducive or not to producing a high value entrepreneurship (Minniti 2008) under the assumptions that entrepreneurship is crucial to achieve sustainable economic growth and, at the same time, the environment in which entrepreneurship is developed is shaped by public policies (Gilbert *et al.* 2004). And in the late 2000s, relevant authors had already stated that the massive promotion of entrepreneurship is not a general ‘magic formula’ to achieve sustainable growth and employment (Shane 2009). On the contrary, academics started to show that only a small proportion of the startups, those growing very rapidly, produce the vast majority of the output in terms of growth and employment. So public policies should focus on measures to promote not small firms in general, but high-growth firms (Haltiwanger *et al.*, 2012).

As an example of this tendency, Fig. 1 shows a screenshot of the results of searching for the phrase ‘entrepreneurship policy’ in Google Books Ngram Viewer. The graph represents the weight of ‘entrepreneurship policy’ with respect to the total number of bigrams in all the indexed books. There are two relevant points to note. First, during the second half of the 1980s, the weight of ‘entrepreneurship policy’ multiplied by a factor of 10, from 0.0000000098% in 1987 and increasing to 0.0000000828% in 1988. And then during the late 1990s and the early 2000s, the weight of ‘entrepreneurship policy’ multiplied by a factor of 25, increasing from 0.0000000442% of the total bigrams in 1999 to 0.000011066% in 2001.

Fig. 1 - Results from the search 'entrepreneurship policy' in Google Books Ngram Viewer (retrieved 13th September 2017).

The Y-axis represents the weight of 'entrepreneurship policy' with respect of the total number of bigrams in all the indexed books; the X-axis shows the time period (1975-2008).

1.4 Overview of the research

1.4.1 Research aim and objectives

Within this context, the aim of this research is to expand the knowledge on entrepreneurial and innovation ecosystem theory as explanatory frameworks of different contexts/realities from the point of view of policy. It could be summarized in the following two questions:

RQ1: How does ecosystem development depend on the economic model and the agents? Are all ecosystems similar?

RQ2: How do policy domain/approaches impact on the development of entrepreneurial activity?

This general aim is addressed through the following specific objectives:

Related to ecosystems theory and the policy domain

- To evaluate how the ecosystem approach is useful to tackle the complexity in emerging environments of innovation and allow extracting insights not directly available through observation. With a view to proposing a new model for the analysis of the dynamics of the ecosystem for both market and/or planned economies.
- To evaluate how the paradigm of entrepreneurial (or innovation) ecosystems could be a valuable approximation to entrepreneurship (or innovation processes) from the public policy point of view, assuming that entrepreneurship is a complex phenomenon that deserves an approach that goes beyond solving market failures.

- To understand how public policies could positively or negatively influence the consolidation of entrepreneurial ecosystems in which high-growth entrepreneurship flourishes and the potential linkages with the entrepreneurial ecosystem approach, considering both the cases of market economies and planned economies.
- To analyze the synchronous academic research knowledge in the field to try to establish potential links of influence between policymaking and academia. This second analysis is expected to contribute to the debate about knowledge utilization in policymaking

Related to methodology

- As text mining is still a relatively new approach when reviewing the evolution of a policy field, an additional objective is to illustrate the possibilities of this type of tool to complement more qualitative approaches.
- To examine how qualitative approaches could be a complement and/or an alternative to quantification in the case of the analysis of the innovation ecosystem (s) in which the availability and/or reliability of the data sources are limited.

1.4.2 Research method

To address these objectives, this thesis is grounded on a pragmatic research philosophy, considering that entrepreneurial and innovation ecosystems represent not a single but multiple realities and require a deductive and exploratory approach.

A range of data collection and analysis techniques have been considered depending on the contexts and realities under study. Consequently, the research design is based on mixed methods both qualitative (case studies, document review) and quantitative methods (text mining techniques).

The availability and reliability of the data sources also justify adopting mixed methods, following the research design shown in the next section.

1.5 Thesis structure and outline

With the above goals, this document is structured into six main chapters. An overview of the structure, objectives and the flow for the contributions of this thesis is shown in Fig. 2.

Fig. 2 – Thesis structure. Source: own elaboration

- Chapter 1 sets out the context for the research and presents the objectives and the structure of the thesis document.
- Chapter 2 reviews the theoretical framework by examining in detail the use of the ecosystem metaphor in business and management studies. In addition, it also details the main features and frameworks in the case of entrepreneurial and innovation ecosystems, as a previous step to establish the research gaps in this field.
- Chapter 3 explains the research philosophy, approach and methods used for the analysis, providing a justification for the methodological choices adopted. Particularly, the text mining process and techniques are detailed for phase 1 (Academia corpus) and phase 2 (EU Policy

corpus) of the analyses. In addition, the chapter describes the qualitative approach followed in the study of the innovation ecosystem in China (phase 3).

- Chapter 4 focuses on the results and outcomes of the analysis following the three phases detailed in the methodology.
- Chapter 5 is based on the results of the text mining analyses to present a further discussion about the relationship between research and policy. It aims to contribute to the debate on the impact of research knowledge on policymaking, particularizing the case of entrepreneurship policy.
- Chapter 6 compiles the main conclusions and implications of the research, as well as the main limitations and weaknesses of the thesis. In addition, it includes recommendations and avenues for further investigations.

2 THEORETICAL FRAMEWORK

The second chapter reviews the state of the art around the ecosystem metaphor in the field of management and innovation studies, taking into account that the notion of ecosystem has been often overapplied⁹.

To this aim, after an introduction about the emergence and evolution of the ecosystem metaphor in business studies to the current conceptualization, the second section sets the ground describing the main concepts and definitions resulting of applying the ecosystem metaphor to particular cases. Then, third section examines the ongoing landscape for the cases of the entrepreneurial and innovation ecosystems and their main explanatory frameworks. Finally, the chapter concludes with the description of the main gaps and challenges found in this field linking them to the research objectives of the thesis.

2.1 The ecosystem metaphor in business and management studies: the antecedents of the entrepreneurial ecosystems

The literature review shows that the specific concepts of ‘innovation ecosystem’ and ‘entrepreneurial ecosystem’ can be considered as relatively new, being a natural consequence of the theory of economic ecosystems (Moore, 1993; 1996; Hakansson & Snehota, 1995), together with that of entrepreneurship and/or innovation.

The term ‘ecosystem’ was coined originally by the English botanist Arthur Roy Clapham in 1930 but the authentic pioneer in the use of the concept in the science of ecology was Arthur George Tansley (Tansley, 1935) who introduced it as the basic unit of nature and linking living organisms and their habitat (Willis, 1997). Nowadays, one of the most commonly accepted definitions of ecosystem is that adopted by the United Nations¹⁰ (1992). This definition remarks the interplays between living organisms themselves and with their environment as the key characteristic. One important consequence is that the scale and the situation of the ecosystem are relevant, but not decisive.

The ecosystem concept in the field of Business and Management studies was firstly used by James Moore (1993). From the point of view of managers, Moore outlined that companies could not be viewed as a member of a single industry but as part of a business ecosystem where customer needs are fulfilled

⁹ According to an article published in 2019 in the research-based MIT Sloan Management Review, the term ‘ecosystem’ had occurred 13 times more frequently than it did a decade ago. See: <https://sloanreview.mit.edu/article/the-myths-and-realities-of-business-ecosystems/>

¹⁰ On its convention on Biological Diversity, the United Nations (1992) provided the following definition: ‘A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit’

by the cooperative and competitive interaction among companies belonging to different sectors (Moore, 1993a). Later, Moore published a book in which he went deeper in the definition of business ecosystem reinforcing the essential role of evolving interaction among individuals and organizations in the performance of the companies and the ecosystem itself (Moore, 1996). After Moore, the influence of business ecosystems on companies' health have been broadly developed in the field of strategic management, including the development of conceptual frameworks to assess the situation of a company within the ecosystem (Iansiti and Levien, 2004).

Other models consider that relationships are not limited to related companies and include every other economically relevant entity (Gordijn, Akkermans and Van Vliet, 2000; Lindmark *et al.*, 2006). Broader approaches consider that the ecosystem is formed by interacting 'players', including companies and institutions that provide knowledge, resources and set 'rules of the game' that evolve over time (Feijoo *et al.*, 2012; Fransman, 2014).

This business ecosystem approach, more focus on management consequences from the point of view of a company, is not exactly the same of the entrepreneurial ecosystem approach, which implies a holistic analysis and evaluation of the ecosystem components to establish the environment conditions that maximize the global output. Nevertheless, Moore's ideas about the constant evolution of a company relationships and its influence on its performance, as it happens for living organisms in a biological ecosystem, supposed a decisive step forward in to understand the notion of entrepreneurial and/or innovation ecosystem.

In this context, the concepts of entrepreneurial ecosystem and innovation ecosystem can be considered as relatively new, being a natural consequence of the study of the context in which economic activity in general (Porter, 1990b; Krugman, 1991; Motoyama, 2008) and entrepreneurship in particular (Malecki, 1993; OECD, 1993; Van De Ven, 1993; Freeman, 1995) are developed. Different institutional frameworks have been proposed, such as industrial clusters (Baptista, 1998), National Innovation Systems (Lundvall, 1992; Nelson, 1993; Freeman, 1995), or Regional Innovation Systems (Cooke, Uranga and Etxebarria, 1997; Asheim and Isaksen, 2002), being the antecedents of the entrepreneurial and innovation ecosystem approaches. These models share the focus on structural aspects and they emphasize the interactions and linkages among actors and the importance of agglomeration and geographical placement. Bu they underestimate the relevance of the dynamic nature of innovation and not explain the relationships between innovators, their innovative activities and the environment (Mercan and Götkas, 2011) .

The ecosystem approach emerges therefore as an evolution of these systems of innovation to address this complexity (Jucevičius and Grumadaitė, 2014), remarking that the system is more than a sum of its parts and drawing from the business ecosystem literature inspired in ecology theories (Vasconcelos

Gomes *et al.*, 2016). Since the initial seminal contributions that disseminate the concepts of innovation ecosystem (Adner, 2006; Adner and Kapoor, 2010) and entrepreneurial ecosystem (Isenberg, 2010a), the academic discourse has rapidly evolved from this ‘systems of innovation’ towards the ‘innovation ecosystems’ and ‘entrepreneurial ecosystems’ and other ecosystem-based paradigms as for example ‘business ecosystems’, ‘knowledge ecosystems’ (Valkokari, 2015) or ‘platform ecosystems’ (Jacobides, Cennamo and Gawer, 2018). In fact, academic and industry literature is now ripped with studies relating innovative and entrepreneurial activities to the notion of ecosystems (Brown and Mason, 2017; Scaringella and Radziwon, 2018).

As a final remark of this introduction, it is fair to say that the increasing adoption of the ecosystem approach both by academics and practitioners has also generated discussion and some controversies, mainly around the definition of the concept and the doubts about the value added with respect to the ‘system’ antecedent (Oh et al., 2016; Ritala and Almpantopoulou, 2017).

2.2 Innovation ecosystems

Since the initial seminal contributions of the innovation ecosystem concept (Adner, 2006; Adner and Kapoor, 2010), it has gained an increasing relevance since the mid-2000s as a framework better suited to emerging industries where the analysis of determinants of supply and the expectations of demand are the relevant factors.

In general, an innovation ecosystem parallels the environmental concept where interrelated elements strive for equilibrium (Jackson, 2011). Digitalization drives to a new and more complex logic of innovation involving multiple and heterogeneous stakeholders and their evolving relationships, that could be conceptualize drawing on the metaphor of a biological ecosystem (Kollock and Dellermann, 2018). Innovation ‘happens’ as a result of the interdependency among players, processes and their interactions (Fransman, 2018, p. 8). In addition, innovation ecosystems are linked to some geographical space, either a city, a region or a country-nation. The physical geography is thought to create clusters that facilitate idea generation and accelerate commercialization (Katz and Wagner, 2014).

The increasing interest on innovation ecosystems has been also accompanied by a range of characterization frameworks. Among different studies, scholars such as Carayannis and Campbell (2009) or Xu, Wu, Minshall and Zhou (2018) have developed frameworks to investigate the innovation ecosystems. The notion of innovation ecosystem has been also received remarkable contributions from practitioners (Hwang, 2013; Morrison, 2013) international institutions such as the World Economic Forum (World Economic Forum, 2017) or the combined effort by the OECD and the World Bank to launch the Innovation Policy Platform (IPP).

The ecosystem is typically modelled as a structure resulting from the interaction between various industry and innovation actors or stakeholders. The most relevant of these actors are businesses –big companies but also small companies, startups and entrepreneurs-, financial markets, universities and research-related organizations, and non-governmental organizations (NGOs) and governmental institutions (Adner, 2006; Frenkel and Maital, 2014). These economic agents display economic relations but as well relate through technological, institutional, sociological and cultural interactions. These economic agents display economic relations but also relate through technological, institutional, sociological, and cultural interactions, and, as it has been widely stated, emerging technologies require new ways of governance and participation of stakeholders (Misuraca, Broster and Centeno, 2012; Kuhlmann and Ordóñez-Matamoros, 2017).

While the value of innovation ecosystem concept is widely recognized, there are still several shortcomings when studying them (Autio and Llewellyn, 2014), especially due to the inability to provide a structured analysis of these interactions among the stakeholders within the ecosystem and their dynamics and to depict the causal path to enhance innovative and/or entrepreneurial activities. In addressing this limitation, Triple Helix (TH) model (Etzkowitz and Leydesdorff, 2000) emerges as one of the most widely adopted and cited frameworks to study the supporting environment and characterize the relationships among the main stakeholders of innovation ecosystems (Chinta and Sussan, 2018; Pique, Berbegal-Mirabent, and Etzkowitz, 2018).

Fig. 3 - Triple helix model: Industry – Government – University. Own elaboration based on the original model from (Etzkowitz and Leydesdorff, 2000).

The TH model of innovation was first set with the seminal publication of *The Triple Helix, University–Industry–Government relations: A laboratory for knowledge-based economic development* (Etzkowitz

& Leydesdorff, 1995). The aim of this approach was initially to depict the evolving interactions among the three key institutions in the innovation process within the knowledge-based paradigm: universities, industry, and government. It provides a suitable framework to study the dynamics within the ecosystem in terms of the evolving role and relationships of the main stakeholders, being applied in different studies that examine the conditions of a certain region to promote innovation (Natário, Pedro Almeida Couto and Fernandes Roque de Almeida, 2012; Lawton Smith and Leydesdorff, 2014). According to Dzisah and Etzkowitz (2009), the dynamic of the TH is based on three basic elements:

- ‘(1) the prominent role of universities in innovation, on par with companies and the government in a society based on knowledge;
- (2) the collaborative relationship between the three core institutional spheres; and
- (3) the helices taking the roles of others.’

Therefore, the Triple Helix model can be seen as an explanatory tool to both depict an existing ecosystem and the main players and roles within and address additional insights about the evolution of the ecosystem through the study of their activity and interactions. Further configurations¹¹ of the model have been proposed since then and studies were largely based in Western economies’ cases (Cai, 2014).

2.3 Entrepreneurial ecosystems

The first mentions of the term ‘entrepreneurial ecosystem’ appear in the work of scholars such as (Prahalad, 2004), Boyd Cohen (Cohen, 2006a) and Paul Bloom and Gregory Dees (Bloom and Dees, 2008). However, it gains popularity thereafter Harvard Business Review published the Daniel Isenberg article *How to Start an Entrepreneurial Revolution?* in 2010 (Isenberg, 2010b). In that article, Daniel Isenberg defined the ‘entrepreneurship ecosystem’ as ‘a set of individual elements that appropriately combined and nurtured results in a successful milieu for innovation’; and proposed a set of nine principles for creating an entrepreneurship ecosystem from the point of view of governments, insisting on the need for comprehensive strategies that take into account local conditions. Isenberg expanded this definition later in several non-academic articles to describe additional characteristics (Daniel Isenberg, 2011), depicting the model of analysis of Babson Entrepreneurship Ecosystem project (Daniel Isenberg, 2011) and clarifying some essential issues in order to develop successful strategies related to the promotion of entrepreneurial ecosystems (Daniel Isenberg, 2014).

¹¹ In particular, the Quadruple Helix, including the ‘media-based and culture-based public’ and the ‘civil society’ as the fourth helix (Carayannis and Campbell, 2009); and the Quintuple Helix, including the ‘natural environments of society’ (Carayannis, Barth and Campbell, 2012).

Since then, the entrepreneurial ecosystem is an increasingly widespread concept and a number of scholars have defined and referred to it, such as Malecki (2011, 2018), Mason and Brown (2014), Vogel (2013), Stam (2014a, 2015), Acs, et al. (2014), Auerswald (2015), Autio (2017a) or Spigel (2016, 2017; 2018), among many others. The concept has also received remarkable contributions by practitioners as Brad Feld (Feld, 2012), or international institutions such as the World Economic Forum (WEF, 2011; World Economic Forum, 2014). These contributions agree on a view about the entrepreneurial ecosystem as ‘a set of interconnected actors (both potential and existing), organizations, institutions, and processes which formally and informally coalesce to connect, mediate, and govern the performance within the local entrepreneurial environment’ (Mason and Brown, 2014). In fact, in spite of the nuances among them, it is possible to observe some key shared features delimiting the notion of entrepreneurial ecosystem regarding to the complex interdependency among actors and factors and the dynamic evolution of their relationships, the conception of the entrepreneurship not only as an outcome but also considering the entrepreneur as a fundamental part of the system and, as a consequence, the need for a holistic approach to analyze the evolution of the system and to evaluate its performance.

In addition, the rising interest on entrepreneurial ecosystems has been accompanied by a number of characterization and evaluative frameworks provided by institutions very different in nature. Among different studies, the Aspen Network of Development Entrepreneurs (ANDE) elaborated one of the most comprehensive reviews about these frameworks (ANDE, 2013). ANDE published in 2013 a methodological guide conceived with the aim of supporting the labour of practitioners in charge of assessing the entrepreneurial ecosystem in developing areas. Before its completion, ANDE conducted an effective comparative study of nine evaluative frameworks from a broad range of scopes, including educational and research institutions (Babson College, George Mason University), international organizations (World Bank, Organization Economic Co-operation and Development –OECD-) and institutions (World Economic Forum), private firms (Koltai and Company), associations (Council on Competitiveness, GSM Association) and even practitioner approaches (Victor Hwan).

Likewise, regarding to the representation of the ecosystem, the research in this thesis is based on those models proposed by Daniel Isenberg and the Babson College in its The Babson Entrepreneurship Ecosystem Project (BEEP)¹² and also on the framework developed by the OECD’s Statistics Directorate within the context of the OECD-Eurostat Entrepreneurship Indicators Programme (EIP)(Ahmad and Hoffmann, 2008; OECD, 2008), previously cited.

¹²The Babson Entrepreneurship Ecosystem Project (BEEP): <http://entrepreneurial-revolution.com/>

The model suggested by BEEP outlined six domains (policy, finance, culture, supports, human capital and markets) that include twelve elements (Leadership, Government, Financial Capital, Success Stories, Societal norms, Non-Government intuitions, Support professions, Infrastructure, Educational institutions, Labour, Networks, Early Customers) interplaying in complex ways. It is very relevant due to its intellectual authority as the pioneering research centre on modelling the entrepreneurial ecosystems.

On its behalf, the ultimate goals of the EIP-OECD are to assess policy makers and to create a consistent and comparable database of entrepreneurship indicators. As shown in the Fig. 4, the OECD framework considers three linked aspects when evaluating an entrepreneurial ecosystem: entrepreneurship determinants, those factors that affect the entrepreneurial performance in the ecosystem and classified in six themes (access to capital, R&D & technology, entrepreneurial capabilities, market conditions, regulatory framework and culture); the entrepreneurial performance, the status of the entrepreneurship in the considered area; and the impacts, the ultimate value created on the economy of the area derived by entrepreneurial activities. This OECD-EIP Framework is valuable due to the orientation to quantitative measurement and the comparability of their data.

Fig. 4 - The OECD/EUROSTAT framework for Entrepreneurships Indicators. Source: own elaboration based on OECD-EIP.

Examining both BEEP and EIP frameworks, it is possible to identify clear between BEEP domains and the EIP determinants. It is obvious that these categorizations are not exactly the same, but it is also true that conceptually both models are relatively similar and for the purpose of this research it is possible to merge them in a common framework as presented in the Fig. 5.

Fig. 5 - Common framework based on the entrepreneurial model of BEEP (fine border) and EIP (thick border). Own elaboration.

More recently The European Index of Digital Entrepreneurship Systems (EIDES) addresses the measurement challenge by appraising the framework and systemic conditions for stand-up, start-up, and scale-up activities in the EU28 countries (Autio et al., 2018).

These frameworks involve a large effort and suppose a comprehensive representation of the context in which entrepreneurship is developed in a certain area. But they are not enough in order to understand how the performance of the entrepreneurial ecosystems evolves because they do not provide a structured analysis of the complex interactions among ventures and the rest of the ecosystem along the time. Despite the limited availability of comprehensive data about the inner dynamics of the entrepreneurial ecosystems, it is possible to conclude the need of considering a time dimension.

As in the case of the innovation ecosystems, the entrepreneurial ecosystem approach stresses the complex and dynamic nature of the context where new ventures are not only launched but also matured and the necessity of adopting holistic strategies by policy-makers in order to contribute to this growing process (Audretsch, Mason, Miles, & O'Connor, 2018). Besides, the entrepreneurial ecosystem approach does not only consider the entrepreneurship as a desirable output since the entrepreneurs perform an essential role in the ecosystem dynamics.

As a concluding remark, it is relevant to notice that innovation and entrepreneurial ecosystem are different concepts, but they are linked and not mutually exclusive (Xu and Maas, 2019). In fact, despite the nuances among them, it is possible to note some relevant shared features regarding to the complex interdependency among actors and as a consequence, the need for a holistic approach to analyze the evolution of the system and to evaluate its performance.

From the beginning, the innovation ecosystem approach has been mainly based on the premise that the user is beyond doubt so it is mostly focused in the supply side (Scaringella and Radziwon, 2018), in contrast with the business ecosystem that explicitly includes a demand side. In addition, although part of the confusion about the term is due it has been applied in both geographical and non-geographical contexts, the notions of innovation and entrepreneurial ecosystems are mostly linked to some specific geography mainly at local or regional but also at national level (spatial dimension) being an essential part of the ecosystem the dynamics interactions and relationships between the different stakeholders of the ecosystem pursuing value (temporal dimension) (Valkokari, 2015; Ritala and Almpantopoulou, 2017).

On the other hand, innovation use to be linked to the entrepreneurial process (Drucker, 1985b), so entrepreneurship is at the heart of the innovation ecosystem. The main difference is that the latter includes the role of large companies (emergent and/or incumbents) both in the supply and the demand side within the innovation process and as a key bridge between entrepreneurial and innovation ecosystems (Autio and Cao, 2019); while the concept of entrepreneurial ecosystem is narrower and refers basically to those geographies in which (innovative) entrepreneurial activity flourishes (Mason and Brown, 2014).

2.4 The need for more analysis and a new theory

As previously introduced, the first mentions of the term ‘entrepreneurial ecosystem’ appears in the work of scholars such as Boyd Cohen (2006) and Paul Bloom and Gregory Dees (2008). Those works already considered policies as a key constituent of the ecosystem; however, they fail to provide any analysis beyond. At the time, policies are typically mentioned as a type of boundary condition that is linked to the role of governments in the ecosystem—consisting mainly of a generic, conducive climate where sustainable businesses can thrive—but hardly any particular recommendation is suggested. As previously mentioned, the notion of entrepreneurial/entrepreneurship ecosystems and the analysis attached to it gained popularity after Daniel Isenberg’s article *How to Start an Entrepreneurial Revolution?* (Isenberg, 2010b). There, again, policies and the role of governments were outlined. In fact, it included a rather comprehensive list of advices that focused on removing structural barriers and other aspects such as culture or education in which policies do play a role. However, there is a lack of a more structured analysis about the public policy rationales and their link to future policy measures.

Since those seminal contributions, the entrepreneurial ecosystem is an increasingly widespread concept, and a number of academic papers and reports from international organizations and institutions, have defined and referred to it, either and specifically or in part, looking into the policies within the ecosystem. These contributions agree on the critical role of the policy domain in setting the framework conditions for the development of entrepreneurship. Among the features of such policy domain are as follows: (i) small business regulation; (ii) taxation schemes; (iii) labour market; (iv) education; (v)

support infrastructures, including finance; and (vi) the promotion of role models and measures to reduce the entrepreneurial risk¹³.

However, as introduced in the section 1.3.2., the study of the policy domain is still in its early stages from a research and policy perspective. From the review in this thesis, it is possible to outline two main streams of limitations.

On the one hand, there is a range of controversies about how the policy interventions should be configured and also about which are the rationales and justification some authors provide recent suggestions for much needed innovative policy approaches (Autio and Levie 2017). To this respect, Erik Stam (2015) reflects on the need for a shift in thinking about the rationales for policy, from market and or systemic failures correction to a wider policy scope in which public government, as part of an entrepreneurial ecosystem of stakeholders, can play an important role as a ‘feeder’ of the ecosystem, for example in adjusting laws and regulations. From the policy perspective, no explanations are provided, in general, on why moving on from one type of policy to the next, nor are there any structured studies on the evolution of such policies, especially in Europe. In addition, the studies on the topic were largely based in Western economies’ cases (Cai, 2014).

On the other, entrepreneurship policy as a research field is under-investigated (Rosa, 2013; Mazzarol and Volery, 2015) even though policies have been acknowledged as part of the relevant context for entrepreneurship (Welter, 2011) and the policy dimension has been identified as one of the key elements of the entrepreneurial ecosystem (Mason and Brown, 2014; Stam, 2015). Although policy domain has attracted the interest of the academia, international organizations and practitioners in general, there is not enough granular analysis on the evolution of this agenda able to identify main themes and foundational concepts, establishing patterns and finding temporal relations between different approaches and geographies.

Therefore, there is still room to improve the understanding of the dynamics of the entrepreneurial ecosystem, both from the research and the policy perspective. In fact, from the literature review conducted is possible to identify three main conclusions related to the research gaps around the entrepreneurial and innovation ecosystem approach:

¹³ Along these lines and as a main example, the Innovation Policy Platform (IPP) is an on-going initiative—developed by the World Bank and the OECD—with the aim of facilitating knowledge on how innovation systems operate. Moreover, it is a space where institutional users from different regions can share good practices. It contains a specific section about the policy rationales and objectives for innovative entrepreneurship, a comprehensive explanation about the main market and system failures, and specific scenarios that require policy intervention. Available at: <https://www.innovationpolicyplatform.org/>

- The increasing adoption of the ecosystem approach both by academics and practitioners has also generated discussion and controversies, mainly around the definition of the concept and the doubts about the value added with respect to the ‘system’ antecedent (Oh, Phillips, Park, & Lee, 2016; Ritala & Almpanopoulou, 2017).

Much of the discussion of entrepreneurial ecosystems has lacked a time dimension (Mason, Colin; Brown, 2014; Stam, 2014b) and, as a consequence, the existing explanatory frameworks are useful as a general taxonomy of domains but not as a representation of the role and impact in the entrepreneurial activity of a given place over time.

- There are several shortcomings when studying innovation ecosystems (E. Autio & Llewellyn T., 2014) and entrepreneurial ecosystems (Audretsch, Mason, Miles, & O’Connor, 2018), especially due to the inability to provide a structured analysis of the interactions among stakeholders within the ecosystems; their dynamics and to depict the casual path to enhance innovative and/or entrepreneurial activity, and, in particular, about the role of policy.
- Closely linked to the previous point, while it is commonly accepted confirmed that policy domain is one of the most relevant research topics related to the entrepreneurial (and innovation) ecosystems but the policy domain is understudied and the policy interventions has been controversial, especially in Europe.

3 METHODOLOGY

This chapter describes the methodological approach and choices adopted to address the research objectives of the thesis. After presenting a general overview, section 3.2 frames the research philosophy followed among the different theoretical approaches. Then, section 3.3 details the research design and the different stages followed to obtain the results and outcomes of the thesis. Finally, section 3.4 describes the data collection and analysis techniques used during the three phases conducted during the investigation.

3.1 Methodology overview

In general, the research methodology illustrates about the process followed and the decisions adopted to address the research questions set by an investigation. For this reason, the methodology allows the external evaluation about the reliability of a research.

This section is based on the research onion approach as a framework to depict the research methodology adopted along this study, as presented in the Fig. 6. This is a widely adopted model developed by Mark Saunders, Adrian Thornhill, Philip Lewis (Saunders, Lewis and Thornhill, 2009). The onion metaphor is used to describe the range of coherent steps through which a researcher should develop a methodology in an effective way. The idea is taking the consecutive decisions and choices from the outer layer to the inner and more specific layer. In particular, from the research philosophy to the approach and methods, then the strategy, the time horizon and finally the particular data collection techniques and procedures.

Fig. 6 - This thesis under the glasses of the research onion model. Source: own elaboration adapted from Saunders et. al (2009)

3.2 Research philosophy

To conduct an investigation, researchers have to evaluate a range of assumptions and choices that, in turn, are linked to the way on how these researcher/s see the world. Precisely, a research philosophy is referred to the set of beliefs concerning to the nature of the reality being investigated (Bryman, 2012). Hence, a research philosophy is related to the nature of the world, the role of the individual in it and the potential relationships among them in terms of the investigation. In practical terms, the decision about the research philosophy of the research use to be determined by the type of knowledge being investigated.

Research philosophy could be framed according to two main areas of philosophy: ontology, the field dealing with the nature of the world and/or reality; and epistemology, the area related to the investigation on which are the most valid way/s to understand this world / reality. Therefore, while ontology answers questions such as ‘what is’ or ‘what can be said’, epistemology is focused on ‘how (to investigate)’.

In this context, there are a range of research philosophies usually adopted in social sciences. Following the Sauders’ research onion framework, positivism and interpretivism represent two opposite extremes. While positivism considers social phenomena have an objective existence that is independent of social

actors, interpretivism understands that reality construction depends on the subjective perceptions of the social actors.

In the middle of the two former approaches, there are a variety of nuances. On the one hand, realism is a philosophical approach close to positivism in the sense that considers reality is independent of the researchers' perceptions. The main difference among them is that realism considers that researcher is influenced by his /her own experiences. On the other hand, pragmatism is closer to interpretivism. Pragmatism considers that there is multiple realities and practical consequences derived from the research findings. And conversely to other research philosophies, pragmatism allow adopting a non-single research strategy (deductive and / or inductive) and multiple research methods in the same study (both qualitative and/ or quantitative).

It should be noticed that there is no a 'better option' related to the choice of the research philosophy. Conversely, it provides a conceptual argument for the methodology used in the a particular investigation, that is obviously conditioned by the nature of the phenomena under research.

Based on the goals of this thesis, a pragmatism research philosophy has been considered as the most appropriate. Entrepreneurial and innovation ecosystems and how public policy could have role on their construction cannot be fenced to a single research strategy/method since they coincide with the idea of multiple realities. In addition, mixed methods are the most suitable to study the different realities in disparate contexts such as those in this study (European Union and China). And, consequently, a range of different data collection and analysis techniques should be considered since availability and reliability of the sources depends largely on that context. As an example of this particular case, the availability and also the ability to process policy documents related to entrepreneurship it is not a restriction in the case of European Union, but it could represent a barrier in the case of China, so it is needed to apply mixed methods adapted to each reality.

3.3 Research design, approach and methods

In practical terms, the study is divided in three consecutive phases combining a deductive approach with a range of mixed research methods due to the exploratory approach necessary for the analysis and the need of combining different data sources to complete it. An overview of the research design and structure of this thesis are shown respectively in the Fig. 6 and the Fig. 2, with three consecutive phases.

As introduced in the two initial chapters of the thesis, even though the increasing attention on entrepreneurship as a strategic driver of progress, entrepreneurship as a policy field and related research are both still in their early stages. Therefore, this thesis sets an initial exploratory stage to study the evolution of the field from the point of view of the academia. Academic research into entrepreneurship policy is particularly interesting due to the increasing relevance of the topic and the limited knowledge

about its evolution. The purpose of this first phase is to obtain an overview of the research narratives in the field by obtaining key concepts, topics, trends, gaps and shifts that have shaped the entrepreneurship policy research agenda since 1990. The analyses also include geographical particularities. Understanding the scientific structure of the entrepreneurship policy field constitutes the first step to place further research on particular contexts.

After that, the second and third phases of the analysis go deep on the analysis of particular contexts, the European Union and China, as representatives of two different socioeconomic systems in an era of globalization. Their approaches to entrepreneurship and innovation have been (and continue to be) radically different. As a consequence, the analyses in each case use different data sources and procedures. In fact, the availability and reliability of the data sources depending on the context and the different periods for the analysis are also significant justifications to adopt mixed methods.

3.4 Data collection and analysis

Phase 1 – Academia (sample – data collection – data analysis)

The initial phase of the study is exploratory and adopts a deductive approach. It aims to explore the key topics, gaps trends and shifts that have shaped the entrepreneurship policy research agenda to date, considering that knowledge about the evolution of the field is still limited.

Mapping research on entrepreneurship policy allows to provide a retrospective view of the emergence and configuration of the intellectual framework in the field, laying the ground for the following phases. In addition, results help to depict the geographical configuration of the field in the search for particular interests depending on the context.

To accomplish these objectives, a range of text mining techniques has been applied to a significant corpus of scientific papers related to entrepreneurship policy. The exploratory nature of text mining permits the extraction of new knowledge from a large amount of unstructured (text) data and it is suitable for the purpose of this phase.

Text mining analysis

Text mining and/or text data mining are a category of data mining techniques. Like data mining, text mining aims to discover new knowledge or hidden patterns from large amounts of data (Delen and Crossland, 2008).

The particularity is that text mining processes natural language text or textual content instead of structured regular data, so it requires some pre-processing tasks. The most common goals of text mining are natural language processing and text representation, concept/entity extraction, search and information retrieval, web mining, information extraction, document classification/ categorization,

document clustering and sentiment analysis (Miner et al., 2012). This phase of the thesis concentrates on concept extraction, document clustering and document classification.

The general workflow of text mining is shown in the Fig. 7.

Fig. 7 - General workflow of text mining. Own elaboration from Miner et al. (2012).

Particularly, this section describes how text mining is applied to achieve these objectives:

- (i) The text data collection and the formation of the corpus of academic papers, that is, the sample under study;
- (ii) The pre-processing tasks to transform the unstructured text data into structured data;
- (iii) The specific text mining techniques and choices using during the analyses.
- (iv) And, finally, the software used to do it.

i. Text collection and definition of the corpus (sample)

The analysis at this initial stage considers a representative selection of literature that explicitly refers to the views of academia on entrepreneurship policy. This sample under analysis is named as corpus Academia. In particular, the corpus consists of a selection of 1,048 articles from ten significant academic journals in the field during the period 1990–2016.

The process to form the corpus is detailed as follows. The corpus Academia is formed by all the policy-based articles from ten academic journals related to entrepreneurship research which are being published from at least the 1990s onwards and have been always ranked in the first or second quartile of the Scopus index. Although all of the entrepreneurship policy literature was not analyzed, the ten journals included

are considered to be representative of mainstream research on the field entrepreneurship. The distribution of papers per journal is shown in Table 1.

An initial search¹⁴ in these journals generated 1,190 items related to policy—1,048 articles, 92 reviews, 26 articles in press, 15 conference papers, and 9 editorials and errata. Following a similar approach than other text mining studies (Basole et al., 2013; Chang and Katrichis, 2016; Ngai and Lee, 2016), the analysis in this thesis considers only the 1,048 scientific articles, corresponding to 1,339 author affiliations, excluding the other items to guarantee higher level of rigour. Fig. 8 shows the distribution of published articles per year. The evolution of the number of papers over the years indicates a growing number of articles in the journals under analysis, especially since the mid-2000s.

Table 1 - Journals included in the sample (1990–2016). Source: own elaboration

Journal	Number of articles in the sample	Scopus SJR	Scopus H Index
Technovation	292	1,738	102
Small Business Economics	240	2,116	98
Entrepreneurship and Regional Development	174	1,581	69
Journal of Business Venturing	85	5,513	140
International Business Review	82	1,180	73

¹⁴ Results from a query in Scopus database on 30 March 2017. In particular, the query used to retrieve all the documents related to policy and published in those ten journals during 1990-2016, was:

```
[TITLE-ABS-KEY ( policy ) AND ( LIMIT-TO ( DOCTYPE , "ar " ) ) AND ( LIMIT-TO ( PUBYEAR , 2016 ) OR
LIMIT-TO ( PUBYEAR , 2015 ) OR LIMIT-TO ( PUBYEAR , 2014 ) OR LIMIT-TO ( PUBYEAR , 2013 ) OR LIMIT-
TO ( PUBYEAR , 2012 ) OR LIMIT-TO ( PUBYEAR , 2011 ) OR LIMIT-TO ( PUBYEAR , 2010 ) OR LIMIT-TO (
PUBYEAR , 2009 ) OR LIMIT-TO ( PUBYEAR , 2008 ) OR LIMIT-TO ( PUBYEAR , 2007 ) OR LIMIT-TO (
PUBYEAR , 2006 ) OR LIMIT-TO ( PUBYEAR , 2005 ) OR LIMIT-TO ( PUBYEAR , 2004 ) OR LIMIT-TO (
PUBYEAR , 2003 ) OR LIMIT-TO ( PUBYEAR , 2002 ) OR LIMIT-TO ( PUBYEAR , 2001 ) OR LIMIT-TO (
PUBYEAR , 2000 ) OR LIMIT-TO ( PUBYEAR , 1999 ) OR LIMIT-TO ( PUBYEAR , 1998 ) OR LIMIT-TO (
PUBYEAR , 1997 ) OR LIMIT-TO ( PUBYEAR , 1996 ) OR LIMIT-TO ( PUBYEAR , 1995 ) OR LIMIT-TO (
PUBYEAR , 1994 ) OR LIMIT-TO ( PUBYEAR , 1993 ) OR LIMIT-TO ( PUBYEAR , 1992 ) OR LIMIT-TO (
PUBYEAR , 1991 ) OR LIMIT-TO ( PUBYEAR , 1990 ) ) AND ( LIMIT-TO ( EXACTSRCTITLE , "Technovation " )
OR LIMIT-TO ( EXACTSRCTITLE , " Small Business Economics " ) OR LIMIT-TO ( EXACTSRCTITLE , "
Entrepreneurship And Regional Development " ) OR LIMIT-TO ( EXACTSRCTITLE , " Journal Of Business Venturing " )
OR LIMIT-TO ( EXACTSRCTITLE , " International Business Review " ) OR LIMIT-TO ( EXACTSRCTITLE , "
Organization Science " ) OR LIMIT-TO ( EXACTSRCTITLE , " Journal Of Small Business Management " ) OR LIMIT-
TO ( EXACTSRCTITLE , " Academy Of Management Journal " ) OR LIMIT-TO ( EXACTSRCTITLE , " Journal Of
Management " ) OR LIMIT-TO ( EXACTSRCTITLE , " Academy Of Management Review " ) )]
```

Organization Science	49	7,151	196
Journal of Small Business Management	42	1,504	85
Academy of Management Journal	37	11,053	266
Journal of Management	33	6,353	176
Academy of Management Review	14	9,056	229

Source: Scopus SJR and Scopus H-Index retrieved from SCImago Journal Rank 2015. For the purpose of the analysis, journals under study have been always placed within the Q1 and Q2 in their respective subject categories since 1990s. More information available at: <https://www.scimagojr.com/journalrank.php?year=2015>

Fig. 8 - Evolution of the total number of articles related to entrepreneurship policy within the ten journals analysed. Source: own elaboration.

The corpus derived from these articles consists of merging document titles, abstracts and keywords that are the most common summaries in scientific papers (HaCohen-Kerner, 2003). This approach for the analysis of academic papers is a standard and broadly used approach in text data mining and bibliometric studies (Felizardo et al., 2011; Glanzel, 2012; Liu et al., 2010). It is also customary not to include the conclusions section, as it is thought that the title describes the main theme of the paper, the abstract is a good summary of the background and the results, and keywords consolidate the essence of the content. In addition, the editorial and peer review process of these journals ensures their quality, so this choice is a fair representation of the articles.

ii. *Pre-processing and stemming processes*

The corpus comes from electronic textual documents: they are unstructured content requiring at least two sets of preparatory processes before the text mining analysis, specifically, a set of pre-processing tasks and then a stemming process.

Following standard practices in text mining (Miner et al., 2012), the pre-processing tasks in this thesis include: (i) tokenization of the document to chop it into indivisible words/phrases pieces or ‘tokens’. These tokens can be defined as a sequence of characters in a particular text that are gathered as semantic units for processing, typically forming a term or a word; (ii) data cleaning to remove certain characters without meaning, such as punctuation, non-alphanumeric characters and numbers; (iii) normalization, to convert words to lower case; (iv) filtering out general English stop words, such as articles, pronouns or prepositions, since they are the most common words and contribute little to the overall meaning. To this end, it is necessary to compare the set of tokens to a predefined dictionary;¹⁵ and (v) filtering out those tokens that contain fewer than a certain number of characters, in the case of this analysis three characters. The output of these five preparatory steps is a tokenized corpus that, in turn, needs to be stemmed.

Stemming is the process of removing affixes from a word and grouping those words with a common root to obtain stem words. As an example, singular and plural nouns and verbs with different conjugations are reduced respectively to the same root (stems). The analysis within this research applies the Snowball English Porter stemmer, an advanced version of the Porter stemmer (Porter, 2001). This is one of the most common stemming algorithms in the field of text mining. It is basically a truncating method based on the idea that the suffixes in the English language are mostly composed by grouping smaller and simpler suffixes and, for this reason, they can be removed under certain conditions while remaining meaningful.

iii. Data analysis: text mining techniques

For the selection of methods and techniques applied in the analysis, robustness and maturity have prevailed as criteria over other most recent and less tested options.

Preliminary results

After these preparatory processes, the text mining workflow begins. The first step is to convert the unstructured text data into structured data by creating the word vectors that numerically define the documents from the tokens. To this end, this research uses term frequency-inverse document frequency (TF-IDF), a statistic that measures the relative relevance of a word in a document from a corpus. The TF-IDF value for each word in a document is proportional to the number of times a word appears in the document, but it is offset by the percentage of documents in the corpus that contain the word. This helps

¹⁵ This pre-built list is provided by RapidMiner and is formed of 452 English common terms such as ‘the’, ‘now’ or ‘yourself’ that are not relevant for the analysis. The whole list is configured as a Java class of the library WV Tool. See: <https://sourceforge.net/projects/wvtool>

to evaluate the real relevance of a word considering that, in general, some words appear more frequently than others but are not necessary more meaningful. As a result, the process obtains a matrix formed by word vectors representing the relationship between words and documents through their TF-IDF values.

The first analysis within the research is examination of the most repeated concepts within the Corpus Academia as a whole, considering the whole period 1990–2016 and also in five-year terms. Five-year frames have been noted as a fair trade-off between gathering relevance and avoiding bias in previous studies of entrepreneurship and management fields (Gamboa and Brouthers, 2008; Werner and Brouthers, 2002). As an additional analysis, the research examines the most relevant words considering three regional sub-corpora, distinguishing those articles authored in the European Union (EU), the United States (US) and South and Eastern Asia (SE Asia), respectively. In addition, a specific analysis by countries in the case of EU is included in the Annex 3.

Cluster analysis

The next step of this text mining process is the cluster analysis of the corpus. Clustering is an exploratory analysis aiming to split data into groups of similar instances (Berkhin, 2002). In the particular case of text mining, clustering divides a collection of documents into coherent groups with similar content clusters (Hotho et al., 2005; Manning et al., 2009). To do this, clustering algorithms aim to optimize the resulting partition by minimizing inter-cluster similarity and maximizing intra-cluster similarity, often measured with a distance function. There are therefore two key aspects to decide to conduct a cluster analysis: the similarity function and the clustering algorithm itself.

For the purpose of the analysis, the euclidean distance is used, being one of the most extensively used techniques for normalized vectors (Hotho et al., 2005; Jain, 2010), including clustering text (Irani, Pise and Phatak, 2016). Clustering algorithms can be divided into different categories, being partitioning and hierarchical the most common methods (Rokach and Maimon, 2005). Considering the size of the sample, a partitioning approach is more suitable for this analysis, and more specifically, K-means, considered the standard algorithm, is selected. This algorithm remains as one of the most popular clustering methods and is widely used since presents a good trade-off in terms of effectiveness (clustering performance) and efficiency (computational requirements)(Jain, 2010; Gaikwad, Chaugule and Patil, 2014).

The functioning of k-means can be summarized as follows. It begins by choosing k initial centroids or cluster centres; then documents (items of the collection) are assigned to the nearest of these k centroids, aiming to optimize the similarity function. In this case, the goal of k-means is to minimize the average squared Euclidean distance of documents from their respective centroids. Then, new centroids are calculated according to the new distribution. The process is repeated until there are no changes among the cluster centroids, or the maximum number of iterations is reached. Note that the result can vary

depending on the initial assignation of centroids (seeding). For this reason, this thesis has used a randomized seeding technique with a maximum of fifteen iterations with random initialization of the start points.

K-means requires the number of clusters as an input parameter that must be assigned beforehand. A range from 4 to thirteen has been used, testing the potential bias of this a priori choice. The more suitable number of clusters has been selected combining expert knowledge (qualitative criterion) and a quantitative approach. For this, the Davies-Bouldin metric has been evaluated for every value of k , considering that a lower Davies-Bouldin index¹⁶ value means a better clustering result.

iv. Software

RapidMiner¹⁷ has been the baseline software to conduct the different text mining analyses of the thesis. RapidMiner is an open source platform that supports multiple applications on the field of data science as for example the text analytics add-on extension that have been used in this research. Some of the advantages of RapidMiner are the existence of a wealth of official documentation and a well-structured online community, the availability of a copyleft license and the possibility of combine and extends its use with Python or R scripts.

The analyses have been complemented with Microsoft Excel.

Phase 2 – EU policy (sample – data collection – data analysis)

The next steps of this thesis aim to examine how public policies could influence positively or negatively on the consolidation of entrepreneurial ecosystems where high-growth entrepreneurship flourishes and potential linkages with the ecosystem approach.

Building on the results of the phase 1, this second phase studies the policy domain within a specific region, the European Union, where the entrepreneurship-support has been controversial. Particularly, the goal is to examine the generation of entrepreneurship policies aiming to understand which are their key constructs, establishing appropriate stages for coherent sets of policies and, above all, determine which was the learning path that took to the next strand of policies.

¹⁶ The Davies-Boulding index (Davies and Bouldin, 1979) is a metric to evaluate clustering partitions, suitable for cases as k-means where the value of k is not known a priori (Arbelaitz et al., 2013).

¹⁷ More information and download available at: www.rapid-i.com.

Under these premises, this second phase contributes to bridge the existing gap on how the EU entrepreneurship policy agenda has emerged and evolved in terms of the European Commission policy cycle, considering that a new College of Commissioners is appointed approximately every five years¹⁸.

In practical terms, the analyses in this second phase is also deductive and based on text mining techniques. It has been designed to be comparable with the results obtained within the phase 1. This permits to analyze of the academic synchronous research knowledge in the field to try to establish potential links of influence between EU policymaking and academia. Besides, this is expected to contribute to the debate about the knowledge utilization in policymaking, taking into account that particularly in Europe the institutional interest in entrepreneurship seems to be driven partly the research in the field (Welter & Lasch 2008).

Text mining analysis

As presented above, the analysis during this second phase are based on the same text mining workflow showed in the Fig. 7 and described in the section 3.4.1. with the only difference related to the text collection and definition of the corpus (sample) for the analysis.

i. Text collection and definition of the corpus (sample)

This second phase considers as a corpus (sample) under analysis a comprehensive selection of literature that refers explicitly to entrepreneurship policies in the European Union named as EU Policy. Particularly, corpus EU Policy is composed by all the European Commission Communications (EC Communications) related to entrepreneurship or startups within the period 1990-2016.

Despite the fact that there are several EU bodies and institutions that produce a wide range of documents, the EC Communications embody a very representative image about the EU views and insights on a particular topic.

¹⁸ For the period 1990–2016, the EC cabinets has evolved as follows:

Commissions led by Jacques Delors (January 1985–December 1994, divided into three consecutive periods: 1985–1988, then 1988–1992 and, finally, 1992–1994);

- Commission led by Jacques Santer (23 January 1995–15 March 1999), with a short interim presided over by Manuel Marín, following the resignation of Santer;
- Commission led by Romano Prodi (September 1999–October 2004);
- Commissions led by José Manuel Durao Barroso (November 2004–October 2014, divided into two consecutive periods: 2004–2009 and 2009–2014);
- Commission led by Jean Claude Juncker (November 2014–present day and is due to serve until 2019).

Source: https://ec.europa.eu/info/about-european-union/organisational-structure/how-commission-organised_en

The EC is defined as the ‘politically independent institution that represents and defends the interests of the Union as a whole’, and the executive branch of the EU that ‘proposes laws, policies, agreements and promotes the Union’ (European Union, 2014). In this sense, the EC holds the monopoly to set down policy proposals (Arndt Wonka, 2008) so it plays a leading role setting the agenda of the EU by defining and bringing together the policy vision of the EU in any particular field, as it is the case of entrepreneurship. From the range of the EC policy documents, the EC Communications are those that establish ‘its thinking on a topical issue’ (European Judicial Network, no date) Although they do not have a mandatory authority or a legal effect, they are used by the EC to set out thoughts and its action plans about different topics in each moment and to promote a common basis for the joint decisions of Member States. They are also typically the base for follow-up initiatives such as *Recommendations* or *Directives*.

In practical terms, this corpus consists of a total of 576 EC Communications. An initial search of the EC policy documents reported 2,120 results. After discarding those that were different from EC Communications, 708 documents were retained. These documents have been manually filtered to remove duplicates and also documents that do not contain any real reference to entrepreneurship in spite of mentioning the term. Finally, the corpus is composed of 576 EC Communications, representing 16.35% of the total EC Communications of the period considered. Fig. 9 shows the distribution of EC Communications per year. A similar analysis has been conducted considering the yearly percentage of EC Communications related to entrepreneurship with respect to the total number of EC Communications. Results are shown in the Fig. 10.

Fig. 9 - Evolution of the total number of EC communications related to entrepreneurship and start-ups per year within the period 1990–2016. Source: own elaboration.

Fig. 10 - Percentage of EC communications related to entrepreneurship per year with respect to the total number of EC communications. Source: own elaboration.

In general, EC Communications do not contain a summarized section which was representative of the full content of the documents similar to the abstract of academic papers. For this reason, corpus EU Policy includes the entire text of each of the documents.

The analyses have been developed considering the whole period, 1990–2016, and also examining five-year terms since 1990, with the exception of the last period (2015–2016), which only comprises of two years. This choice is based on the typical EU policy cycle, considering that a new college of Commissioners is appointed approximately every five years and aiming to be comparable with the results of the phase 1.

The rest of the stages of the text mining process (ii. preprocessing and stemming process, iii. Data analysis: text mining techniques – preliminary results, text mining techniques and iv. software used for the analysis –) have been already described within the section 3.4.1.

Phase 3 – AI (and EdTech) ecosystem in China (sample – data collection – data analysis)

The phase 3 analyzes the role of policy when developing innovation and entrepreneurial economies in planned economies, studying the paradigmatic case of China. In particular, the objective of this phase is to further enhance the understanding of how governmental initiatives work as innovation engines in the industry, especially in planned economies, using the example of AI (and EdTech) in China.

As previously introduced, the approach, time frame for development and availability of data sources are completely different as in the case of the European Union, so it has not been possible to study the using text mining techniques due to two main reasons. First, a representative sample of policy documents related to China and written in English is not available. And second, linked to that, as the researcher is not able to understand Chinese, it is very difficult to conduct a reliable text mining analysis considering that many choices and decisions during the analysis are connected to the meaning of the terms. Therefore, case study has been considered as the appropriate method in this phase, given the complexity of studying the context of China.

Based on this premises, an extended case study have been developed as a realization of the ecosystem theory in this context. Also following a deductive approach, the analysis proposes a revisited asymmetric Triple Helix (ATH) model for the qualitative analysis of the AI innovation ecosystem; and, as an extension, the examination of key insights of the EdTech ecosystem. The ATH model in this thesis is an evolution of that developed by Cai (2013), adding insights from the particular institutional logics in China, as presented in the following sections. This ATH model is an original contribution of this thesis for the analysis of the innovation ecosystems in the case of China.

In practical terms, it is based both on an in-depth document review and on interviews with experts. This approach based on case study also stress how a qualitative perspective is useful to tackle the complexity in emerging environments of innovation and allow the extraction of insights and gaps that are not directly available from a quantitative analysis of the ecosystem. In addition, it also shows that qualitative methods are an alternative and/or a complement to quantitative analysis in those ecosystems in which the availability of up-to-date statistics is limited, as in the case of a rapidly changing environment such as the innovative industries in China.

Sample – Case studies

The study of the innovation ecosystem has been developed through and extended particular case study about the ecosystem of artificial intelligence (AI) and EdTech.

The choice of this extended case study is threefold: first, these are two of the more innovative industries in China but the knowledge about the real performance and future perspectives are still limited; in addition, they are strongly connected since AI is the most prominent technology used in EdTech solutions; and finally, it is also due to practical reasons as the researcher has been involved in two reports for the European Commission about these two innovative industries during the thesis period. Key insights to contextualize AI and EdTech respectively are provided below.

AI and EdTech in China

AI has definitely evolved from being just a technological fancy trend to become an international field of competition, and the major role of China is beyond any doubt.

This new paradigm has been possible thanks to the consolidation of several key technological enablers.¹⁹ Despite the existence of important limitations to AI today, for example it is very narrow – domain specific – and does not display the general-purpose reasoning capability of humans (Kelly, 2017), experts and analysts refer to it as a new industrial revolution in its capacity to change economy and society. It is poised to change not only the way in which we think about productivity or our relationship with our environment but also elements of national power. Just as past industrial revolutions transferred power to the more industrialized nations, AI can be a similar game changer at the international level (Bughin *et al.*, 2018).

In this context, several nations have specific AI strategies, and policy makers from around the world (NESTA, 2019) and international organizations such as the OECD²⁰ have demonstrated great interest in supporting a broad adoption of AI while managing the potential risks and challenges, balancing innovations and social protection. This global trend is largely led by the two largest technology players, the US and China, two superpowers competing for AI world hegemony (Renda, 2019), with the EU, South Korea, and Japan as next, but minor, contenders.

In the case of China, it presents some particularities that direct even greater attention to AI. Firstly, at macroeconomic level, the development model followed by China has evolved, becoming a leading force

¹⁹ (i) The exponential growth of data – coming mostly from the Internet of Things (IoT) – that can be used to train learning machines, combined with (ii) more powerful computer processing capabilities that can be used for deep neural networks and other learning techniques and with (iii) advances in the algorithms that can make machines very effective at solving a variety of problems across industries.

²⁰ Information about the OECD initiatives is available at <http://www.oecd.org/going-digital/ai/>.

in the digital economy. AI plays a key role aiming to overcome the physical limitations of capital and labour as a new way to generate growth.

Nevertheless, there are other interests beyond mere economics. China's recent role as a major global power demands reforms to adapt the established international multilateral system to its new needs. Schemes such as the Belt and Road Initiative or institutions such as the Asian Infrastructures Investment Bank can therefore be seen as instruments through which China can shape a geopolitical environment that is more favourable to its interests (Delage, 2017). Digital technologies – and again AI in particular – are essential components of this strategy, showcasing a new, wholly domestic, independent, and cutting-edge industry and a technology-based approach to economics and politics with a different slant from the West. The strict application of national laws to cyberspace or the usage of AI-related technologies to contribute to social harmony are prominent examples of this differentiated approach in China context which in turn demands for an in-depth investigation.

For the purpose of this document, EdTech is simply considered as the use of new technologies in and around the education system. New technologies in EdTech usually encompass AI, IoT, robotics, big data, cloud computing, blockchain, and biotech. Nowadays, the most prominent of them within EdTech is AI, in particular in China as the projects examined in this document prove.

AI in education refers mostly to the modelling and eventual replication of human perception, cognition, reasoning and decision-taking. From a technical perspective AI in education includes neural networks, computer vision, automated reasoning, knowledge-based systems, natural language processing, evolutionary and genetic computing, and ontological, reinforcement, adversarial and machine learning.

Beyond these high-level insights into the Chinese success factors and the general agreement considering China as a paradigm when mapping global approaches to AI and /or EdTech, research works analysing the development of AI in China is limited. And, in fact, there is still a gap between the mainstream discussion around the role of China in AI and EdTech and the knowledge about who the key stakeholders are and which of their relationships configure the landscape in both fields in China.

Model for the analysis: a revisited ATH

As explained in the chapter 2, the Triple Helix model (Etzkowitz and Leydesdorff, 2000) can be seen as an explanatory tool to both depict an existing innovation ecosystem and the main players and roles within, and address additional insights about the evolution of the ecosystem through the study of their activity, dynamics and interactions. The following subsections examine (i) the specificities the Chinese context and review previous approaches in the literature; and (ii) propose a particular model for the analysis of this phase.

i. *Triple Helix Model in China context*

Based on centralism,²¹ China presents key socio-economic particularities that should not be neglected from an ecosystem perspective, as presented in the introduction. First, the possibility of establishing national boundaries, contrary to the commonly accepted proposition that ecosystems are not limited to national and/or regional contexts (Tsujimoto et al., 2018). It is also worthy to emphasize on the key role of the governments in China, not only as legislators and regulators, but also providing data, venture capital, structuring human capital, choosing winners and purchasing, particularly in the AI domain. And this process happens top down from national to regional and local governments, but also leaves room for experimentation at the regional and local levels as it will be later detailed.

On the other hand, while a number of studies have applied the TH model in China context (e.g. Lu and Etzkowitz, 2008; Zhang, Zhou, Porter, Gomila, and Yan, 2014; Zhou, 2008; Jongwanich, Kohpaiboon, and Yang, 2014), the particularities subsequently demanded for a revised Triple Helix model to reflect China's context (Cai, 2014). As Yuzhuo Cai summarized, 'the Triple Helix is indeed the solution for China, but to achieve the end the road is hard due mainly to some unique characteristics of the Chinese context' (Cai, 2014, p. 3). These differences refer not only to the economic structure and organization issues but also broad aspects such as the political system, culture, and social norms. Derived from those reflections and drawing from Etzkowitz's approach (2008),²² Cai suggested a specific TH model by adding insights from the particular institutional logics in China. The result is a 'delayed government-led model' that represents an evolution of the previous characterization of the TH relationship between university, industry, and government in China as a statist model (Etzkowitz & Zhou, 2006).

Cai and Liu's (2014) TH model is primarily based on the case study of Tongji University Creative Cluster in Shanghai, China. In their work, the initial interactions took place between the university and the surrounding industry (mainly university spin-offs) and were spontaneous. While such university-industry collaborations were encouraged by national policies, governments at different levels were not

²¹ China's constitution defines its political system as a 'people's democratic dictatorship' aiming to develop a 'socialist market economy'. Available at http://www.npc.gov.cn/englishnpc/Constitution/2007-11/15/content_1372962.htm

²² According to Etzkowitz (2008), the triple helix is configured on three levels, the two first approaches being preliminary stages for the real innovation helix:

1. In the first stage or *statist model*, the government rules the relationships between academia and industry. Common examples are the traditional approach of countries in LATAM, the URSS, or even France.
2. In the second stage or *laissez-faire* model, the three actors are relatively independent and industry is the driving force. Sweden and the US are common examples of this approach.
3. In the third stage or *balanced* model, which is an evolution from the two previous approaches with no specific driving force among industry, the government, and academia, all three contribute to the knowledge society.

originally involved. As the cluster grew and conditions changed, the district government got involved as a partner through reflective control. In this second stage, the relationships between university, industry and district government were much like the imbricating Triple Helix model where the three parties ‘overlap and collaborate with each other’ (Cai and Liu, 2015. P.18). As the cluster’s economic and social impact continue to grow, central and municipal government started to get involved. During this stage, with various sources of support provided, central government also incorporated and linked the cluster into the national innovation system. The TH has then evolved to become government-led where different levels of government at central, municipal and district levels took charge of the overall development of the university and industry cluster at particular stages. In a final stage, though the district and municipal governments are still working together with the university, they have also started to take the more traditional role of regulators.

In summary, the government-led model takes into account the dynamic relations among university, industry and government at different levels and provides a suitable explanation on how bottom-up initiatives could be integrated with top-down plans. Thus, the government-led conceptual model proposed by Cai (2013) and Cai and Liu (2014) is used as the base reference to propose the analytical model for the phase 3 of the thesis. This model is revisited, further particularized and discussed in the next subsection.

ii. A revisited Triple Helix model for China’s AI ecosystem

As a summary and for the scope of this thesis, the innovation ecosystem approach permits to address the complexity of emerging environments of innovation to draw meaningful conclusions that are not directly available from other means. Those are the type of challenges involved in analysing the AI industrial ecosystem in China, an ever-changing and many-sided phenomenon located in a complex but particular geography aiming to dominate some key technological industries. Despite presenting some limitations in providing a structured analysis of the interactions among the main actors of the ecosystem, the TH represents an acknowledged framework to describe the relationships between the government, universities, and industry as the main stakeholders. The author considers Cai and Liu’s (2014) TH model is particularly appropriated to describe the innovation context in China, including its particularities, with some adjustments as described in the next paragraphs.

First, Cai and Liu’s (2014) TH model is developed primarily by studying the development of a particular local cluster. However, the development of AI in China carries many singularities which pose questions on whether this model is capable of capturing the complete picture. Firstly, AI is being applied to a whole range of industries (Baccala et al., 2018), and it is better to think about AI not as a discrete type of technology but as a basic enabling technology, like electronics or general-purpose software. Kevin

Kelly suggested that, just as electricity empowered and enlivened all sorts of objects, AI will similarly ‘cognitize’ objects, making them more intelligent and useful (Kelly, 2014). In fact, the impact of AI has been noted to be just as transformative as electricity (Lynch, 2017), but, of course, AI will not only benefit the relationship with objects but will also automatize all types of processes – too complex to tackle previously – either in industry (Cotteleer and Sniderman, 2018) or in service-related economic activities. The ecosystem paradigm has been used to analyse not only firm based-ecosystems but also ‘broad socio-technical regimes’ and ‘industry-crossing economic developments’ (Almpanopoulou, Ritala and Blomqvist, 2019), as is the case of AI (and also in EdTech).

In addition, while Cai and Liu’s (2014) TH model focuses on capturing a regional innovation system, this thesis studies the AI (and EdTech) ecosystem in China from a country and industry level. Two particular aspects should be considered to this respect. Firstly, from researcher’s perspective, the digital success of China is driven by three main factors: (i) a large and young Chinese market, enabling rapid commercialization of digital business models fuelled by strong public and private venture capital funds; (ii) a rich digital ecosystem, expanding quickly beyond a few large companies to emerging start-ups; and (iii) strong government support for companies, universities, and research centres, providing favourable economic and regulatory conditions on three axes: acting as an investor, as a consumer of digital technologies, and as a provider of key data for companies experiencing advantageous conditions. Secondly, although China continues to operate on a centrally planned system,²³ with innovation initiatives following a top-down approach, in many instances, regional and local governments have the mandate to develop their own innovative activities independently from the rest of the country. This situation is an evolution of the traditional cross-regional competition in economic terms (Li, Li and Zhang, 2000).

Altogether, this thesis argue that both the particularities of AI and of China require a revisited approach to Cai’s government-led TH model able to encompass the novelties of this case. As a result, the framework proposed for China’s AI ecosystem is an asymmetric Triple Helix model (ATH) (Fig. 11) in which (i) the central government controls the global context of innovation but provides a certain degree of autonomy to regional, local, and even district governments to conduct their own policy experiments, which could be discarded and/or being extended depending on the results achieved; (ii) the role of the industry is re-examined to highlight larger digital companies, but also the start-ups that commercialize

²³ Since 2014, the Chinese national government has launched a series of key national economic, regulatory, and policy initiatives that touch upon AI with the aim of creating a €13 billion AI market in China by 2018 and making China the world’s leading AI power by 2030.

these new business models, and the finance domain (from both public and private points of view) with a particular mention of venture capital; and (iii) that includes the role of universities and other R&D centres, producing new knowledge and training people.

Fig. 11 - Asymmetric Triple Helix (ATH) model for the AI ecosystem in China. Source: Own elaboration adapted from Cai (2013) and Cai and Liu (2014).

Therefore, the proposed ATH model differs from Cai and Liu's (2014) model in three main perspectives. The first lies on early government interventions. In the TH model, government intervention comes after the initial university-industry collaborations become successful. However, central government sets up strategic plan and pulls together a range of resources to support the development of AI across the country before any AI clusters started to self-emerge. Secondly, regional and local level governments have certain degree of autonomy in designing their own AI related policies rather than just following largely overpowered by central government. Thirdly, the proposed ATH model has an in-built emphasis on

large enterprises, start-ups as well as venture capitals whereas Cai and Liu's (2014) stressed that the one of the characteristics of TH in China lies on the university-owned enterprises which 'integrate several stages of the research, development and commercialization process into one organizational entity, thereby avoiding a long and complicated negotiating process with other enterprises' (p.20), that it is not necessarily the dominant situation in the innovative industries arenas in China.

Data collection and analysis

As previously mentioned, the investigation of the case studies adopts an innovation ecosystem perspective to include and examine all the key players that could have an influence on their respective evolution. To do it, the revisited asymmetric Triple Helix (ATH) model presented in previous section is considered and descriptive research is conducted to validate the ATH model proposal and the domain analysis developed. To this regard, this analysis aims to compile the way in which the AI (and EdTech) innovation ecosystems in China are being built, which are the key features of the three spheres of the Triple Helix -governments, industry and academic/research institutions- as well as the dynamic context of the ecosystem through the identification of main aspects related to the flows of skills, knowledge and funding and the interactions among them.

In practical terms, the methodology followed combines document analysis and fieldwork, undertaken during the period 2017– 2018 in the case of the AI ecosystem and 2019 in the case of EdTech ecosystem. Fieldwork include an in-depth qualitative study and also interviews with experts and relevant stakeholders. Details related to them are described below.

Semi-structured questionnaire

The initial step was building a semi-structured questionnaire to gather expert's vision formed by a total of 32 questions (see Table 2), allowing both open and Likert-scale answers. Experts for the survey were selected from the available contacts in the China AI ecosystem, in particular through China Association of Artificial Intelligence, Chinaccelerator and the main universities devoted to AI in China.

The semi-structured questionnaire was distributed through online invitation by email and WeChat using the surveys' provider Typeform between March and June 2018 to 120 experts approximately equally distributed among the three main areas identified in the framework: government, industry, and universities. As some of the experts participated also in validation events during the elaboration of the study, where reminders were provided on the opportunity of participating in the survey, the response rate of 22% is higher than usual average for online surveys.

The respondents (N=26) comprised significant representatives of key AI stakeholders in China, in particular working on AI in governmental bodies or institutions (N=2), industry (N=18: 8 at large

companies, 2 at small or medium companies, 6 at start-ups, and 2 venture capital), and universities (N=5). Anonymity was offered, and one participant preferred not to specify his or her working domain. The average age of participants was 38 years, 15% were women and 85% men, and the nationality split indicated that 41% were born in China and 59% were foreign professionals with an average of 9 years of working experience in China.

The questionnaire was structured on four blocks: the AI innovation ecosystem's status, challenges and prospects; the AI ecosystem's leading actors, advantages, and disadvantages; AI's future opportunities and threats in China; and personal background, including expertise in 'AI in China'. Despite the limited sample size, the results contributed to identifying the main particularities of the Chinese AI ecosystem to validate the theoretical model that supported the analysis and the stakeholders' relationships, and primarily serves an explorative and illustrative purpose. The survey was dynamic and used an adaptation of the experiment board methodology (Loon, 2014).

Table 2 - Questionnaire sent to AI experts. Source: own elaboration.

AI Experts Survey

AI innovation ecosystem's status, challenges and prospects

1- To evaluate the current health status of the AI innovation ecosystem in China, which mark would you give?

如果评估当前中国人工智能创新生态系统的健康状况，您会给出什么分数？（1糟糕 - 5优秀）

2- Why? Please explain

请说明理由

3- Which are the prospects of the AI innovation ecosystem in China in the next 5 years?

未来5年中国人工智能创新生态系统的前景如何？（1非常消极 - 5非常有希望）

4- Why? Please explain

请说明理由

Which do you think is the biggest challenge / gap for the China AI roadmap to 2030 (aim: 'to become world leader in AI')? (open question) 您认为在中国人工智能达到2030年规划目标（'成为人工智能领域的领导者'）的最大挑战/差距是什么？（开放问题）

5- How would you address the above challenge / gap? (open question)

针对这个挑战您会有什么建议？（开放问题）

6- Which industry do you think will be more disrupted by AI in China? Why? (open question)

你认为在中国哪个行业会被人工智能影响最大？为什么呢？（开放问题）

AI ecosystem's leading actors, advantages and disadvantages

7- Will innovation in AI in China come primarily from large companies or from start-ups? Please explain the reason

人工智能在中国的创新主要来自大公司还是初创公司？请说明原因

8- Will new AI start-ups be able to challenge existing large companies in AI in China or will they be acquired by existing Internet giants at some point? (Open question)

新的AI初创公司能够挑战AI中现有的大型公司吗？还是会在某些时候被收购？（开放问题）

9- Which advantage do you think a Chinese company in AI has compared to a foreign company to succeed in China? (open question)

您认为中国的AI公司与外国公司相比，有哪些优势？（开放问题）

10- What advantage do you think a foreign company in AI has compared to a Chinese company to succeed in China? (open question)

您认为外国的AI公司与中国公司相比，有哪些优势？（开放问题）

11- Which is the role of patents in AI in China?
专利在中国人工智能的发展起到什么作用？（1无关 - 5非常重要）

12- Which is the main advantage of venture capital for AI in China? (open question)

人工智能风险投资在中国最大的优势是什么？（开放问题）

14- Which is the main disadvantage of venture capital for AI in China? (open question)

人工智能风险投资在中国最大的劣势是什么？（开放问题）

AI opportunities and threats in China

15- Which is the weakest R&D area in AI in China? (open question)

中国最薄弱的AI研究领域是什么？（开放问题）

16- Which cities (or specific areas of a city) would you locate an AI startup in China? (open question)

中国的哪个城市（或者城市的特定地区）最适合创立AI初创企业？（开放问题）

17- Which will be the role of algorithm transparency and accountability in AI in China? (from 0- no role whatsoever to 5 – key role for developments)

算法透明度和问责制将在中国AI发展中起到什么作用？（从0-没有任何作用到5--发展的关键角色）

18- How probable is a fragmented (solutions not compatible) AI / tech scenario between regions of the world? (from 0 – no fragmentation at all to 5 – solutions fully incompatible across constituencies)

世界各地之间存在零散化AI技术情景（解决方案不兼容）的可能性如何？（从0 - 完全没有分散化到5 - 解决方案在各地完全不兼容）

19- How probable is AI contributing to harm of people at large in the mid-term?

在中期来讲，人工智能有多大可能会广泛的对人们造成伤害？

Personal background

20- How many years of experience do you have in tech industry?	
在科技行业从业年数？	
21- How many years of experience do you have in AI industry?	
在人工智能行业从业年数？	
22- How many years of experience do you have in academia related to technology?	
在科技相关学术界从业年数？	
23- How many years of experience do you have in academia related to AI?	
在人工智能相关学术界从业年数？	
24- How many years of experience do you have in gov. institutions related to technology?	
在科技相关政府机构从业年数？	
25- How many years of experience do you have in gov. institutions related to AI?	
在人工智能相关政府机构从业年数？	
26- How many years have you worked in China?	
请问您在中国的工作年限？	
27- Which is your gender? / 性别	
28- Which is your age? / 年龄	
29- In which area of AI do you work? (if other, please indicate)*	
AI technology in general / 基础人工智能技术	
Ecomics / business of AI / 经济/商业	
Social impact of AI / AI社会影响	
Institutional approach to AI (government bodies, public funding,...) / AI的体制方法（政府，公共基）	
Neural networks / 神经网络	
Computer vision / 计算机视觉	
Automated reasoning / 自动推理	
Knowledge-based systems / 基于知识的系统	
Robotics / 机器人	
Natural language processing / 自然语言处理	
Evolutionary and genetic computing / 进化和遗传计算	
Machine learning / 机器学习	
Other	
30- In which application of AI do you work? (if other please, indicate)*	

	Agriculture / 农业	
	Automobile, transportation, smart driving / 汽车 · 交通 · 智能驾驶	
	Commerce, retail / 商业 · 零售	
	Consumer electronics / 消费类电子产品	
	Education / 教育	
	Energy / 能源	
	Food / 食品	
	Finance / 金融	
	Healthcare / 健康	
	Insurance / 保险	
	Legal / 法律	
	Manufacturing / 制造业	
	Marketing / 市场	
	Media / 媒体	
	Real state / 房地产	
	Security / defence / 安全/保卫	
	Sports / 体育	
	Telecoms / 电信	
	Tourism / 旅游	
	Other	

31- Which is the best description of your position in the company/organization?

请问如何描述您在公司的职位？

Senior Management / 高管
 Manager / 经理
 Software developer / 软件工程师
 Hardware developer / 硬件工程师
 Algorithm engineer / 算法工程师
 Product Manager / 产品经理
 Professor / 教授
 Researcher / 研究人员
 Other

32- Which is the best description of your company / institution? (if other please, indicate)

请问如何描述您所在公司?

Governmental body or institution / 政府机构

Large – listed company / 大型公司

Small / medium Enterprise / 中小企业

Start-up / 初创企业

Venture capital – Business angel / Series A / 风险投资-天使/A轮

Venture capital – Series B and beyond / 风险投资-B轮或以上

University / 大学

Research centre / 研究中心

Other

Thank you for your participation

谢谢你的参与

Desk research

Secondly, taking the proposed model as a reference, the examination of key stakeholders and their relationships was carried out by means of an exhaustive secondary source documental revision, representing the AI and EdTech initiatives or projects of each of the stakeholders.

Textual analysis was performed following a structured revision identifying the name of initiative/project, date, the supporting entity (government institution, organization, company), the AI area target and the description. This desk research gathered a data set as exhaustive as possible from multiple sources as detailed in the following: the national government analysis involved the revision of all the AI policy-related initiatives publicly available during the period 2015–2018 (Table 8); the regional governmental domain was addressed by selecting all the policy initiatives related to AI promoted in TIER1²⁴ cities (Beijing, Shanghai, Shenzhen, and Guangzhou) and those included in the TIER² classification highlighted by the survey experts as AI future opportunity areas (Nanjing, Wuhan, Hangzhou, and Chengdu) (Table 9); the industry analysis considered the AI company projects

²⁴ China's tiered city system is a hierarchical classification that segments China into four categories considering development factors (gross domestic product (GDP), political administration, population size, development of services, infrastructure, cosmopolitan nature, retail sales, etc.). Although not officially proposed by the Chinese Government, it is commonly used by economists, consultants, and businesses. All TIER1 cities have a GDP over US\$300 billion and are directly controlled by the central government; the TIER2 GDP is US\$68–299 billion and it includes provincial capital cities and sub-provincial capital cities. <https://knowledge.globalwebindex.net/hc/en-us/articles/212633345-Chinese-Tier-Classification>.

announced by (i) large national companies (Fig. 38), selecting the four companies designated by the Government as members of the artificial intelligence national team; (ii) large international companies, selecting the four largest US companies with relevant presence in China (Apple, Amazon, Google, and Microsoft); (iii) Chinese unicorns (Table 10), according to industrial rankings (CB Insights, Credit Suisse, 2019); and (iv) start-ups and small companies selected from diverse industry sources. For the university domain analysis, the revision included the top five universities according to the ranking ‘Top 60 AI universities of Chinese mainland’ (Table 11).

In the case of EdTech, the study is an extension of the AI ecosystem. For the purpose of this document EdTech is simply considered as the use of new technologies in and around the education system. Data collection took place during the period 2018-2019, In particular, this study uses the following sources of information: desk research of Chinese and foreign analysis of education system in China and new technologies; author and one of the thesis supervisor’s direct experience in the education system in China; interviews with Chinese students, parents, and education professionals; visits to schools and universities; and author and one of the thesis supervisor’s participation in the innovation ecosystem in China.

Experts validation (seminars)

Finally, results were presented and discussed in two close-door seminars to 27 AI specialists in a roundtable on the AI innovation ecosystem in China within the Global Artificial Intelligence Conference²⁵ in Beijing, 19–20 May 2018, and a specific event on AI and start-ups organized in Shanghai on 15 May 2018 with the support of Chinaccelerator and SOSV Venture Capital.

In the case of EdTech, the study was discussed with technology and education specialists in several events, mostly within the Global Artificial Intelligence Conference²⁶ in Nanjing 25-26 May 2019.

²⁵ See <https://2018gaitc.caii.cn/en>

²⁶ See <https://gaitc.caii.cn/en>

4 RESULTS

This chapter compiles the main outcomes of the three phases of the thesis following the research design described in the methodology. In particular, section 4.1. and section 4.2 show respectively the results of the text mining analyses for the two corpora of documents, corresponding with the two initial stages of the research (corpus Academia and corpus EU Policy); and then, section 4.3. compiles the results of the case study for the innovation ecosystem in China. All sections include an introductory piece of theory to frame the context of the analysis.

4.1 Phase 1 – Results of the text mining analysis for the corpus Academia

Results of the phase 1 include the text mining analysis in the case of the corpus Academia. After an overview on the literature on the topic to contextualize the results of the analysis, next sections follow the text mining workflow depicted in the Fig. 7. Initially, a range of descriptive statistics about the corpus are shown, including a geographical dimension depending on the authors' affiliation. Then, the preliminary results of the analysis in terms of most repeated concepts both for the whole period and in five-year terms; and finally, the last section compiles the results of the cluster analysis.

As a context for these results, it is relevant to briefly notice the current situations of the research on entrepreneurship policy. A review of the literature on the topic reveals that despite the growing body of knowledge in the field, it is still under-investigated (Mazzarol and Volery, 2015; Rosa, 2013). In addition, the interest of researchers has been mainly focused on the latter phases of the policy cycle, while setting the agenda and formulation stages remain as a pending challenge (Arshed, 2017).

Drawing a parallel with entrepreneurship as a research field, this has evolved from being defined as fragmented and lacking of a conceptual framework during the early 2000s (Shane and Venkataraman, 2000) to be recently considered as a mature discipline (Busenitz et al., 2014; Zahra and Wright, 2011). But this has not been the case for entrepreneurship policy, usually attributed to its novelty as a research field and also to the multiple dimensions of entrepreneurship (Audretsch et al., 2007; Hözl, 2010). As Hözl (2010, p. 188) summarizes, 'different conceptions and definitions of entrepreneurship lead to different entrepreneurship policies'. In fact, while it is commonly accepted that public policy can influence entrepreneurship (Acs and Szerb, 2007; Verheul et al., 2002; Wennekers and Thurik, 1999), the need of a broad and horizontal orientation (Hözl, 2010) and there is no one-size-fits-all strategy to stimulate entrepreneurial activity (Minniti, 2008), debates have appeared about almost everything else related to entrepreneurship and policy initiatives at all levels of governance (O'Connor, 2013; Stam, 2014a; Lucas *et al.*, 2018)

That is not to say that there is no relevant entrepreneurship policy literature. From the seminal works authored by Storey (1994), Verheul et al. (2002), Hart (2003) or Lundström and Stevenson (2002b, 2005), among others, there has been a large number of studies on the topic, ranging from the analysis of specific policy instruments

applied to different units of entrepreneurship and/or policy stages and geographies (Acs et al., 2016; Autio and Rannikko, 2016; Dennis, 2011) to studies about the potentiality of public intervention (Figueroa-Armijos and Johnson, 2016; Grimm, 2006; Van Stel et al., 2007) and even about the role of government as an active entrepreneurial agent (Mazzucato, 2011) or deeper theoretical reviews of the field (Audretsch et al., 2007; Baptista and Leitao, 2009; Bennett, 2014). In addition, policies have been acknowledged as part of the relevant context for entrepreneurship (Welter, 2011) and the policy dimension has been identified as a key element of the entrepreneurial ecosystem (Mason and Brown, 2014; Stam, 2015; Xu and Dobson, 2019).

Entrepreneurship policy has also received remarkable updates from international organizations and institutions such as the OECD²⁷, European Commission²⁸ or UNCTAD²⁹ who have developed initiatives to promote entrepreneurship. Similarly, as a main example, the Innovation Policy Platform (IPP) previously introduced in section 2.3. is an ongoing initiative developed by the World Bank and the OECD with the aim of facilitating knowledge on how innovation systems operate. Moreover, it is a space where institutional users from different regions can share good practices. It contains a specific section about the policy rationales and objectives of innovative entrepreneurship, a comprehensive explanation of the main market and system failures, and specific scenarios that require policy intervention.³⁰

Despite these contributions, construction of the entrepreneurship policy body of knowledge is still in progress. At this point, the main motivation of this phase of the study is not to advise on the future configuration of entrepreneurship policy as a research topic, but to unwrap the past by unveiling how key themes of the entrepreneurship policy research agenda have emerged, evolved and/or declined over time as a foundation on which to build further developments in the next sections.

²⁷ In 2007, the OECD published a Framework for the Evaluation of SME and Entrepreneurship Policies and Programmes, aiming to offer policymakers a practical guide to improve the evaluation stage of entrepreneurship programmes. This publication derived from a recommendation of the Second OECD SME Ministerial Conference celebrated in Istanbul in 2004. The Third OECD SME Ministerial Conference took place in 2018 in Mexico and further recommendations are expected. More information available at: https://read.oecd-ilibrary.org/industry-and-services/oecd-framework-for-the-evaluation-of-sme-and-entrepreneurship-policies-and-programmes_9789264040090-en#page1te

²⁸ The EC and the OECD launched the Better Entrepreneurship Policy Tool in 2018 to support inclusive entrepreneurship, including a self-assessment tool and guidance to improve the design of these policies.

²⁹ UNCTAD developed the Entrepreneurship Policy Framework in 2018 with the aim of supporting the promotion of entrepreneurship in developing countries. More information available at: <https://unctad.org/en/Pages/DIAE/Entrepreneurship/Entrepreneurship-Policy-Framework-and-Implementation-Guidance.aspx>

³⁰ More information available at: <https://www.innovationpolicyplatform.org>

Descriptive statistics

For the purposes of the analysis, corpus Academia is initially splitted to include a geographical dimension in the study, particularly to analyze those papers authored by researchers affiliated to SE Asia, the EU and the US. In addition, annex 3 includes a specific analysis for the EU region, including an additional split into countries within the Union.

It is obvious that this analysis is only a snapshot of the whole entrepreneurship research in the considered geographies under study and it is evidently limited by the sample and the fact that authors' current affiliation is only one aspect of the context, which is much more complex. However, it aims to offer some additional insights to enrich the debate about how the research on entrepreneurship policy has been configured per region since the early 1990s and the contributions to the whole research picture.

From the whole corpus Academia, there are 558 documents corresponding to EU affiliations³¹ 340 documents corresponding to US affiliations and 118 documents with SE Asian affiliations.³² Considering that the total sample is formed by 1,048 articles, the European Union largely leads the research in this field for the period under study, with EU-affiliated authoring of 53.2 per cent of the papers, followed by US-affiliated authors participating in almost one third of the total amount of papers and SE Asia-affiliated authors working on 11.3 per cent.

Fig. 12 shows how the regional production of papers has evolved since 1990. Those papers authored by EU- and US-affiliated researchers present a similar distribution, accounting for a quarter of the documents during the 1990s, a third during the 2000s and the rest of them since the 2010s. On the other hand, the distribution of SE Asia-affiliated papers was lower during the 1990s, to explode during the initial lustrum of the 2000s, then presenting a similar number to their EU and US counterparts during 2005–2014 and decreasing during the last period.

³¹ In the case of the EU, the United Kingdom largely leads the research in the region for the period under study with more than 35 per cent of the total number of affiliations, followed by the Netherlands, Spain, Italy, Germany, Sweden and France, together comprising almost half of EU authors' affiliations. Then follows a group of six countries with at least ten affiliated papers (Belgium, Finland, Denmark, Greece, Portugal and Austria), and finally a long tail of countries to complete the 24 countries with at least one affiliated paper. Slovakia, Latvia, Lithuania and Malta are not included, with no affiliated researcher within the Corpus during 1990–2016. Annex 3 gathers a specific analysis for the EU region.

³² In particular, papers in the sample correspond to authors affiliated to China, Hong Kong, India, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand. South Korean and Japanese affiliated authors account for 20 per cent and 18 per cent respectively of the total production in the region, followed by China (14%), India (13%), Singapore (10%), Taiwan (9%), Thailand (4.8%), Malaysia (3%) and the Philippines with one unique affiliated paper (0.8%).

Fig. 12 - Regional distribution of papers in SE Asia, the EU and US sub-corpus per five-year term (1990–2016)

Fig. 13 shows the distribution of papers taking into account the different combinations of author affiliations for the three regions under study. As a brief summary of the main results, the percentage of SE Asia with one unique country affiliation is around 63 per cent; while this percentage rises to around 70 per cent in those papers affiliated to the EU and US, there is only one paper co-authored simultaneously by SE Asia-, EU- and US-affiliated authors. Going into detail about inter-regional and intra-regional collaborations, it should be noted that there are only two papers co-authored by different SE Asian affiliations, while papers with SE Asia-US and SE Asia-EU authorship represent respectively 13.6 per cent and 15.3 per cent of the regional sample. In the case of EU-affiliated papers, there are more papers co-authored collaboratively by EU- and US-affiliated authors than those elaborated only with other EU counterparts. Similarly, in the case of US-affiliated papers, collaboration with EU-affiliated researchers represents 17.9 per cent of the total number of papers. Finally, results show that the percentage of collaborations with other affiliated authors is similar in the case of the three regions under study, with a slightly lower rate in the case of SE Asian papers.

Fig. 13 - Regional distribution of papers per type of affiliation within SE Asian, EU and US sub-corpora (1990–2016)

Table 3 shows the total distribution of papers per five-year term in each region compared to the evolution of the different types of collaboration during the same periods. Results are somewhat homogeneous, with a peak in SE Asia-EU, SE Asia-US, EU-US and EU-EU collaborations during 2005–2014. In the case of EU-US collaborations, this tendency continued to grow during the last two years of the period under study, accounting for 25 of the 61 shared papers published in 2015 or 2016.

Table 3 - Distribution (%) of SE Asia, EU and US affiliated papers by type of collaboration, in five-year terms

	Total number of papers	1990–94 1995–99 2000–04 2005–09 2010–14 2015–16					
		1990–94	1995–99	2000–04	2005–09	2010–14	2015–16
SE Asia	118	6%	11%	29%	25%	26%	3%
Only SE Asia (one country)	74	7%	12%	38%	18%	24%	1%
Only SE Asia (more than one country)	2	0%	0%	100%	0%	0%	0%
SE Asia-EU	18	0%	11%	11%	33%	44%	0%
SE Asia-US	16	0%	6%	13%	44%	31%	6%
SE Asia-EU-US	1	0%	0%	0%	100%	0%	0%
SE Asia-Others	7	29%	14%	0%	43%	0%	14%

EU	558	10%	14%	13%	20%	29%	13%
Only EU (one country)	388	13%	18%	16%	19%	24%	10%
Only EU (more than one country)	51	2%	4%	6%	24%	41%	24%
EU-SE Asia	18	0%	11%	11%	33%	44%	0%
EU-US	61	2%	7%	5%	21%	41%	25%
EU-SE Asia-US	1	0%	0%	0%	100%	0%	0%
EU-Others	39	3%	8%	8%	21%	36%	26%
US	340	13%	14%	12%	22%	27%	11%
Only US	236	18%	18%	14%	21%	22%	7%
US-SE Asia	16	0%	6%	13%	44%	31%	6%
US-EU	61	2%	7%	5%	21%	41%	25%
US-SE Asia-EU	1	0%	0%	0%	100%	0%	0%
US-Others	26	0%	8%	15%	19%	35%	23%

Therefore, SE Asia-affiliated authors seem to be more inclined to collaborate with the outside world, but they tend to collaborate more with authors from US or EU countries than with surrounding countries. In addition, EU- and US-affiliated papers represent the most common external collaboration—in the case of the EU, even with a higher representation than those papers with only EU authors. From a chronological perspective, there is a common turning point in the increase of collaboration among different affiliations since the mid-2000s, with the highest rate of co-authoring both outward and inward during the period 2010–2014.

Preprocessing and preliminary analysis

As part of the text mining process, the initial stage consists of pre-processing the corpus. It amounted initially to 11,902 root terms, which were reduced to 7,722 tokens after stemming.

Global corpus Academia

After that, the preliminary analysis consists of the absolute word frequency, measured as the total occurrences of a word within the Corpus Academia after eliminating irrelevant elements and consolidating those terms with similar meaning by using the Porter stemmer, as explained in section 3.4.1.

Fig. 14 displays the most frequent words in this corpus. Terms related to the business perspective are placed in high positions, with *firm*, *enterprise* and *company* having the highest number of occurrences; while *entrepreneur* and *business* are the third and fourth most frequent words respectively. The term *policy* ranks second. Altogether, these terms are consistent with the aim of this research. In a similar manner, *technology* and *innovation* appear in sixth and seventh positions respectively. Along the same lines, *knowledge* is 18th, *science* 22nd and *data* 36th. Intertwined with technology are those themes linked to finance and socioeconomics, with

capital, *venture*, *investment* and *finance* placed 23rd, 26th 28th and 31st, respectively. Furthermore, *development* is fifth, *economy* eighth, *industry* ninth, *growth* 14th, *market* 15th, *social* 40th and *employment* 34th.

An interesting insight is the position of *size* at forty-ninth, showing the interest of academia in firms' size as a key aspect of the contribution of entrepreneurship to productivity and innovation. The institutional perspective includes *govern* at 16th, *institutional* 17th, *network* 27th, *system* 33rd and *competition* 41st. Collectively, the technological, socioeconomic and institutional viewpoints, with no clear pre-eminence among them, seem to point towards multiple perspectives that are required to study entrepreneurial policy from the academic perspective. However, there are no significant references to terms related to education, as mentioned above. As an additional note from a geographical viewpoint, *region* is placed twelfth, the aggrupation of *nation* and *country* is 13th, while *international* is only located 30th. Such terms are an early indication that most of the academic analysis refers to specific geographical areas or is at least influenced by such.

Fig. 14 - Top 50 frequent word stems within the Corpus Academia by absolute number of occurrences (1990–2016)

An analysis was applied to each five-year period from 1990–2016 as a relevant input of the study. Figures 15-20 show the most repeated word stems in periods of five years since 1990 except for the last period (2015-2016) which obviously only comprises two years.

First, it is interesting to examine the relative position between the aggregation *firm-enterprise-company* and *entrepreneur*: the former leads until 2005-09, but since then *entrepreneur* have surpassed it, even becoming the most frequent word in 2015-16. In a similar pattern *sme* has escalated positions over the years. For instance the term *sme* appeared at 148th position in 1990-1995 but then has gone up within the top 50, being at 17th in 1995-1999 (the highest), and then keeping a relatively constant profile at 39th in 2000-2004, 21st in 2005-2009, 25th in 2010-2014 and finally rising again up to 17th in 2015-2016, a similar pattern to that of *startup* (from 56th in 2000-04 to 51st in 2015-16).

The evolution of *technology* and *innovation* is also relevant. *Technology* starts at 2nd position in 1990-04 and 3rd in 1994-1999 and in 2000-2004 and then begins to decline moving to 9th in 2005-2009, 7th in 2010-2014 and 20th in 2015-2016. On the contrary, *innovation* departs from 8th in 1990-94 and 10th in 1995-1999, but then it

increases its relevance positioning at 7th in 2000-04, 4th in 2005-2009 and 2010-2014 and 5th in 2015-2016. *Data* and *university* present a similar pattern as *innovation*. *Data* starts at 86th in 1990-94 and then goes up to 49th and 48th in 1995-99, 39th in 2005-09 and 26th in 2010-14 and 2015-16. Particularly interesting is the emergence of *university*: the term was far from the top 50 during the 1990s and then ranking 56th in 2000-04 and 43rd, 44th and 43rd in 2005-09, 2010-14 and 2015-16, respectively.

Social in another interesting case. The term started out in 1990-95 at 124th, in 1996-00 at 46th and in 2000-04 at 61st. However, since 2005-09 *social* has gone up at 25th and it has continued being more and more frequent in the next periods, at 22nd in 2010-14 and at 15th in 2015-2016. To this regard note that most of the terms related with economics remain basically stable, with the own term *economy* staying within the top ten for all the periods. Maybe the little exception is *industry* that has declined from 4th position in 1990-94 and 8th position in 1995-1999, 2000-2004 and 2005-2009 to 12th in 2010-2014 and 16th in 2015-2016.

As previously stated, *education* is far to be among the most frequent terms during all the considered periods, although its best rankings are during the last years of the overall period being at 59th in 2010-14 and 74th in 2015-16. Concepts related to education, such as *skill* or *train* are not either relevant with the unique exceptions of *learn*, that is relatively relevant during 1995-99 (61st) and 2000-04 (59th), and the case of *university* that is in the top 50 since 2005 as mentioned above.

Regarding geographical considerations, *country-nation* and *region* stay well above *international* for the whole period with slight variations between them: after an initial period that are almost equally frequent at 15th and 14th positions, *country-nation* dominates from 1995-99 up to 2005-09, and then *region* overtakes along the period 2010-2016, with *region* at 10th position in 2010-14 and 9th in 2015-2016 while *country* goes down at 13th position in 2010-14 and at 11th position in 2015-2016.

Terms related with ecosystem, that is, terms related with entrepreneurial activities context and conditions including interactions with the rest of the agents, display interesting evolution patterns. *Environment* and *system* both rank their lowest in the initial period of 1990-94 (100th and 49th, respectively), being 1995-99 the period with the highest position for *environment* (at 31st) and 2005-09 for *system* (at 26th). *Network* and *cluster* spiked at 2005-09 (16th and 32nd, respectively) with the latter almost unheard of in the period 1990-99. Note also that the very term *ecosystem* is virtually missing up to 2015-2016, when it has appeared at 269th position.

Considering ecosystem domains, as previously described, *policy* keeps a position at the top three for all the considered periods due to be the focus of the research. *Finance* also appears in the top 50 for all the considered periods: it starts at 35th in 1990-94 and then rises up to 28th, thereafter declining to 32nd in 2000-2004 and 41st in 2005-09 and finally it rises at the top 30 during the last years, being 28th and 27th in 2010-14 and 2015-16 respectively. Then *market* is very relevant for all the periods remaining at the top 50 with the side note of going down to 36th in 2010-2014 and to 82nd in 2015-2016. *Culture* behaviour is irregular: it ranks 224th in 1990-1994 and then moves up to the Top 200 during the following four five-year periods, reaching 63rd position, its highest

rank, at 2015-2016. Finally, *human* is far from the leading positions being the 92nd term at 2010-2014 as its best ranking.

Fig. 15 - 50 most frequent word stems for the corpus Academia in 1990-1994

Fig. 16 - 50 most frequent word stems for the corpus Academia in 1995-1999

Fig. 17 - 50 most frequent word stems for the corpus Academia in 2000-2004

Fig. 18 - 50 most frequent word stems for the corpus Academia in 2005-2009

Fig. 19 - 50 most frequent word stems for the corpus Academia in 2010-2014

Fig. 20 - 50 most frequent word stems for the corpus Academia in 2015-16

Next, as in the case of the global corpus Academia, this phase 1 analyses the absolute word frequency within the three regional sub-corpora, distinguishing those articles authored by SE Asia, the EU and the US respectively, and compares them with the results of the global picture and in relation to each other.

Southern and East Asia Academia sub-corpus

Fig. 21 shows the most frequent terms in the SE Asia Academia sub-corpus. In this case, *technology* is the most repeated term, rising from 6th position in the global corpus Academia. Similarly, *innovation* rises to 5th position from 7th when considering the whole corpus.

In contrast, the three most repeated terms in the whole corpus decline here. Concretely, *firm-enterprise-company*, *policy* and *entrepreneur* decrease to second, third and tenth positions respectively. Looking at other common agents of entrepreneurship, *smes* climbs from 40th in the whole corpus to 28th within the SE Asia-affiliated papers, while *startup* declines to 243rd position from 40th in the global corpus Academia.

Growth, *social* and *employment* fall dramatically within the SE Asian sub-corpus, ranking in 33rd, 79th and 103rd positions respectively, while they are the 14th, 32nd and 35th most repeated terms in the global corpus Academia. In addition, *industry* rises three positions to sixth, but *economy* drops to eighth from ninth in the whole corpus; looking at the business dimension, *business* declines from third to sixteenth and *management* remains in eleventh position.

The contribution of terms related to research and knowledge is prominent in those papers authored by SE Asia-affiliated researchers. *Research*, *knowledge*, *transfer* and *university* go up to eighth, eighteenth, 48th and 67th positions respectively from the previous tenth, eighteenth, 64th and 80th, while *science* keeps 22nd position. From the financial dimension, *venture* and *investment* decline here to 25th and 29th from 26th and 19th in the whole corpus, while *finance* drops to 72nd.

From an institutional perspective, there are also differences compared to the global corpus Academia, since *govern*, *system* and *competition* rank 13th, 14th and 16th here, rising from the previous 16th, 34th and 42nd.

Finally, there are interesting insights when looking at the geographical dimension. *Country-nation* rises to seventh position from 13th in the whole corpus, but *region* declines to 29th from 12th. This is reinforced by the high positions of the specific names of the Asian countries under study, for instance: *China* and *Korea* are in the top 50. Furthermore, *international* and *foreign* rise to 24th and 42nd positions. Focusing on those terms related to context/location, *network* and *cluster* rise to 26th and 46th positions from 27th and 57th within the whole corpus.

Fig. 21 - Top 50 frequent word stems within the SE Asia Academia sub-corpus by absolute number of occurrences

EU Academia sub-corpus

Fig. 22 displays the most frequent terms in the EU-Academia sub-corpus. Words in the top ten are very similar to the global corpus Academia, with the minor exceptions of *innovation*, which rises from seventh to fourth position when considering papers with EU authors only, and *technology*, which drops from sixth position considering all the papers to eight when considering papers with EU authors only.

A more detailed analysis of the performance of entrepreneurial agents in the corpora offers interesting insights. While there are no differences for in first position for *firm-enterprise-company* and third position for *entrepreneur*, the positions of the terms *startup* and overall *smes* are higher when considering papers with authors with EU affiliations. However, *size* is at 49th within the analysis of the whole corpus Academia and at 66th from the EU Academia point of view, perhaps showing less interest from authors affiliated to EU institutions in firm size in the context of entrepreneurship policies.

Other significant differences within the most frequent words are *employment*, which ranks 27th in the EU Corpus Academia and 35th in the global corpus Academia, and *knowledge*, *science* and *transfer*, ranking 16th, 18th and

44th in the EU Academia and 18th, 22nd and 64th respectively within the whole corpus Academia. Similarly, terms related to finance are more relevant in the EU corpus Academia, with *venture*, *investment* and *finance* at 22nd, 23rd and 24th when considering papers related to EU authors and the same terms at 26th, 28th and 31st respectively within the whole corpus Academia.

In contrast, the business dimension underperforms when analyzing the EU Academia compared to the global analysis, with *business* and *management* ranking fifth and fourteenth versus fourth and eleventh within the whole corpus

Regarding the institutional perspective, terms such as *govern*, *system*, and *competition* rank 16th, 34th and 42nd in the global corpus Academia, while the same words drop to 34th, 35th and 61st within the EU corpus Academia.

The comparative analysis of words related to geography and context also offers interesting differences between the EU Academia and the global Academia corpora. While terms referring to geographical level, such as *international*, *nation-country* and *region*, are in a slightly higher position in the case of the EU Academia, differences are greater when considering both generic terms related to context and/or location, such as *context*, *agglomeration* or *geography*, and a greater level of detail with terms, such as *local*, *cluster*, *network* or *relationship*.

Fig. 22 - Top 50 frequent word stems within the corpus EU Academia sub-corpus by absolute number of occurrences

US Academia sub-corpus

Fig. 23 shows the most frequent terms in the US-Academia sub-corpus. *Entrepreneur* replaces *firm-enterprise-company* as the most repeated word within the papers authored by US-affiliated researchers, reinforced by the rise of *individual*, which is here in 36th position from around the top 100 within the global Corpus Academia. In contrast, while *startup* slightly falls from 44th to 40th, the role of *smes* drops dramatically to 292nd position from 41st within the global corpus Academia.

Within the top ten most repeated words, it is also remarkable that *policy* has descended from second position to fourth, and *technology* and *innovation* go down from sixth and seventh when considering the whole corpus Academia to seventh and eleventh respectively when analyzing those papers authored by US-affiliated researchers. On the other hand, *business*, *economy* and *management* rise to third, fifth and eighth positions respectively from fourth, eighth and eleventh in the global corpus Academia; *market* continues this tendency, gaining a position to become the 14th most repeated word, while *growth* falls from 14th in the global corpus to 19th within US-affiliated papers.

While terms such as *employment*, *social* and *support* hold the same positions in both the US sub-corpus and the global corpus Academia, there are significant rises in the case of *environment* and *culture*, placed at 26th and 57th when considering papers produced by US-affiliated authors.

There are divergences when analyzing terms related to finance: while *finance* and *investment* fall to 46th and 52nd respectively considering US-affiliated papers compared with 31st and 28th within the global Corpus Academia, *venture* rises to 13th position from 26th in the global analysis. Similarly, *research* and *university* rank ninth and 41st and tenth and 80th in the global Corpus Academia, *science* and *knowledge* decrease to 27th and 45th within the US Academia sub-corpus from 16th and 18th when looking at the whole corpus Academia.

From a geographical perspective, there are significant differences between the global corpus Academia and the US sub-corpus. *Country-nation* and *international* rank 12th and 25th, rising from 13th and 30th positions within the global analysis. The rise of *global* strengthens the international dimension of the analysis in US-affiliated papers. Coherent with the domestic administrative organization in the US, *region* ranks 54th position here, decreasing from 12th within the global corpus Academia, while *state* rises to 40th position, ranking 110th in the global analysis. Looking at those terms related to context and/or location, such as *cluster*, *local*, *agglomeration* or *network*, all of them hold lower positions in the US sub-corpus than in the global corpus Academia.

Fig. 23 - Top 50 frequent word stems within the corpus US Academia sub-corpus by absolute number of occurrences

Cluster analysis

The next stage in the analysis is conducting the k-means clustering. As mentioned in the methodology section, the number of clusters (k) should be specified a priori by the researcher. Hence, the analysis starts with an evaluation of the results of the Davies-Bouldin criterion for the k-means clustering results for k values from four to thirteen, followed by a qualitative examination of the cluster results.

Global Corpus Academia

The Davies-Bouldin index presents the best (minimum) values for nine, eleven and twelve clusters using the k-means clustering algorithm. Therefore, in the following, this analysis studies the results from four to twelve clusters.

When the number of clusters is four, *Innovation–Technology–Research*, *Geography/Location*, *Entrepreneurial process* (i.e. *agents–finance–venture capital–regulation–employment*) and *Management* represent the main themes. A new theme, *Internationalisation (Investment–Export)*, emerged in the case of five clusters. The six-

cluster analysis separates the general theme of *Agents–Finance–Venture Capital–Regulation–Employment* into issues related to *Agents–Inclusion* and *Employment–Regulation–Finance–Venture Capital*. Seven clusters introduce *Market–Sectors* as a new topic. The eight-cluster partition splits the *Internationalisation* theme into two topics—*Investment* and *Export*. In addition, the eight-cluster partition introduces a new specific theme, *Research–Knowledge*, which is separated from *Innovation–Technology*. The nine-cluster partition adds a new topic, *Support*. In the ten-cluster partition, *Geography/Location* is divided into *Agglomeration*, which is mainly related to innovative/ technological sectors; and *Lifecycle*, related to the impact of geography on the entrepreneurial process. Also, the theme of *Management* emerges again and adds a new topic, *Policy*. The eleven-cluster partition shows three *Geography/Location*-related clusters: (i) *Agglomeration*, (ii) *Lifecycle* and (iii) knowledge-based *Industry*. The twelve-cluster partition summarizes and groups the themes as follows: (i) *Inclusion*; (ii) *Research–Knowledge*; (iii) *Internationalisation–Investment*; (iv) *Geography/Location–Lifecycle*; (v) *Geography/Location–Industry*; (vi) *Internationalisation–Export*; (vii) *Support*; (viii) *Innovation–Technology*; (ix) *Employment–Regulation–Finance*; (x) *Geography/Location–Agglomeration*; (xi) *Management*; and (xii) *Venture Capital*. From the researcher perspective, this twelve-cluster partition is a meaningful combination of the main themes in entrepreneurship research from academia.

Results of the analysis for the twelve-cluster partition of the corpus Academia are shown in Table 4, with the defining topics for each cluster, and in Fig. 24, with a breakdown of the number of papers per cluster. *Inclusion* leads the ranking on the number of papers, followed closely by *Employment–Regulation–Finance* and, at a distance, by *Management* and *Research–Knowledge*. The results of the other cluster partitions are shown in Tables 16 - 24 in the Annex 2. In addition, Table 15 in the Annex shows the top five relevant³³ papers included in each cluster as an illustration of the research scoped in them.

³³ Papers in each cluster have been sort on relevance criteria provided by Scopus (more information available at: <https://libguides.library.uu.nl/c.php?g=202187&p=1330838>).

Fig. 24 - Distribution of papers for the twelve-cluster taxonomy (Corpus Academia, 1990–2016). Source: own elaboration.

Next, this section has analyzed the evolution of the twelve clusters during the 1990–2016 study period by comparing the number of papers corresponding to each theme every five years, with the exception of the period 2015–2016, as shown in Fig. 25. In particular, the main changes within the evolution of clusters are outlined in the following.

Inclusion only starts to be truly relevant in 2005, and especially after 2010, when topics like women, social entrepreneurship or immigrants gain momentum. Likewise, the relevance of *Management* increased in 2005 and presented a relative maximum in 2015–2016. The relevance of *Research–Knowledge* remained constant from 1995, with a peak in 2010–2014, whereas, the number of papers related to *Innovation–Technology* made a quantitative leap in 2005. *Support* is related to research and scientific activities to some extent and reached a maximum in 2000–2004. Likewise, the behavior of *Internationalisation–Investment* and *Internationalisation–Export* was very similar until 2010. *Investment*, which is related to expansion by means of establishing abroad, reached its maximum in 2010–2014; however, the tendency of *Export*, with a focus on selling abroad and China, made the maximum shift in 2015–2016.

Location-related clusters also show significant differences. For instance, *Geography/Location–Sector* has a national dimension and reached its maximum in 1990–1995; however, it then declined, especially in 2005. *Geography/Location–Lifecycle* gained relevance in 2000 and remained relatively stable until 2014, with the anecdotic result that there is no related paper in the period 2015–2016. The number of articles related to *Geography/Location–Agglomeration* started to grow intensively in 2005, enjoying a relative maximum in 2015–2016, when regional dimension and the importance of connections were perceived as key features of entrepreneurship. Finally, the number of papers about *Employment–Regulation–Finance* was at its highest in

2010, just after a decline in 2005–2009, coinciding with the financial crisis. However, *Venture Capital* displayed a maximum in 1990–1994 and 2010–2014.

Fig. 25 - Evolution of the relative weight of number of papers in the twelve-cluster taxonomy for each five-year period (Corpus Academia, 1990–2016). Source: own elaboration.

Table 4 - Top 20 relevant word stems for the twelve-cluster analysis of the Corpus Academia (1990–2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	<i>Inclusion</i>	<i>Research - Knowledge</i>	<i>Internationalisation - Investment</i>	<i>Geography / Location - Lifecycle</i>	<i>Geography/ Location - Industry</i>	<i>Internationalisation - Export</i>	<i>Support</i>	<i>Innovation - Technology</i>	<i>Employment - Regulation - Finance</i>	<i>Geography/ Location - Agglomeration</i>	<i>Management</i>	<i>Venture Capital</i>
1	entrepren	technolog	subsidiari	cycl	cluster	export	incub	innov	employ	network	organiz	ventur
2	region	transfer	multin	life	technolog	foreign	park	system	smes	knowledg	polit	capit
3	busi	univers	knowledg	technolog	biotechnolog	invest	scienc	region	firm	region	manag	invest
4	rural	patent	foreign	energi	industri	domest	technolog	smes	growth	tie	organ	fund
5	women	industri	japanes	metal	telecommun	china	univers	product	tax	innov	corpor	vc
6	develop	research	invest	product	electron	spillov	special	firm	credit	spillov	strategi	equiti
7	educ	innov	local	cluster	nation	enterpris	locat	process	subsidi	learn	environment	inform
8	econom	spin	host	recycl	competit	intern	innov	model	size	entrepren	respons	decis
9	social	project	expatri	local	govern	direct	tenant	technolog	self	social	institut	financ
10	start	knowledg	risk	industri	innov	firm	multimedia	enterpris	job	firm	theori	bootstrap
11	ventur	commerci	polit	stage	internet	countri	servic	design	busi	technolog	work	corpor
12	enterpris	intellectu	divest	curv	global	outward	yacht	nation	guarante	growth	famili	entrepren
13	activ	properti	oversea	nanotechnolog	korea	trade	firm	manufactur	market	bridg	firm	market
14	immigr	manag	acquisit	market	region	perform	base	knowledg	bank	endogen	perform	criteria
15	cultur	develop	intern	innov	countri	review	linkag	instrument	financi	organ	cultur	angel
16	institut	govern	typolog	simul	firm	young	virtual	develop	rate	collabor	strateg	vcs
17	growth	collabor	strateg	cast	develop	manufactur	manag	energi	effect	communiti	employe	prefer
18	support	learn	embedded	effici	sector	host	analog	learn	loan	cluster	human	human
19	famili	institut	review	constraint	system	economi	custom	centr	financ	industri	govern	financi
20	femal	capabl	frontier	accumul	network	busi	strait	research	start	structur	resourc	compani

Cluster analysis from the SE Asia, EU and US regional perspective

Analysis of the particularities of the topics of those research papers on entrepreneurship policy from SE Asia, EU and US affiliations draws additional interesting regional insights. Table 5 and Fig. 26 show the percentage of SE Asia-, EU- and US-affiliated papers included in each cluster and for the whole corpus Academia.

Comparison of these results shows that the percentage of SE Asia-affiliated papers related to *Inclusion* and *Employment–Regulation–Finance* are much lower than the general case and with respect to EU- and/or US-affiliated documents. On the other hand, SE Asia authored papers present a higher rate of papers in the *Research–Knowledge*, *Internationalisation–Investment* and *Internationalisation–Export* clusters.

Likewise, almost a quarter of the US-affiliated papers belong to the *Management* cluster, widely surpassing the participation of authors from the other affiliations. In addition, the percentage of US-affiliated papers related to *Venture Capital* is higher than in the remaining cases, but the participation of US-affiliated authors in *Support* and *Innovation–Technology* papers is limited.

Finally, the share of EU-affiliated papers related to *Management* is lower than in the other cases, while EU authors tend towards an increased presence with respect to the general case in those papers belonging to *Employment–Regulation–Finance* and *Support*.

Table 5 - Percentage of SE Asia/ EU /US-affiliated papers per cluster.

	SE Asia (118 papers)	EU (558 papers)	US (340 papers)	Global (1,048 papers)
<i>C1 - Inclusion</i>	9.3%	19.9%	22.4%	19.9%
<i>C2 - Research–Knowledge</i>	26.3%	12.5%	10.0%	12.6%
<i>C3 - Internationalisation–Investment</i>	5.9%	1.4%	1.8%	1.9%
<i>C4 - Geography/Location–Lifecycle</i>	1.7%	1.4%	0.9%	1.5%
<i>C5 - Geography/Location–Industry</i>	10.2%	6.6%	7.1%	8.4%
<i>C6 - Internationalisation–Export</i>	11.0%	7.3%	4.1%	5.9%
<i>C7 - Support</i>	1.7%	2.3%	0.3%	1.6%

<i>C8 – Innovation–Technology</i>	9.3%	10.7%	2.9%	8.4%
<i>C9 - Employment–Regulation–Finance</i>	6.8%	22.4%	16.5%	18.8%
<i>C10 - Geography/Location–Agglomeration</i>	5.9%	4.7%	4.1%	4.3%
<i>C11 - Management</i>	9.3%	6.8%	24.7%	12.9%
<i>C12 - Venture Capital</i>	2.5%	3.8%	5.3%	3.7%

Fig. 26 - Distribution/Percentage of papers per cluster within the global Corpus Academia and the SE Asia, EU and US sub-corpora

Similarly, Table 6 shows how papers authored through collaboration among SE Asia-, EU- and US-affiliated researchers are distributed within the twelve clusters.³⁴ As previously mentioned, EU-US is the most frequent collaboration, with 61 co-authored papers. Of those, there are 14 papers related to *Inclusion* and ten papers related to *Employment–Regulation–Finance*, which is coherent with the general interests of EU and US researchers separately. In addition, there are 13 papers related to *Management*, in spite of EU authors in general not being inclined to participate in this topic.

Among the 18 and 16 papers with SE Asia-EU and SE Asia-US authorship respectively, a remarkably high percentage of papers are related to *Research–Knowledge*, much higher than the rate of papers on this topic from the EU and US with no SE Asian co-authors. In addition, six of the sixteen papers shared by SE Asia-US affiliated researchers belong to *Management* and six of the eighteen SE Asia-EU co-authored papers are related to *Internationalisation–Export*.

Finally, focusing on the collaboration inwards in the EU, there are only two papers related to *Innovation–Technology*, while *Inclusion* and *Employment–Regulation–Finance* account for 11 and 12 papers respectively, giving a shared rate of around 45 per cent of the total papers in this category. Furthermore, the proportion of papers related to *Geography/Location–Agglomeration* in this case doubles in comparison to the corresponding rate in both the general EU sub-corpus and the global Corpus Academia.

Table 6. Number of SE Asia/EU/US co-authored papers per cluster

	SE Asia-EU	SE Asia-US	EU-US	EU inwards
<i>C1 - Inclusion</i>	1	1	14	11
<i>C2 -Research–Knowledge</i>	4	4	8	7
<i>C3 - Internationalisation–Investment</i>	1	1	0	1
<i>C4 - Geography/Location–Lifecycle</i>	0	0	0	0
<i>C5 - Geography/Location–Industry</i>	3	1	2	3
<i>C6 - Internationalisation–Export</i>	6	1	3	4

³⁴ There is one unique paper shared in the period by SE Asia-, EU- and US-affiliated authors; it belongs to the *Research–Knowledge* cluster.

<i>C7 - Support</i>	0	0	1	1
<i>C8 - Innovation–Technology</i>	1	0	2	2
<i>C9 - Employment–Regulation–Finance</i>	0	1	10	12
<i>C10 - Geography/Location–Agglomeration</i>	0	1	4	5
<i>C11 - Management</i>	1	6	13	3
<i>C12 - Venture Capital</i>	1	0	4	2
TOTAL	18	16	61	51

4.2 Phase 2 – Results of the text mining analysis for the corpus EU Policy

Results of the second phase compile the outcomes of the text mining analysis for the corpus EU Policy. As in the phase 1, this introductory section briefly reviews the approach of European Union to entrepreneurship policy to contextualize the analysis. Next, results of the results of the text mining analyses are presented, including the most repeated concepts both for the whole period (1990-2016) and by lustrums and the cluster analysis.

It is widely accepted that the Lisbon Agenda in 2000 represented a pivotal moment in the way policy makers consider entrepreneurship in Europe. The strategy was conceived with the aim of making Europe ‘the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010’ and was endorsed by all the Member States.

Prior to Lisbon Strategy and the concrete policy definition³⁵ launched in the early 2000, entrepreneurship in Europe was far from being a key policy topic. Since the late 80’s to the late 90’s, policy makers discourse evolved along those years to finally raise awareness on the relevance of introducing entrepreneurship into the policy debate as one of the keys to unlocking greater employment growth and competitiveness in Europe (European Commission, 1998). Connected to this period, relevant academic contributions come from David Audretsch and Roy Thurik that identified up to five stages in the European process from no policies up to the Lisbon Agenda (Audretsch et al. 2002; Audretsch and Thurik 2010).

At a subsequent stage in which the concept of entrepreneurial economy in Europe was finally emerging (European Commission, 2003a, 2004), the debate among stakeholders was focused on the alternatives to shape and implement a targeted entrepreneurship policy. From an academic perspective, this issue was part of the long debate on the balance between public intervention and market freedom that has been addressed in detail (Gómez-Barroso, 2019). In this context, some authors explore the constituents of what should entrepreneurship policy look like, highlighting the role of policy in enabling the creation and commercialization of knowledge as a core difference from traditional business policy (Acs and Szerb, 2007).

Acknowledging the relevance of entrepreneurship and despite the efforts made by the EU, the mentioned debate about policy appropriateness and effectiveness have partly driven research in the field with approaches that are seemingly diverse and heterogeneous, depending on the context of the researcher (Landström, 2015; Welter et al., 2008). Some examples are the analysis of policy capacity to support innovative entrepreneurship (Grilo and

³⁵ As the EC stated, the Communication on innovation policy (2003b), the Communication on industrial policy in an enlarged Europe (2002) and the Green Paper on Entrepreneurship in Europe (2003a), form a ‘coherent framework for the development of an enterprise policy that fosters competitiveness of companies and contributes to the growth of Europe’s economy’.

Thurik 2005; Cincera and Veugelers 2014; Henrekson and Sanandaji 2017) or the reflections about the role of economic policies at the macro level to encourage high-quality entrepreneurship and stimulate employment and innovation (Román, Congregado and Millán, 2013). Another relevant study presented by (Ramlogan and Rigby, 2012) examines the effectiveness and impacts of a number of regional and national publicly supported policies for entrepreneurship development.

By contrast,

The results in this section could contribute on addressing this research gaps on the identification of the strategic topics that have led entrepreneurship policy from an EU perspective. In this sense, putting all these pieces in context can illustrate the interest of the academia on entrepreneurship policy in Europe and the gaps worth exploring. For that purpose, the notion of ‘policy cycle’ as previously introduced can be used. Drawing from this theory and the literature review conducted, Fig. 27 shows that scholars’ attention has been concentrated on the last stage within the policy cycle, but there is a research gap in the rest of the stages. This situation does not only apply to the EU, considering that some authors have noted that the academia has shown limited interest on the study of the initial stages of the policy cycle in the field of enterprise policy (Arshed, 2017).

Fig. 27 - Conceptualization of the policy cycle process and its link to research focus on entrepreneurship policy. The paper focuses on the dark shaded area. Source: Own elaboration.

Within this context, results in this section provides granularity to understand in detail the evolution of this entrepreneurship policy domain within the entrepreneurial ecosystem in the initial stages of the policy cycle, extending previous attempts that in any case stops at the early 2000s.

Preprocessing and preliminary analysis

The results of pre-processing and stemming for the corpus EU policy are as follows. The corpus EU Policy started with 31,283 root terms, which were reduced initially to 21,111 root terms after the stemming process and then to 9,013 root terms after pruning out the less frequent root terms³⁶, seeking a trade-off between relevance of the terms and requirements in terms of process time and memory resources. The pruning process of the whole data set, before the analysis, is recommended in those cases where there is an excessive number of terms, as this is the case with more than about 10,000 terms per corpus (Ertek, Tapucu and Arin, 2013).

The preliminary analysis consists of the absolute word frequency, measured as the total occurrences of a word within the corpus EU Policy after having pruned out irrelevant elements and consolidating those terms with similar meaning by using the Porter stemmer as explained in previous methodology section.

Fig. 28 shows the most repeated words stems in the whole corpus. *State*, *country*, *member* and *nation*, all gathered as a single term, are the most repeated concepts in this corpus, followed by *European* at 2nd, all of which are rather obvious results for EC documents. Considering topics related specifically to the economics of entrepreneurship, *employ*, *work*, *labour* and *job*, grouped as a single concept, rank at 3rd in the analysed EC Communications; followed by *market* at 6th, *economy* at 7th, *sector* at 17th, *industry* at 29th and *growth* at 30th, thus, highlighting which are the policy priorities at the EU. In addition to *policy*, which appears at 5th place as the general theme of this research, a number of related terms surface in the corpus, such as: *programme* at 8th, *support* at 10th, *measure* at 16th, *strategy* at 34th, *competition* at 38th, *plan* at 47th, *regulation* at 63rd and *legislation* at 66th. *Innovation* appears at 18th, accompanied by *research* at 19th and *technology* at 32nd, which are indicators of the high relevance attached to new technologies as the base for innovation and entrepreneurship from the point of view of policymakers. Financing-related terms are a next group of interest, with *finance* at 12th, *fund* at 20th and *invest* at 22nd.

A significant group of terms are those related to education, with *education* at 28th, *train* at 39th and *skill* at 70th, which points to a gap in the investigation on human capital in the entrepreneurship policy research agenda, due to its absence there. The business perspective is represented by *firm*, *company* and *enterprise*, all of which are grouped-ranked at 14th, while *business* is at 26th and *entrepreneur* is at 180th. The social point of view is quite frequent, since the term *social* emerges at 11th, with *people* at 44th, *sustainability* at 55th and *participation* at 61st. From a geographical point of view, in addition to the European and national references, the regional level is also significant with *region* at 23rd.

³⁶ Root terms with less than 40 occurrences were pruned out.

Fig. 28 - Top 50 most frequent word stems within the corpus EU Policy by absolute number of occurrences (1990–2016)

Similar studies were carried out in each five-year period, since 1990–2016, except for the last period (2015–2016), which only comprises of two years as shown in Figs. 29–34.

As mentioned, employment is one of the main themes for the EC during the period 1990–2016, with *employ-work-labour-job* all four terms grouped always in the top 3 during the whole period. Similarly, the term *economy* is mostly placed around the top 10, ranging from 14th and 12th position in 1990–94 and 1995–99 to 8th in 2000–04, 7th in 2005–09, 8th in 2010–14 and 10th place in 2015–16. Comparing *industry* and *sector*, while relevance of *industry* is declining from 6th in 1990–94 to 21st in 1995–99, 44th in 2000–04, 52nd in 2005–09 and 83rd position in 2015–16, *sector* remains stable -and lately above *industry* – moving from 23rd in 1990–94 to 19th in 1995–99, 16th in 2000–04, 30th in 2005–09, 17th in 2010–14 and 25th in 2015–16.

Within the policy domain, it is interesting how *regulation* and *legislation* present a similar evolution from positions around 100th in 1990–2004 increasing to around top 50 in 2005–2016, an indication of the EC position about how entrepreneurship policy is becoming actionable through specific legislative measures.

The evolution of the relevance of *innovation* is quite consistent, starting at 112nd position in 1990-94 and then going up to 30th and 31st in 1995-99 and 2000-04 and finally ranking at 10th place both in 2005-09 and 2010-14 and 20th in 2015-2016. On the contrary, *technology* and *research* movement to lower positions since 2010 is obvious, starting at 33rd and 17th in 1990-94; 18th and 23rd in 1995-99; 33rd and 17th again in 2000-2004; 41st and 13th in 2005-09, and then falling to 60th and 31st in 2010-14 and 80th and 132th in 2015-16, respectively. However, the progress of *digital* and *data* is the opposite, with very limited occurrences up to 2009, but then they respectively emerge at 144th and 75th in 2010-14 and overall at 37th and 44th in 2015-16.

The importance of *investment* is growing from 38th and 36th positions in 1990-94 and 1995-99, to 28th in 2000-04 and 26th in 2005-09, and 16th in 2010-14 and 7th in 2015-16. Similarly, *fund* is at 27th in 1990-94, 31st in 1995-99, 37th in 2000-04, 25th in 2005-09 and then rise to 11th in 2010-14 and 9th in 2015-16. It is also remarkable the evolution of *growth*, which stays at 142nd and 81st in 1990-94 and 1995-99 and then goes up to 38th in 2000-04, 17th in 2005-09, 20th in 2010-14 and 35th in 2015-16.

Following the ecosystem framework displayed in the Fig. 5, it is also possible to briefly analyze the six domains³⁷ proposed for the entrepreneurial ecosystem. First, *market* is a very relevant term during all the considered period, ranking at the top 10 until 2010 and even at the top 5 during 2010-16. *Policy* is at 13th in 1990-94 and then rise to 9th in 1995-99, 5th both in 2000-04 and 2005-09, to then decrease to 7th and 12th in 2010-14 and 2015-16th. The evolution of *finance* is similar: after an initial rank of 10th *finance* remains between 10th and 20th place during 1995-2009 and then rises to the 4th position in 2010-14 and 2015-16, a result consistent with the evolution of *invest* previously described.

Human capital increasing relevance could be analyzed through the evolution of concepts as *education*, *people* or *skill*. *Education* is one of the hot topics since 2000 when remains constantly in the top 25 after previous ranks at 37th in 1990-94 and 168th in 1995-99; and *skill*, which is far from the top 100 in 1990-94 and 1995-99, but then goes up to 73rd in 2000-04, 57th in 2005-09, 49th in 2010-14 and 52nd in 2015-16. On a side note, *culture* is not very significant, and it is always placed around 200th position or even lower during 2015-2016.

Adopting an agent perspective, *firm-enterprise-company* the three terms all grouped are above *sme* and *entrepreneur*, during all considered periods except in 2010-2014, when they are about the same level with *sme* at 29th and *firm-enterprise-companies* at 34th. However, at the same time it is possible to observe that *firm-enterprise-company* relevance is decreasing from 8th place in 1990-94 to 10th in 1995-99, 14th in 2000-2004, 19th

³⁷ The Babson Entrepreneurship Ecosystem Framework also includes ‘Supports’ as a domain of the ecosystem. It covers a range of heterogeneous components such as physical infrastructure (telecommunications, energy, incubators...), support professions (lawyers, accountants,...) and non-governmental institutions (conferences, associations...). Despite the term ‘support’ is at the top 50 for all the periods with the exception of 1995-99, this thesis could not fully ascertain its pertinence within the entrepreneurial domain.

in 2005-2009, 34th in 2010-2014 and 50th at 2015-16. And during the last period, ‘sme’ goes down at 179th and it is surpassed by the rise of ‘startup’ at 146th.

Social is also a key topic in the corpus EU policy, staying at the top 20 during all periods since 2000, being placed formerly at 21st in 1990-94 and 35th in 1995-1999. Then, it goes up to 6th position in 2000-04, 16th in 2005-09, 14th in 2010-14 and 18th in 2015-16. Related to *social*, *people* evolves from 152nd in 1990-94, 117th in 1995-99, 35th in 2000-04, 48th in 2005-09, 67th in 2010-14 and 34th in 2015-16; and it is also significant the emergence of *youth*, which is not even in the top 500 during 1990-94, 1995-99 and 2000-04, then rises to top 200 in 2005-09 and 2010-14 and finally goes up to 73rd in 2015-16, showing the increasing importance of youngsters from the policymakers entrepreneurial point of view.

Looking at the geographical dimension, national and European levels are obviously the most repeated words all the periods. However, regional and local levels have disparate trajectories. ‘Region’ ranks 26th in 1990-94, 22nd in 1995-99 and 2000-04, and then peaks at 12th in 2005-09, to decrease to 27th in 2010-14 and 67th in 2015-16, while *local* is lately almost disappeared starting at 82nd in 1990-94, 72nd in 1995-99, 57th in 2000-04, and then moving to 214th in 2005-09, 250th in 2010-14 and 207th in 2015-16.

Fig. 29 - 50 most frequent word stems for the corpus EU Policy in 1990-1994

Fig. 30 - 50 most frequent word stems for the corpus EU Policy in 1995-1999

Fig. 31 - 50 most frequent word stems for the corpus EU Policy in 2000-2004

Fig. 32 - 50 most frequent word stems for the corpus EU Policy in 2005-2009

Fig. 33 - 50 most frequent word stems for the corpus EU Policy in 2010-2014

Fig. 34 - 50 most frequent word stems for the corpus EU Policy in 2015-2016

Cluster analysis

The next stage in the analysis of this phase 2 consists of the usage of the K-Means clustering algorithm to group similar documents of the corpus together and drill into the categorisation and relationships between terms. The K-Means algorithm needs the a priori selection of the optimal value for the number of clusters. For this reason, this analysis starts with a subsequent evaluation of the K-Means clustering results for a range of values of k , from four to thirteen, by comparing their performance using the Davies-Bouldin Index. In fact, the standard approach for the selection of the number of clusters in partitioning algorithms, such as K-Means, is determined typically by running independent analysis for different values of k and evaluating the significance of resulting partitions (Jain, 2010).

In this case, the Davies-Bouldin index minimum values correspond to nine, eleven, twelve and thirteen clusters. Therefore, this research examines the results of the analysis from four to thirteen clusters. Starting with four clusters, the groups result in: (i) *Digital Technologies–Innovation–Research*; (ii) *Primary sector–Culture–*

Environment–Energy; (iii) *SMEs–Business– Finance*; and (iv) *Education–Inclusion*. The five-cluster partition isolates *Migration* as a particular topic in a specific group. In the case of six clusters, *Migration* merges with *Digital Technologies–Innovation*, and *Research* emerges as a separated theme from *Digital Technologies–Innovation*. Advancing to seven clusters, *Migration* becomes a separated topic again and both *Research* and *Primary sector–Culture* are also separated from *Digital Technologies–Innovation* and *Environment–Energy*, respectively. Eight clusters introduce *Employment* as a new theme, grouping concepts related to labour. The nine-cluster partition adds a broad new cluster that could be summarised as *Infrastructures–External relations*. Likewise, that broad new cluster is split in two in the ten-cluster analysis, being *Infrastructure* and *External relations*. In the eleven-cluster analysis, *Taxation–Regulation* is separated from *SMEs–Business–Finance*. The twelve-cluster analysis divides *Digital Technologies* and *Innovation–Research* in two separated clusters, and it maintains the rest of the themes. Finally, the thirteen-cluster analysis separates *SMEs–Business* from *Finance*, and it maintains the rest of the aforementioned themes. From the perspective of this thesis, this thirteen-partition clustering is a rather meaningful combination of the main themes for entrepreneurship policy in the EU.

Results of the cluster analysis are summarised in Table 7 for the thirteen clusters, by means of the top 20 concepts in each case. Similarly, the remaining results of the supervised cluster options are shown in the Tables 25 – 33 in the Annex 2. Likewise, the defining topics of each cluster could be used to classify the EC Communications related to entrepreneurship policy, as shown in Fig. 35.

Fig. 35 Distribution of EC Communications (Corpus EU Policy) related to entrepreneurship for the thirteen-cluster taxonomy (1990–2016)

The next step of the cluster analysis is to study the evolution of the thirteen-cluster partition by lustrums during the period 1990–2016. Fig. 36 shows the results of this analysis. Some of the more remarkable differences, among periods for each theme of the thirteen-cluster partition, are exposed in the following. The cluster on *Research–Innovation* peaked during 2000–2004, just when the Lisbon Strategy was adopted, and it remained stable until 2015. *Digital Technologies* presents a similar behaviour, with a peak in the number of documents up to 2015, correlating with the launch of the Digital Single Market Strategy in 2015 and the legislative initiatives connected to relevant topics—like collaborative economy or digital platforms. The relevance of *SMEs–Business* grew from 1995 to 2014 and then decreased dramatically, which was coherent with the deceleration of the specific SME policy developed by the EC. *Regulation–Taxation* increased the number of documents since 2005, simultaneously with the global financial crisis that burst in 2007–2008 and the subsequent period of recession and public intervention. *Finance* became relevant since 2000 and shows a significant growth in the percentage of documents belonging to this topic in the last period, 2015–2016, highlighting the recent interest on public support through venture capital of entrepreneurship.

The behaviour of *Inclusion* presented a peak in 2000–2004, when the Lisbon Agenda was adopted, but it decreased in 2005–2009; however, it started to grow again in 2010, as a consequence of the adoption of the Europe 2020 strategy. *Employment* reached a maximum in 2000–2004 when entrepreneurship was considered as a pivotal activity to reduce unemployment; however, it started to decline in 2010 when most of the goals of the Lisbon Agenda were not achieved. On the other hand, *Education* became relevant in 2000 and strengthen its position by 2005, coinciding with the Lifelong Learning Programme launched by the EC in 2007 and the later consideration of entrepreneurial skills as key competences. Similarly, *Environment–Energy* grew by 2005 and reached a maximum number of documents in 2010–2014, coherent with the focus of the Europe 2020 strategy on sustainability and efficiency in the use of resources. *Tourism–Culture–Primary sector* is a broad topic that reached its maximums during 2005–2014 and then declines. Similarly, *Infrastructures* grew during 2000–2010, coinciding with some standardisation and interoperability initiatives at the EU level. Finally, *Migration* emerged in 2005 and picked up momentum again in 2015; whereas, *External relations–Justice* had a peak in the number of documents during the accession of East European countries in 2000–2004, and it increased again in 2015, as a consequence mostly of the new negotiations about trade agreements.

Fig. 36 - Evolution of the relative weight of EC communications related to entrepreneurship in the thirteen-cluster taxonomy for each five-year period (corpus EU Policy, 1990–2016)

Table 7 - Top 20 relevant word stems for the thirteen-cluster analysis of the corpus EU Policy (1990–2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
	<i>Research - Innovation</i>	<i>Inclusion</i>	<i>Taxation - Regulation</i>	<i>Education</i>	<i>Migration issues</i>	<i>Tourism - Culture - Primary sector</i>	<i>Employment</i>	<i>Environment and Energy</i>	<i>External relations - Justice</i>	<i>Infrastructure</i>	<i>SMEs - Business</i>	<i>Digital Technologies</i>	<i>Finance</i>
1	research	gender	tax	youth	migrat	tourism	unemploy	energi	textil	standardis	smes	ICT	euro
2	biotechnolog	women	crisi	educ	immigr	maritim	labour	carbon	Turkey	transport	craft	digit	ventur
3	patent	poverti	singl	learn	asylum	cultur	pension	eco	trade	safeti	entrepren	internet	EIB
4	innov	men	energi	teacher	refuge	heritag	Lisbon	emiss	WTO	Africa	enterpris	onlin	investor
5	scienc	equal	consum	student	visa	urban	wage	green	judici	railway	up	space	loan
6	panel	children	vat	school	irregular	marin	employ	raw	corrupt	port	bankruptcy	interoper	capit
7	cluster	mainstream	reform	languag	traffick	sea	worker	wast	court	rail	insolv	satellit	cash
8	excel	inclus	fiscal	lifelong	return	coastal	tax	electr	export	logist	burden	broadband	equiti
9	industri	discrimin	citizen	teach	resid	fish	ESF	environment	enlarg	aviat	multiannu	electron	bank
10	manufactur	famili	digit	univers	illeg	creativ	reform	renew	justic	accid	internationalis	commerc	EIF
11	knowledg	exclus	bank	train	admiss	rural	older	recycl	acqui	road	commerc	comput	currenc
12	ICT	disabl	transposit	skill	recept	ERDF	age	materi	solidar	health	busi	telecom	asset
13	technolog	health	stabil	peopl	seeker	fisheri	rate	climat	Balkan	navig	cluster	spectrum	payment
14	Lisbon	inequ	burden	adult	origin	citi	GDP	gas	food	African	micro	user	amount
15	horizon	decent	border	graduat	arriv	farm	women	industri	negoti	energi	charter	deploy	pension
16	SMEs	pension	euro	mobil	eastern	biodivers	guidelin	water	parti	surveil	procur	data	liabil
17	societ	incom	enforc	qualif	host	travel	expenditur	fuel	reform	Galileo	vat	platform	debt
18	team	labour	procur	Erasmus	labour	local	gender	clean	energi	enlarg	failur	copyright	credit
19	ethic	care	unemploy	apprenticeship	border	agricultur	job	bio	Ukraine	infrastructur	observatory	telecommun	revenu
20	dissemin	age	recoveri	vocat	crime	anim	cohes	consumpt	Western	mode	ventur	signatur	statement

4.3 Phase 3 – AI (and EdTech) ecosystem in China

This section presents the outcomes of the extended case study about the AI (and EdTech) innovation ecosystem in China, according to the specific analytical framework presented in the section 3.4.3. With a different approach than phases 1 and 2, this phase 3 of the thesis is exploratory in nature and support the theoretical research on the current AI ecosystem in China that updates previous attempts at characterization to provide a conceptual scheme of analysis in a more systematic way. In this sense, results in this phase are based on document analysis, an in-depth qualitative study and on interviews with experts and relevant stakeholders.

As a context, it is relevant to note that the potential of AI and related technologies and sectors as the case of EdTech have not been lost on China's policymakers. Words by President Xi³⁸ introduced in the section 1.3.2. that are the main example of this. In fact, the government has, since 2015, launched a series of key national economic initiatives that touch upon AI and its areas of development, the foremost being the 13th Five Year Plan, the Made in China 2025 initiative, the Robotics Industry Development Plan, the Internet Plus Artificial Intelligence Three-Year Implementation Plan, and the Next Generation Artificial Intelligence Development Plan. In a nutshell, the aim of these plans is making China the world's leading AI power by 2030. Also, President Xi declared at the International Conference on AI and Education in May 2019 that China is willing to work with other countries in discussing issues related to AI and innovative education adaptation amid AI's rapid development.

Within this context, this section summarizes key insights from the collected evidence following the revisited ATH model displayed in the Fig. 11. Results are presented in the same section considering that AI ecosystem in China encompasses the majority of EdTech solutions. Particularly, it starts with the review of both the general and specifically-related-to-AI government and policy initiatives since 2014 (section 4.3.1). This analysis aims at the validation of the base hypothesis of this phase of the research on the central role that the institutional bodies - including regions and cities- are playing in the innovation ecosystems in China. From there, section 4.3.2. continues with an investigation of the most relevant AI projects under development in China led by the main –most valued- large companies and start-ups and, in a third step, section 4.3.3. reviews of the status from universities, research centres and government funded research-oriented initiatives. Next, section 4.3.4. examines the dynamics of the AI ecosystem, this is, the relationships between the three main helices / stakeholders. For this the researcher has selected venture capital (government-industry relationship), human capital (industry-universities relationship), knowledge production (universities-industry relationship), and data availability framework (government-industry relationship).

³⁸ President Xi stated that (China) '... should unswervingly follow an independent innovation path featuring Chinese characteristics, stick to the guiding principles of independent innovation, leap-frogging development in key sectors and development supported by science and technology and oriented towards the future' (Xi, 2014),

Finally, the results of these dynamics are captured in a section 4.3.5., detailing a range of selected case studies with a specific section about EdTech solutions.

Government

Due to the political system of China, the framework for the development of any innovation ecosystem depends largely on policies and governmental bodies' initiatives, both at national and regional/local level. These initiatives consist basically in measures to provide:

- (i) Favourable regulations.
- (ii) Subsidies and financing in advantageous conditions.
- (iii) Providing access for eligible companies to databases of personal information,
- (iv) Favours the implementation of tech-based solutions for security, safety and other public objectives related to control and social engineering across the country. As a main example of the latter note that the social credit system run by different companies and pilot deployments in China includes the punishment for those with low scores of impeding access to the public education system.

National initiatives

Table 8 summarizes all the national AI policy initiatives in China in the period 2015-2018. They are classified by the supporting entity, the position within the AI value chain, and the aim of the initiative.

Table 8 – AI policy-related initiatives at the national level in China (2015-18). Source: Own compilation.

Initiative	Launch date	Supporting entity	Position within the AI value chain	Vision/aim
Made in China	20 May 2015	State Council	Industry	China will become an advanced and prestigious manufacturing power by 2025
Internet +	4 July 2015	State Council	Services, infrastructure	Creating an industrial ecology of active innovation, open cooperation, and coordinated development
Robot Industry Development Plan	27 April 2016	Ministry of Industry and Information Technology, National Development and Reform Commission, Ministry of Finance	Industry	Development of intelligent industrial and service robots

13th Five-Year Plan for National Science and Technology Innovation	28 July 2016	State Council	Science and Technology, Industry	AI as a key element of the research and development and innovation strategy
Consumer Goods Standards and Quality Improvement Plan	6 September 2016	State Council	Apps/content	Commercialization, patentability, and standardization of several technologies (including AI)
Cybersecurity Law	1 June 2017	Standing Committee of the National People's Congress - State Council	Apps	Establish the legislative framework on cybersecurity
Notice on 13th Five-Year Plan for National Strategic Emerging Industries	19 December 2016	State Council	Industry	Promote AI application in key economic and social fields
Opinions on Promoting Healthy and Orderly Development of Mobile Internet	16 January 2017	CPC Central Committee General Office – State Council	Services	Step up the layout of key AI technologies across mobile industries
New Generation AI Development Plan	8 July 2017	State Council	Apps/content, Services, Infrastructure, Industry, R&D	Use the first-mover advantage and build a world science and technology powerhouse in the field of AI
Three-Year Action Plan to Upgrade Manufacturing Sectors	29 November 2017	National Development and Reform Commission	Industry	Stimulate growth in key industries and develop robots with autonomous programming, human-machine collaboration, and dual-arm collaborative robots
National-Level Innovation Platform for Intelligent Vehicles	29 March 2018	National Development and Reform Commission	Infrastructure, Industry, R&D	Solve the problems and obstacles in the development of intelligent vehicles, attracting key enterprises, encouraging overseas mergers and acquisitions, and enhancing the research and development capabilities of intelligent vehicles

From the analysis, it is apparent that, since 2015 a number of strategic initiatives addressing the whole value chain have proliferated (Fig. 37), starting with a specific focus on industry development and slowly taking up all the other elements in the value chain.

A summary of the contents of these initiatives includes (i) the support for the involvement of public and publicly aligned companies, (ii) standardization as a strategic thrust, (iii) innovative purchases from governmental bodies, (iv) issuing and enforcement of all type of regulations and regimes – such as intellectual property, (v) addressing the interactions between the industrial–military complex and the civil sectors, (vi) the promotion of human capital, (vii) the availability of financing, and (viii) the facilitation of access to data.

Fig. 37 – Key national initiatives that touch upon AI in China (2015–2019). Source: own elaboration.

Missing elements until the end of 2018 were the research in fundamental challenges in AI and the ethics debate on AI. About the former, it is interesting to note that all the main companies in AI in China keep research centres in the US as a means to gain access to potential upcoming disruptive developments. About the latter, the regulatory focus in China is mostly on how to place AI within the scope of the rule of law and not referring to issues related to the transparency and accountability of the algorithms. In this respect, until very recently, an opinion generally held by experts in China was that, with the existing level of technical development, the existing laws and regulations were enough to solve the problems (People's Daily, 2018; Tan, 2018). However, lately some voices have called for new legislation (Cao, 2018) and new regulation is being proposed as of 2019 to curb the excessive gathering of personal data by private companies, and also proposals for self-regulatory AI code of ethics although without much clues on its enforcement.

Arguably, the most salient examples of the influence of these framework conditions are the multiple and successful solutions based on voice, image and facial recognition systems that are already being deployed, and the different solutions aimed at the so-called social credit -rather trust or reputation- system for citizens and companies. Pending issues in these deployments, however, are lack of standards, issues about the compatibility of solutions, bureaucratic inefficiencies (Godement *et al.*, 2018), and technological limitations.

Regional /local initiatives

Similarly, there are also many initiatives taking place in China at the regional and local levels, supported by the respective governments, see Table 9 for a compilation of initiatives of TIER1 and most relevant TIER2 cities in the period 2017-2018. In general, China has 17 national-level innovation demonstration zones, which were selected by the State Council and enjoy favourable policies to encourage innovation and regional economic growth. Most of the opportunities lie in the East (Beijing, Shanghai, Hangzhou, Guangzhou and Shenzhen), with the major exception of Chengdu in Sichuan province, although all the main cities have shown commitment to the development of AI. Precisely, one of the main features of the AI innovation ecosystem in China from the policy point of view is the particular type of competition for talent between different locations – or clusters of locations – and particularly the new policies launched by second-tier cities.

From the analysis, it is possible to conclude that policy in China is developed on a top-down basis, but relevant initiatives are also put into practice as experiments at the regional and local levels with the aim of extending those successful projects to other areas or even the whole country. The approach to policy making is radically practical, based on several different – sometimes hardly compatible – strategies, all of them based on a trial-and-error approach by testing new policies in pilot projects. Depending on the outcomes of these tests, policies are abandoned, refined, or rolled out across the country (Stepan and Duckett, 2018).

Table 9 – Main regional/local initiatives related to AI in China (2017-18). Source: Own compilation.

	Beijing	Shanghai	Shenzhen	Nanjing	Wuhan	Guangzhou	Hangzhou	Chengdu
Area(s)	Venture capital, talent, support facilities	Talent, venture capital, support facilities	Talent, venture capital	Talent, critical mass	Talent, critical mass	Support facilities	Support facilities	Talent, critical mass
Vision/ Aim	AI-oriented funds; enhancing AI talent and support facilities Establishing a demonstrative hub for innovative development in Xionggan	Promoting talent in emerging technologies; large AI-oriented fund; innovative parks for start-ups	Investment angel funds; large grants for scientific teams (Peacock Initiative), facilitating access to Hong Kong	Special residence visa (hukou) for skilled workers, subsidies to attend job interviews, housing advantages	Residential community to attract graduates through discounts on rentals	Industrial parks related to the manufacturing industry	Incubators partly subsidized by the Government for entrepreneurs (former workers of Alibaba)	One week of free accommodation for fresh graduates, promoting quality of life,

Industry

Following the ATH model, the second step of the analysis addresses the role of the different types of businesses within the ecosystem. According to the analysis, overarching results show a preference of technology companies to address mass markets, and also how traditional industries need to work with technology companies to develop specialized AI in a lengthy process with lower returns on investment (Lucas, 2018).

Large companies

From the analysis, it can be noticed that three different groups of large established companies play a leading role: (i) the big three internet giants in China—Alibaba, Baidu, and Tencent—each with a particular focus on ecommerce, location/navigation and healthcare respectively, and overlaps in payments and social networks; (ii) a second group of large companies partially involved in AI, including the ride-hailing company Didi Chuxing, the on-demand service provider Meituan-Dianping, the mobile handset and network equipment manufacturer Huawei (and also ZTE and Xiaomi, respectively in networks and handsets), and the speech and language recognition firm iFlytek – formerly a unicorn³⁹; and (iii) a third and last group of large foreign tech companies – mostly from the US – that have set up research centres and joint ventures in China to position themselves in what they thought could be a promising innovation landscape, such as Apple, Amazon Web Services, Google and Microsoft. No European large company holds any relevant position in the AI innovation ecosystem, to the author’s knowledge with the minor exception of Siemens in so-called ‘industry 4.0’.

Fig 38 displays the areas of these three groups of large companies in China’s AI innovation ecosystem. As a summary, China’s large companies are both particularly supportive of the government initiatives and use the positive perception of consumers to experiment with applications that are unheard of outside China, mainly in areas related to online consumption, security, public safety, public administration and social networks.

In addition, the limited number of top companies in AI in China, as in technological sectors elsewhere, causes investors to tend to bet on two to three dominant players, and these dominant players usually capture most of the emergent start-ups to ensure the continuation of their dominant positions, in particular in general consumer-related markets. Related to this growth strategy, another common approach across large companies in AI in China is funding research centres abroad (mainly in the US) in addition to the centres on the Chinese mainland.

³⁹ Lately, Bytedance could well belong to this section (it is still included in the next section on start-ups), not only for its valuation, but also because of its decision on finding its own space disregarding acquisition offers from Tencent. Bytedance uses AI to engage users, among others, with images and short videos (Douyin, Tiktok, Helo, ...) and news (Toutiao).

As mentioned, their aim is to tap into new knowledge and potential disruptive advancements in this domain. At the same time, US companies -Google, Microsoft, Apple- keep research centres in China to tap on knowledgeable human capital and attract developers (and market) to their platforms. Also, it is worth to mention that the hardware and software driving most of China's AI comes from US companies – chips from Qualcomm and Nvidia and software from Google's TensorFlow. Since the US ban – now rescinded – on ZTE and the complicate situation with the Huawei case, all the main Chinese tech companies have accelerated their plans – within the 2025 Made in China policy – to build their own AI chip sets, aiming to achieve a higher level of independence in chip manufacturing or even leap-frogging it towards specialized AI chips, but the current situation is that China's semiconductor industry is still lagging behind.

Fig. 38 – Areas of specialization of the main large companies in China's AI innovation ecosystem (2017-18). Source: own elaboration.

Start-ups

Table 10 summarizes all the reported AI related start-ups in China that reached unicorn status in 2017-18, including a brief description of the main aspects of the projects that they lead, and their market value.

Table 10 – Valuation and headquarters of AI-related unicorns in China as of January 2019. Source: own elaboration based on market analysts' data.

Company Name	Headquarters	Aim / Description	Market Value (\$bn)
Pony.ai	Freemont (CA)	Autonomous driving	1.0
Mobvoi	Beijing	Voice recognition, natural language processing, and vertical search technology in-house	1.0

Tongdun Technology	Hangzhou	Intelligent risk management and decision making	1.0
iCarbonX	Shenzhen	Personalized health care	1.0
Momenta	Beijing	AV perception software	1.0
Unisound	Beijing	Voice technology and AI chip for NLP applications	1.0
Face++	Beijing	Image / facial recognition technology	1.0
17zuoye	Shanghai	Personalized education platform	1.0
4Paradigm	Beijing	Anti-fraud for insurance and banking	1.2
Horizon Robotics	Beijing	Robotics	1.5
Yitu Technology	Shanghai	Facial recognition technology and medical imaging and diagnostics	2.4
Cambricon	Beijing	Neural AI processors	2.5
Cloudwalk	Guangzhou	Facial recognition technology	3.3
SenseTime	Hong Kong	Image / facial recognition technology	4.5
Ubtech Robotics	Shenzhen	Robotics	5
DJI	Shenzhen	Drones	15
Bytedance	Beijing	Personalized videos and news curation	75.0

Most of the unicorns are based in Zhongguancun in Beijing (the so-called China's Silicon Valley), though there are others located in Shenzhen (more hardware-related), Shanghai (service-related), Hangzhou (around the Alibaba's ecosystem) or Guangzhou. This is another indication of opportunities being concentrated in some regional/local specialized clusters competing for attractiveness. In the case of AI, although there is considerable competition for talent and the ubication of AI-related start-ups between regions and cities in China, most of the relevant universities, venture capital and national government connections are located in Beijing.

Regarding the specialization domain, the ratio of unicorns based on advanced scientific research capability (health care, biotech, software, robotics, AI, etc.) is still higher in the US than in China as of 2019 in general. Chinese unicorns are more focused on platforms and business serving directly consumers' needs (B2C). Some analysts have remarked that these features reflect, on the one hand, that China's consumer market is large and emerging and, on the other, that China is still in the catch-up phase in terms of science and technology development with respect to the US (Credit Suisse, 2019).

It should also be noted that, although there are no foreign-owned AI unicorns in China, there is considerable activity of non-fully Chinese AI-related start-ups in China. Sometimes they use the traction of the Chinese market – a very tough market but with easier access to medium-sized companies – to gain additional momentum and return to their home region or extend into third-country markets.

Universities and research-oriented institutions

The third step of the ATH analysis addresses the role of universities and research institutions with regard to AI development in China. Table 11 displays the initiatives of the top research institutions in the period 2017-18.

Table 11 – Main AI initiatives in China in top universities and research institutions (2017-18). Source: own compilation.

Institution	Main initiatives in AI	Area / Fields
<i>Tsinghua University</i>	<ul style="list-style-type: none"> State Key Laboratory of Intelligent Technology and Systems 	Computer science – general research
<i>Peking University</i>	<ul style="list-style-type: none"> Department of Machine Intelligence (formerly Center for Information Science) 	<p>Interdisciplinary research (ten departments, including mathematics, computer science, and electronic engineering)</p> <p>Machine perception, intelligent information processing, and machine learning</p>
<i>Zhejiang University</i>	<ul style="list-style-type: none"> College of Computer Science and Technology 	Computer science and technology – general research
<i>Shanghai Jiaotong University</i>	<ul style="list-style-type: none"> Intelligent voice technology – computer science department School of Artificial Intelligence 	<p>Computer science – intelligent voice technology</p> <p>Fundamental theory and technology, chips and system architecture, and applications such as smart cars</p>
<i>University of Science and Technology of China</i>	<ul style="list-style-type: none"> Huangpu (Whampoa) Military Academy 	Industrial automation, intelligent equipment control, pattern recognition, and intelligent information processing
<i>Xi'an Electronic and Science University</i>	<ul style="list-style-type: none"> School of AI 	Electronics and science – general research
<i>Nanjing University</i>	<ul style="list-style-type: none"> Artificial Intelligence School Nanjing Branch of JD Artificial Intelligence Research Institute 	<p>Machine learning, data mining, pattern recognition, information retrieval; evolutionary computation, neural computing and their applications</p> <p>Cognition and reasoning, machine learning; natural language understanding, computer vision, robotics, game and ethics</p>
<i>Changchun University of Science and Technology</i>	<ul style="list-style-type: none"> Artificial Intelligence School 	Interdisciplinary research (e.g. Photoelectric technology, precision manufacturing, computer science, information communication, quantum and nanotechnology)
<i>Wuhan University</i>	<ul style="list-style-type: none"> AI joint laboratory (Xiaomi Inc. and Wuhan University) 	Machine translation, emotion recognition and calculation, image enhancement and noise reduction, image in depth information calculation, task-based conversation context natural dialogue generation, speech processing, intelligent question and answer
<i>Chinese Association for Artificial Intelligence (CAAI)</i>	<ul style="list-style-type: none"> The CAAI is the only state-level science and technology organization in the field of AI in China 	Unite artificial intelligence science and technology professionals – general research
<i>National Key Laboratories</i>	<ul style="list-style-type: none"> National Engineering Laboratory for Speech and Language Information Processing (NEL-SLIP) National Engineering Laboratory of Virtual Reality (VR)/Augmented Reality (AR) Technology and Application National Engineering Laboratory of Brain-Like Technology and Application 	Computer science and technology – general research
<i>Sinovation</i>	<ul style="list-style-type: none"> Privately run research centre on AI 	Upgrade thousands of traditional companies across China using AI, in particular the big state-owned enterprises – general research

As a summary, universities and research-related institutions play two pivotal roles in AI development: (i) the provision of talent, and (ii) the production of knowledge, which are achieved not only by training new scientific and technological talent but also by conducting basic research. This means moving beyond the focus on increasing the absolute number of students and experts, and placing greater emphasis on the quality of education (Zhang Jun, 2018).

This new strategic focus is reflected in the shift in the training and research within the AI field. Previously, AI teaching and research were carried out through the cooperation between the faculties/schools of the related majors (such as computer science, mathematics, and electronic engineering). But in April 2018,⁴⁰ the Ministry of Education issued the ‘AI Innovation Action Plan for Colleges and Universities’. It proposes to establish one hundred ‘AI+X’ specialization categories, publish fifty world-class teaching materials for undergraduate and graduate studies, develop fifty national-level high-quality online open courses, and establish fifty artificial intelligence faculties, research institutions, or interdisciplinary research centres by the year 2020. The plan also suggests introducing education for AI at the level of primary and secondary schools (already going on at selected locations), although experts disagree about its need and real impact.

The result is that already a range of specialized graduate and postgraduate schools of AI has been founded, and the main Chinese universities are launching educational programmes and research opportunities in AI.

Regarding research, the main organization to launch calls to fund research is the National Natural Science Foundation of China (NSFC). As of 2017-18, their calls in AI were mainly oriented towards three aspects: (i) frontier research on artificial intelligence; (ii) the intelligent autonomous body; and (iii) intelligent decision making of complex processes.

As an additional relevant insight, China’s academic institutions aim to increase their international exposition up (Chen & Li, 2019). Therefore, although China’s AI innovation ecosystem is developing relatively independently from that in other countries, researchers based at universities and research centres in different countries are the main means of connection with other countries’ ecosystems -mainly with the US- through a virtuous circle of sending excellent students to the most prestigious institutions and then promoting the return to China with attractive packages.⁴¹

The overall new role of universities and research-related institutions has resulted in China rising and already leading in AI rankings related to human capital and knowledge production: publications in main journals and conferences, patents, and absolute numbers of new graduates in AI, as discussed below.

⁴⁰ Available at http://www.moe.gov.cn/srcsite/A16/s7062/201804/t20180410_332722.html

⁴¹ In 2008, China launched the Thousand Talent Program to recruit global experts in science in technology. As of 2018, the program brought more than 7,000 experts, mostly overseas Chinese, with about 100 of them top researchers in AI.

Triple helix dynamics

Based on experts' opinions, accompanied by key insights from the desk research, this section examines the main aspects related to the interactions and flows of the agents in the ATH. These relationships are categorized in four types of flows: (i) venture capital, (ii) human capital, (iii) knowledge production and (iv) data, which is aligned with previous approaches emphasizing the exchanges among the agents of the network as drivers of value not being these only material (goods, services) but also intangibles like knowledge or benefits (Allee, 2011). These categories are used also to describe the case studies that represent the dynamics of the AI innovation ecosystem in China in the next section.

i. Venture capital

Starting with financial capabilities, there is a wide consensus of experts acknowledging the apparently 'unlimited' venture capital and government funding support as one of the main assets for the development of AI in China. In fact, as shown by the figures of market analysts, venture capital in China has set a record high in terms of investments year by year with the consolidation of the major role of public-based investment and a deep focus on AI (KPMG Enterprise, 2019; PwC and CB Insights, 2019). There are some potential side effects, mainly due to the risk of 'not smart enough investments', crowding-out more professional investors, creating signs of a financial bubble (Lucas, 2018), and sending expert (private) venture funds to later capital rounds (series B, C, ...) where it is easier to distinguish the real potential of a start-up company (Huang, Pagano and Panizza, 2017). In fact, as a consequence, during 2019, although outside the time scope of the analysis of this thesis, it is worthy to note that the amount of AI funding has decreased significantly with more stringent criteria to evaluate the viability of AI-related start-ups and signalling that the most obvious opportunities to reap the benefits of mass markets were already used.

ii. Human capital

Regarding the human capital capabilities, several experts have acknowledged the quantity and the quality of AI talent as one of the main challenges ahead for the development of the Chinese ecosystem. China has dramatically expanded its technical workforce, both domestically and by attracting foreign talent, but it is still behind the EU and the US not only in terms of the absolute number of experts but also in terms of their level of expertise (Elsevier, 2018; JFGagne, 2018; Ng, 2018).

One of the main questions is how to achieve a large enough provision of AI talent and ensure that the local education system is able to supply well-qualified employees, as the virtuous circle of high school education in China, education at prestigious foreign universities, and later recruitment for a high-end expert talent position

in China might not suffice.⁴² The difficulties of increasing the pool of talent are also related to the knowledge and skill set needed to succeed in the application of AI to a particular domain and the shortcomings of the education system, which is none too prone to innovation/creativity. As one of the experts summarized, ‘there is a need of ground-breaking thinking in the underlying theory’. In this sense, ‘more opening up’ is viewed by the experts as a possible solution.

Similarly, a related issue from experts’ survey refers to the gap between available talent and its application to existing industry, including the non-alignment between research call themes, focused on breakthrough AI technologies, and the practical needs of adoption in (traditional) industry. This appears to be particularly important with respect to fundamental AI research, algorithms and infrastructure.

Also, as previously highlighted, this lack of a sufficient skilled workforce involves a national competition between cities/regions for talent and investments. The accumulation of talent, funds, and opportunities in new tech industries lie mainly in the East, Beijing, Shanghai, Shenzhen, and Hangzhou as the ideal cities in which to locate an AI start-up from the experts’ point of view, with the minor exception of Chengdu.

iii. Knowledge production

Looking at knowledge production, the lack of a common definition of AI and the difficulty of establishing clear boundaries within the AI disciplines are the main challenges to measuring the potential of AI. To cope with these limitations, conclusions combine the survey of experts with data from the most recent research available in addition to a specific analysis conducted in the thesis which examines the Chinese research production in top AI journals,⁴³ checking AI subdomains, and comparing it with US- and EU-affiliated research in the same period. Table 12 presents the results of the classification of 1,408 papers from the top journals in AI in 2017, considering the main AI subdomains and the authors’ affiliation. As a summary, China leads in the general classification and in every subdomain, with the exceptions of computer vision and perception and natural language processing and semantics – although the data here are limited. This is the same conclusion from studies done by the White House (2016), and also according to Elsevier (2018) and WIPO (2019). Looking into the content of the publications, China-based academic papers still showcase incremental innovations and not breakthrough ideas that are still coming from other geographies such as Europe and the US (Shoham *et al.*,

⁴² Including the possible existence of barriers to the movement of high-tech experts.

⁴³ The list has been extracted by number of citations from the 2016 edition of the *Journal Citation Report*. The list of selected journals is as follows: *IEEE Transactions on Evolutionary Computation*, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *International Journal on Computer Vision*, *IEEE Transactions on Fuzzy Systems*, *IEEE Transactions on Cybernetics*, *IEEE Computational Intelligence Magazine*, *International Journal on Neural Systems*, *IEEE Transactions on Neural Networks and Learning Systems*, *Information Fusion*, *Neural Networks*, *Integrated Computer-Aided Engineering*, *Journal of Machine Learning Research*, *IEEE Transactions on Image Processing*, *Artificial Intelligence*, *Pattern Recognition*, *Knowledge-Based Systems*, and *Medical Image Analysis*.

2018). Going through the citations and reputation of the journals where the articles have been published, China still lags behind the US and Europe respectively, but it also shows a growth during the last two decades (Elsevier, 2018). Therefore, in summary the reach of Chinese research is still regional, but aspiring to lead globally.

Table 12 - Analysis of papers from top AI journals in 2017. Source: own analysis.

AI subdomain	China	EU	US	No. of Papers
Evolutionary and genetic computing	49%	35%	16%	129
Neural networks	57%	17%	15%	338
Computer vision/perception	35%	35%	30%	418
Automated reasoning/reasoning with uncertainty/optimization	52%	29%	14%	219
Robotics/planning/multiagent systems	65%	19%	14%	107
Natural language processing/semantics	29%	52%	19%	21
Machine learning/other learning techniques	45%	30%	29%	201
Total	49%	28%	22%	1408

As in the case of scientific papers, China has become a global leader in terms of the number of patents (Van Roy, Vertesy & Damioli, 2019). In the specific case of AI, the US and China are largely leading in patent applications (WIPO, 2019). Like the case of academic papers, China's position falls when considering not only the quantity but also the quality of the AI patents.⁴⁴ Among other factors, it can be mentioned that the high proportion of applications filed only in China could be due to the main interest of Chinese researchers in the domestic market, while the low percentage of citations and grants could be due to the relative novelty of Chinese patents with respect to those in other countries.

In this respect, the experts corroborated these assertions. The majority of them agreed that China is already a scientific and technical superpower but also emphasized relevant limitations of the AI ecosystem, such as the

⁴⁴ This classification is established considering whether the patents have been granted, cited, or belong to extended patent families. According to WIPO definitions, the three criteria are defined as follows:

- Families with at least one patent granted: This is considered 'as a validation by independent patent examiners of the novelty and inventiveness of the invention for which patent protection is being sought'.
- Citation of patent families: If the patent is mentioned at least 20 times in later published patents, 'this indicates the impact of the invention on later inventions'.
- Extension of patents to several patent offices: This is an indication of 'both the desire of the patent applicant to commercialize the invention in multiple markets and the market size'.

‘lack of researchers for fundamental theory’, ‘the limited scope of research’, and ‘the only focus on some aspects such as facial recognition’.

iv. Data availability framework

Another relevant aspect remarked on by the experts is related to the data available in China. More data is available than anywhere else due to China’s huge population and its intensive usage of many types of systems and applications. In China, there are also fewer obstacles to personal data collection and usage than in other jurisdictions, and there is also a young market eager for novelties and nominally less worried about privacy. Last but not least, the government has an interest in the deployment of large AI-based applications with a social impact. However, experts emphasized that the data available in China are ‘not very diverse’ and are of ‘relatively low quality’, mainly due to the inward orientation. Therefore, some AI solutions would only be valid for niche markets and would be difficult to extend to other geographies.

As a distinctive feature of the AI ecosystem in China, the experts also called attention to the fact that the critical views regarding AI, although on the increase, are still relatively low key, almost always referring to companies’ usage of AI and taking good care to not incur disloyalty towards a policy that is highly supportive of AI. While the calls for policy support voiced in the EU and the US focus on algorithmic transparency and accountability (Garfinkel *et al.*, 2017) and warn about moral responsibilities outsourced to algorithms, in China, the focus is more on placing AI within the scope of the rule of law. However, the pervasive usage of AI in China has highlighted that the absence of a more forward-looking perspective could lead to a lack of verifiable algorithms or trustworthy devices and systems. As one of the experts argued, compared with the West, ‘there is (in China) a greater focus on short term goals than on long term implications’.

ATH results: case studies within the AI ecosystem

Following the ATH model, the last step of the analysis displays how the helices interact dynamically with each other and provide specific solutions. For this, the most relevant AI projects implemented during 2017-18 have been compiled as shown in Table 13, classified by industry and key technological domain within AI. As previously mentioned, the interactions produce relationships of different types (venture capital, human capital, knowledge production, data availability framework), as discussed below and result in specific projects and solutions. Further details of the most relevant cases could be found in the Annex 4 with specific insights into the interactions between governments and companies.

The first observation is how the overall development of these projects mimics the proposed ATH model. The top-down framework model consists of China’s AI plan for leveraging the momentum provided from the government to move beyond the outcome that the market alone could provide. Next, the projects are developed rather practically from companies, based on a trial-and-error approach that allows room for experimentation and to test and refine new policies. Depending on the success of these projects, they are either discarded, modified

or scaled up. In a final stage, governments adopt a more traditional role of regulators -mostly to ensure social goals- in addition to their practical support to companies. The cases of the Toutiao news service from Bytedance and Kuaishou video network backed by Tencent are paradigmatic. The huge success of Toutiao's curated news recommended by a machine learning algorithm was followed by the public discovery that this was taking the users into extreme types of contents. In April 2018, China's State Administration of Radio and Television and Cyberspace Administration asked both news website Toutiao and livestreaming website Kuaishou to remove obscene and violent content. The explanation from providers was that AI-based algorithms were responsible for promoting videos according to preference and popularity, regardless of the content. As a result, the services were discontinued for about one month and reformed to include now both AI and humans to censor contents and ensure mainstreaming.

A next immediate result from an overarching examination of these cases is that AI applications are widely available and have an impact on the daily lives of China's citizens, combining convenience, efficiency, personalization, and surveillance, and providing a head start for companies involved in them.

A third result is how most of these cases require the collaboration of different levels of government and companies, on one hand validating the asymmetric approach to the triple helix model as stated above, and on the other the alignment of public and private interests. Thus, governments at national and/or regional level play a prominent role defining the strategy, providing a supportive environment and in the majority of the cases being an end customer of the solution. Also, most of the cases refer to B2C provision models, and therefore it can be concluded that the alignment between government and companies' interest takes place when mass markets with individual consumers are addressed. The cases reviewed in the Annex 4 detail the influence of different levels of government in the development of technologies and the strategic positioning of companies in the areas of i) smart cities, ii) e-health, iii) security, iv) microelectronics, and v) foreign large tech companies.

As another main piece of evidence, the Ministry of Science and Technology announced the establishment of the association for the new generation of artificial intelligence development planning promotion on November 2017. There, the first list of national artificial intelligence open innovation platforms has been published, which includes automatic driving relying on the Baidu platform⁴⁵, a City Brain (smart cities) relying on the Aliyun (Alibaba cloud) platform, medical imaging relying in the Tencent platform, and intelligent voice applications relying on the iFlytek platform. All of them are in collaboration with different universities and involve the participation of start-ups and companies in their respective fields. Another practical consequence is this

⁴⁵ In fact, the Chinese government in March 2018 gave Baidu permission to test cars on public roads in the suburbs of Beijing, making it first on the roads in China. The company's goal is to test the system in buses made by Chinese manufacturer King Long later in 2019. Baidu's initial self-driving cars will be developed with China's Chery Automobile Co, although it also has a 2021 target to produce Level 4 autonomous cars in partnership with Chinese automaker BAIC Group (Welch and Behrmann, 2018)

alignment is the prevalence of AI-based solutions and projects implemented in the field of security and public safety.

As another main example, Alibaba is championing AI-based reputation systems that can be a blueprint for China's authorities' interest in using technology for a 'social credit system', or more precisely, a 'social trust system'. Most information in this system -called Zhima Credit- comes from Ant Financial's Alipay, with more than 520 million users, and automatically determines a person's creditworthiness by examining his or her daily financial transactions and connections. The system also has access to data external to the applications and derived from interactions of the user with public services and bodies. There are many other implementations of similar social trust systems from different governmental bodies at city or provincial level.

On the security and public safety sphere, there are many solutions that rely on data provided by governments. For instance, projects from Megvii / Face++ use video identification systems that have access to the data on criminals or other people under search. iFlytek provides technology to record court hearings and aid judges in the review of criminal cases of homicide, theft, telecom fraud and illegal fundraising. LLVision is a startup that uses AI-enabled glasses⁴⁶ to help authorities to spot criminals at public venues and it is already in use in railway stations for ID verification. The AI company Grisdum has teamed up with the Beijing Intellectual Property Court to develop remote trials service on WeChat. Intellifusion has worked with municipal police forces across the country to install surveillance systems in subways and streets. Besides, its AI and facial recognition technology is used by Shenzhen city council to fine jaywalkers. Similarly, Yitu Technology has provided technological support for identification of suspects at main events. Its solution called Dragonfly Eye, is implemented by about 200 local and regional policy forces, including Qingdao, Suzhou, Xiamen public transportation or Shanghai metro system. The company has also worked with Chinese customs and immigration authorities to identify wanted suspects and smugglers. Summing up, facial recognition devices are being used by the police, insurance companies, education providers or even judges, not only for personal identification but to track facial expression and determine the customer or subject attitude.

Another relevant example on these helices interactions is the involvement of publicly controlled companies in the development of AI projects. One of the most relevant examples are the regional/municipal transport systems, being the Shanghai or Beijing Metro a paradigm.

The innovative purchases both by local and national governments also show how the helices are related. The flagship project of iFlytek is one of the best examples. It basically consists of an AI-enabled general practitioner medical robot that passed the written test of China's national medical licensing examination in November 2017.

⁴⁶ One challenge for facial recognition software is that it struggles when running on CCTV cameras, because the picture is blurry. The wearable glasses with AI on the front end can provide immediate and more accurate feedback.

The robot can automatically capture and analyze patient information and make an initial diagnosis. The project was officially launched in March 2018 with a pilot project with Anhui (Hefei) Provincial Hospital and the system was developed in partnership with Tsinghua University. In fact, iFlytek, launched by alumni of the University of Science and Technology of China, has founded together with the university a national key laboratory: ‘National Engineering Laboratory for Speech and Language Information Processing’.

Other interesting evidence of the interactions is the funding of AI projects. Capital from public bodies, venture capitalists and big companies has been pouring into AI-related start-ups. An example is a part of Tencent’s flagship project of building an ecosystem around healthcare,⁴⁷ the company is investing in local and international health and medical start-ups, from wearable tech to genomics. The last step in this strategy is Tencent Doctorwork, a joint venture with GAW Capital, Medlinker and Sequoia China, which operates offline medical facilities called Tencent Clinics, planning to open new clinics in China during 2018 to provide offline services linked to a mobile app monitoring customers’ health status.

Two additional evidences from case studies are CloudWalk, Megvii / Face++ and SenseTime. CloudWalk received a \$300 million investment from the Guangzhou Municipal Government in 2017. The company is devoted to facial recognition technology and its solution is deployed across several banks, including Agricultural Bank of China, Construction Bank and Merchants Bank, for authentication at ATMs. Megvii / Face++ received \$460 million in its November 2017 round of venture capital -the largest to a computer vision startup in 2017-. It was led by a China government’s venture capital fund with participation from the Russian government and backed by Ant Financial (Alibaba) as well.

It is also worth mentioning the relationships and interactions of the three helices around AI training and research. An interesting evidence of these dynamics are the ‘national laboratories’⁴⁸, three of the special projects developed related to AI as part of the ‘Internet +’ initiative. In these projects take part different universities, companies, government dependent organizations and the initiative is led by the National Development and

⁴⁷ An estimate says Tencent has invested about €3 billion in medical start-ups since 2014 (Lew, 2018).

⁴⁸ The three national laboratories are:

- The National Engineering Laboratory of Virtual Reality (VR) / Augmented Reality (AR) Technology and Application. It is led by Beihang University although it also has a branch at Beijing University of Technology (BIT). The organizations in collaboration are: Beijing Institute of Technology, China Electronics Standardization Institute, Goertek Inc, and Wisesoft.
- The National Engineering Laboratory of Brain-like Technology and Application. It is led by and located in University of Science and Technology of China, Hefei, Anhui. The organizations in collaboration are: Fudan University, Shenyang Institute of Automation Chinese Academy of Sciences, Institute of Microelectronics of Chinese Academy of Sciences, Institute of Neuroscience of Chinese Academy of Sciences, Baidu Inc., Microsoft Research Asia, and iFlytek.
- National Engineering Laboratory of Deep Learning Technology and Application. It is led by and located in Baidu Inc. The organizations in collaboration are: Tsinghua University, Beihang University, China Electronics Standardization Institute, and China Academy of Information and Communications Technology.

Reform Commission, a key governmental agency under the State Council. Each of them is focused on key innovative capabilities within the AI field.

Finally, almost every leading company is collaborating with universities across the country in a range of ways. As non-exclusive examples, JD.com announced the Nanjing Branch of JD Artificial Intelligence Research Institute, which will be built near the NJU and will become the training station for the students of its Institute of Artificial Intelligence⁴⁹. Xiaomi Inc. and Wuhan University announced the establishment of an AI joint laboratory⁵⁰. And iFlytek⁵¹, Tencent⁵², Baidu⁵³, Megvii⁵⁴ or Deepblue⁵⁵ have established AI colleges in partnership with top universities.

Connected with this, EdTech is a thrilling landscape in China due to the relevance that Chinese families attach to education. Here, again, national, regional, local governments in China have contributed with the conditions (plans, strategies, regulations, room for experimentation) and the practical support (venture capital, purchases, lax regulations on personal data) for innovations to happen in the field of EdTech. Huge demand and support have resulted in a huge consumer adoption and some of the startups in this field in China have acquired already unicorn status (VIPkid, Liulishuo and 17zuoye in the period considered)

From the ATH perspective it is worth to analyse the evolution of EdTech solutions, especially those focused on the education beyond regular classes. They typically use AI to provide a tailored education approach to each student. Success has been so considerable, with an average student using these solutions at least one hour every day, that has created a backlash. Now, from 2019, a strict regulation ensures a maximum amount of time devoted to this application, a curfew time and an evaluation of contents to ensure that they are aligned with the age and knowledge of the child.

⁴⁹ https://www.nju.edu.cn/_t465/f7/d4/c3814a260052/page.htm

⁵⁰ <http://fonow.com/view/206675.html>

⁵¹ Partnership with Southwest University of Political Science AI Law School (Chongqing), the Chongqing University of Posts and Telecommunications, Nanning University (Guangxi), Anhui University School of Information Technology, Jiangxi Vocational College of Applied Technology and Chongqing Vocational College of Science and Technology

⁵² Partnership with Shenzhen University, Liaoning Technical University, Shandong University of Science and Technology and Liaocheng University (in Shandong)

⁵³ Partnership with Jilin University, Hunan Normal University, Henan Institute of Finance

⁵⁴ Partnership with Nanjing University and Xi'an Jiaotong University

⁵⁵ Partnership with Central South University and Jiangsu University of Technology of Technology

Table 13 – Relevant ongoing AI company case studies in China (2017-18). Source: own compilation.

Organization – case study	Industry	Key technology	Description	Agents (Helix) involved	Relationship (s)
Alibaba – City brain	Government	Cloud	City management	<ul style="list-style-type: none"> Government (national and regional/local level) Industry (large companies) 	<ul style="list-style-type: none"> Venture capital Knowledge production Data availability framework
Alibaba DoctorYou	Health care	Image recognition	Medical diagnosis	<ul style="list-style-type: none"> Government (national and regional/local level) Industry (large companies) 	<ul style="list-style-type: none"> Venture capital Knowledge production Data availability framework
Alibaba – Pig	Agriculture	Image recognition	Pig rearing	<ul style="list-style-type: none"> Industry (large companies) 	<ul style="list-style-type: none"> Data availability framework
Alibaba Supermarkets	Retail	Face recognition	Supermarkets without employees	<ul style="list-style-type: none"> Government (national and regional/local level) Industry (large companies and start-ups) 	<ul style="list-style-type: none"> Venture capital Data availability framework
Alibaba – Zhima	Ecommerce	Online transactions analysis	Rate reputation – customer social credit	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups and large companies) 	<ul style="list-style-type: none"> Venture capital Human capital Knowledge production Data availability framework
Baidu	Automobile	Driverless car	2019 for highways	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Venture capital Human capital Knowledge production Data availability framework
Baidu DeepVoice	Media	Text-to-speech	Mimic any voice	<ul style="list-style-type: none"> Government (national) Industry (start-ups / large companies) Universities & Research centres 	<ul style="list-style-type: none"> Venture capital Human capital Knowledge production Data availability framework

Baidu + Huawei	Telecoms	Open platform for mobile devices	Mobile app developers	<ul style="list-style-type: none"> • Industry large companies) (/ 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Beijing University	Education	Face recognition	Enter into dorms	<ul style="list-style-type: none"> • Government (national and/or regional/local level • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
ByteDance	News / Social networks	Personalized content	Curated news and videos	<ul style="list-style-type: none"> • Industry (start-ups) 	<ul style="list-style-type: none"> • Data availability framework
CloudWalk	Banking	Face recognition	ATM operations	<ul style="list-style-type: none"> • Government (regional/local level • Industry (start-ups / large companies) 	<ul style="list-style-type: none"> • Venture capital • Data availability framework
Chinese Academy Sciences	of Government	Data mining	Diplomacy	<ul style="list-style-type: none"> • Government (national and/or regional/local level • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Didi Chuxing	Transportation	Driverless car	Self-driving taxi service	<ul style="list-style-type: none"> • Government (national and/or regional/local level • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Megvii / Face++	Security	Face recognition	Gov. records data on criminals/missing people	<ul style="list-style-type: none"> • Government (national and/or regional/local level • Industry (start-ups / large companies) 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework

				<ul style="list-style-type: none"> Universities & Research centres 	
Gridsum	Government	Document management	Remote trials in intellectual property cases	<ul style="list-style-type: none"> Government (national level) Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Venture capital Knowledge production Data availability framework
Heaven's Temple	Tourism	Face recognition	Retrieve toilet paper	<ul style="list-style-type: none"> Government (national and/or regional/local level) 	<ul style="list-style-type: none"> Data availability framework
iFlytek	Health care	Robot/user interface	Patient diagnosis	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups / large companies) Universities & Research centres 	<ul style="list-style-type: none"> Human capital Knowledge production Data availability framework
iFlytek	Law	Voice recognition	Criminal cases hearings	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Venture capital Data availability framework
Intellifusion	Security	Surveillance	Subways and streets. Taxi drivers' identification. Jaywalkers	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Data availability framework
KFC	Food	Face recognition	Menu acquisition and dietary recommendations	<ul style="list-style-type: none"> Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Data availability framework
LLVision	Security	Face recognition	Verification of ID at public venues through glasses	<ul style="list-style-type: none"> Government (national and/or regional/local level) Industry (start-ups / large companies) 	<ul style="list-style-type: none"> Knowledge production Data availability framework
NIO	Automobile	Voice recognition	2018 mass production	<ul style="list-style-type: none"> Government (national and/or regional/local level) 	<ul style="list-style-type: none"> Venture capital Human capital Knowledge production

				<ul style="list-style-type: none"> • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Data availability framework
Ping An	Insurance	Facial expressions	Insurance premium if the customer tells the truth	<ul style="list-style-type: none"> • Government (national and/or) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Policy Cloud	Security	Information integration	Trace suspects and anticipate behaviours	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Knowledge production • Data availability framework
SenseTime	Security	Face recognition	Surveillance footage	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Shanghai Marathon	Leisure	Face recognition	Personalized video of the race	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Data availability framework
Shanghai Metro	Transportation	Face/voice recognition	Tickets, recommended route	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) 	<ul style="list-style-type: none"> • Venture capital • Data availability framework
Shenzhen – Hong Kong Border	Security	Face recognition	Automatic border crossing	<ul style="list-style-type: none"> • Government (regional/local level) • Industry (start-ups /) 	<ul style="list-style-type: none"> • Data availability framework

				•	
Tencent – AIMIS	Health care	Image recognition	Disease diagnosis	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Human capital • Knowledge production • Data availability framework
Tencent Wechat	– Governance	Face recognition	Digital ID	<ul style="list-style-type: none"> • Government (national) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Venture capital • Knowledge production • Data availability framework
Xio Liange	Security	Surveillance	Gov. project to monitor people in 55 cities	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Universities & Research centres 	<ul style="list-style-type: none"> • Knowledge production • Data availability framework
Yitu – Dragonfly Eye	Security	Face recognition	Customs, immigration identification, public transportation	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) • Universities & Research centres 	<ul style="list-style-type: none"> • Knowledge production • Data availability framework
Yitu – AICare	Health care	Image recognition	Medical test analysis	<ul style="list-style-type: none"> • Government (national and/or regional/local level) • Industry (start-ups / large companies) 	<ul style="list-style-type: none"> • Knowledge production • Data availability framework
17zuoye	Education	Personalized content	Learning multi-platform (students, teachers, parents)	<ul style="list-style-type: none"> • Industry (start-ups / large companies) 	<ul style="list-style-type: none"> • Venture Capital

5 FURTHER DISCUSSION

As presented in the section 1.4.1., one of the objectives of this thesis is to analyze the synchronous research knowledge and policy output, trying to establish potential links of influence between policymaking and academia.

Previous research has shown an increasing interest on the relationships between research and policy (Boswell and Smith, 2017), being entrepreneurship research a paradigmatic case on how research and policy are two disparate worlds (Zahra and Wright, 2011). Building on the results of the text mining analyses conducted during phases 1 and 2, the discussion in this chapter precisely intends to contribute to this ongoing debate about how research and policy relate each other. And it is carried out in the context of EU in which entrepreneurship support policies has been noted as especially ineffective, in particular when supporting innovative or high-growth entrepreneurship. In addition, in spite of the analyses during this thesis are obviously limited by the samples, they provide evidences on how text and data mining tools could be used to enrich the debate around the use of knowledge in policymaking.

The chapter is organized in three sections: firstly, the two initial sections frame the debate briefly introducing the current state about the relationships between research and policy (section 5.1) and the particular case of the entrepreneurship research in the EU (section 5.2); then, section 5.3 provides a combined examination of the results obtained in the phases 1 and 2 of the analysis. The overall result is a retrospective view of the emergence and configuration of both EU policy and academic bodies of knowledge on entrepreneurship policy, looking for potential linkages and/or differences.

5.1 The ongoing debate about relationships between research and policy

The notion of research impact and how it should be assessed has become a hot topic both from the policy and academic perspectives during the last years. Conventional approaches such as citation indexes or impact factors play a relevant role at academic level, but they are far to reflect how scientific knowledge impacts on society (Mårtensson *et al.*, 2016). Much of the debate around impact derived from the complex relations between science and policy and how knowledge is and should be used in policymaking (Starkey and Madan, 2001)

The interest on these relations is not new. During the last four decades, diverse theories and models has been developed to explain them and the debate is still open. Ideally, the best scientific knowledge should support public decision-making (OECD, 2015b) and, as a consequence, the development of the best conditions promoting the understanding of academia and policymakers has gained relevance at international level during the last decade (Kenny *et al.*, 2017). However, a range of controversies emerge when going into the details. And these controversies emerge not only to explain how these relations should be theoretically modelled but also on how the flow of knowledge between research and policy has been configured over time (Daviter, 2015), varying from those defending that research influences policy to those arguing that policy influences research or

even those authors considering that research and policy are disconnected. And these general trends are divided in turn with full of nuances about the convenience in each case.

To this respect, Christina Boswell and Katherine Smith have recently published a deep review depicting four main approaches to conceptualize relationships between research and policy and how this affect to the impact agenda (Boswell and Smith, 2017). From these authors' perspective, relationships could be viewed as: (1) knowledge shaping policy, gathering simpler and linear models of influence and also more complex approaches considering diverse options such as that the influence is nuanced by a communication gap between the two worlds or even the very famous notion of 'enlightment' function of knowledge in policymaking (Weiss, 1977, 1979); (2) policy and politics shaping research, that could viewed as the reverse and in general the opposite model of the previous one, being the policy the leading sphere that set the research agenda and influence how knowledge is used. The significance of this prevalence of policy varies depending on the author, but what is common to this trend is that the use of knowledge is determined by the similarity with dominant policy ideas; (3) co-production, based on the idea that research and policy develop a mutual influence; (4) and finally, considering research and policy as autonomous spheres, two separate systems with different aims, incentives and logics with no casual influence across them.

While these four approaches could be grouped under a general idea, they are not totally homogenous and every of them could be splitted in turn by different connotations or they even could be grouped under different labels. The conclusion is that debate about relationships is far from being close. On the contrary, there are arguments and significant contributions not only in which is the sphere that lead the flow of influence, but also if it is possible to establish some type of link due to the insurmountable differences between them.

5.2 Entrepreneurship research and policy: the case of EU

In spite of its novelty, entrepreneurship research is not unconnected to the debate about the use of knowledge and evidence in policymaking. Currently, the engagement between entrepreneurship scholars and policymakers and even entrepreneurs themselves is limited and some authors have argued that if entrepreneurship research aims to influence policy, it is required 'a substantive shift in the focus, content, and methods' (Zahra and Wright, 2011, p. 67). In fact, some scholars have remarked the need to address the gap between academic research results and their usefulness in practice for policymakers (Grimm, 2006) and entrepreneurs (Steffens et al., 2014)

In addition, entrepreneurship research results have been noted as unspecific or not directly applied by policymakers. Some authors have noticed that there is an increasing tendency in entrepreneurship research to theory-driven works (Brush, Manolova and Edelman, 2008) although, simultaneously, policymakers require recommendations that can be directly applied in their specific context. Besides, an effective communication of the entrepreneurship research findings is key to achieve stakeholders engagement (Steffens et al., 2014). These issues should be added to the usual barriers to achieve evidence-based policymaking, mainly arising from the urgencies within the policy cycle. Particularly relevant is remarking that research interest on entrepreneurship

policy can be seen as unbalanced given the number of researchers focusing on the implementation and evaluation stages (Arshed, 2017) but formulation and agenda setting have attracted less attention. As Lundström and Stevenson noted (2006, p. 7), that in general there is ‘limited knowledge on how entrepreneurship policy is constructed’.

Therefore, this suggests that there are still considerable opportunities to improve the adoption of research results in the policymaking process, especially considering that entrepreneurship policy as a research field is under-investigated (Rosa, 2013; Mazzarol and Volery, 2015).

In the particular case of EU, despite policy has played a crucial role in the entrepreneurship research led by European scholars (Rosa, 2013; Landström, 2015), there is also a distance between research and policymaking in the field and to there is not any study trying to identify particular links between the two domains. In general terms, research on entrepreneurship policy in the EU agree that the general rationale for policy interventions has been traditionally based on the idea of correcting market failures (Audretsch, Grilo and Thurik, 2007) and also systemic failures (Autio, 2016). The exact nature of these failures appears as rather diverse across the literature, and as a response several strands of specific measures have emerged in the EU space. However the effectiveness of these initiatives has been largely contentious by researchers, and no explanations are provided, in general, on the rationales for moving on from one strand of policy to the next at EU level, nor are there any structured studies on the evolution of such policies in what has been defined as the most complex socio-political and economic space in the world (Kleibrink and Magro, 2018).

In a next level of detail, as mentioned in the introduction of the section 4.2, some authors have identified up to five stages in the European process—from no policies on entrepreneurship to implementation— (Audretsch et al., 2002; Audretsch and Thurik, 2010) that can be interpreted as a first attempt at describing a learning curve for the entrepreneurship policy agenda. Particularly, those five stages can be summarized as follows:

- First, during the 1980s, European Economic Community (EEC) policymakers reject the benefits of entrepreneurial economy and the assumption of the Silicon Valley success. On the contrary, advantages of European integration are considered in terms of efficiencies and scale economies obtained by large firms as a consequence of the extension of the internal market, while contribution of entrepreneurship is not considered at all (see Cecchini Report on the European Single Market (1988), an advance of the Maastricht Treaty (1993)).
- Second, during the mid-1990s, European policymakers started to value Silicon Valley performance, but continued to promoting traditional industries in Europe. As an example, Nelson (1993) concluded that national system of innovation in United States was characterized by policies and institutions much more conducive to radical innovations than European.

- Third, by the mid-1990s, European policymakers realized that entrepreneurial economy represents an undeniable advantage in terms of economic performance, but it is not compatible with European culture and institutions.

As a result, at the end of 1990s the United States and Europe economic gap in terms of GDP per capita was greater than ever since II World War. During that decade, United States created 22 million of net new jobs and the unemployment rate was lowest since 1960, while Europe unemployment grew up to highest rates since post-war. Besides, without considering mergers, while all of the biggest firms in Europe in the end of 90's were already large corporations in 1960, eight of the twenty largest companies in US did not exist yet or were very small in 1960 (Timmons, 1999).

- Fourth, considering the divergence in terms of economic performance, during the second half of 1990 European policy makers start to agree in considering that it is necessary a policy shift to promote a knowledge based economy as the way to recover economic growth.

Lisbon Agenda in 2000 represented a pivotal moment in the way policy makers consider entrepreneurship in Europe. The strategy was conceived with the aim of making Europe "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010" and was endorsed by all the Member States.

- Fifth, since 2000, European Union policymakers start to develop a entrepreneurship policy. Despite the first initiatives to promote entrepreneurship had been launched by national governments, from the point of view of the Union Green paper on Entrepreneurship in Europe (2003) represented a common approach of the Member States on how public policy could reinforce entrepreneurship

In fact, since those early attempts at classification, there is a high degree of agreement about the emergence of a specific entrepreneurship policy agenda in the EU and the consideration of the Lisbon Agenda as the pivotal moment. However, that perspective lacks enough granularity to understand, in detail, the evolution of the entrepreneurship policy domain nor it includes possible relationships with the academic research; and in any case it stops in the early 2000s.

At EU country level, Friederike Welter and Frank Lasch introduced in a special issue on entrepreneurship research in Europe the importance of the national context and the role of research communities for the consolidation of entrepreneurship research (Welter and Lasch, 2008). Those authors distinguished then between those nations with 'inward-looking communities', mainly larger countries with internal critical mass for a strong national research (United Kingdom, France, Germany), being the language noted as one of the possible causes in cases such as France or Germany; and the tendency of smaller countries such as Scandinavian nations to an 'outward looking' and international footprint. Obviously, these authors noted that 'inward-looking' countries are less inclined to share knowledge abroad and, as a consequence, that this 'could hamper knowledge spillover

of national discussions and ideas'. However the interest of this approach, this thesis argues for other different classifications influenced by context at country level, worth to be explored.

Therefore, even though the increasing attention on entrepreneurship as a strategic driver of progress, entrepreneurship as a policy field and related research are both still in their early stages, particularly in EU in which it seems that the policy learning curve has not yet reached maturity. Notwithstanding the interest of both policymakers and academics in the field, in practical terms they configure two distant domains with controversial views in many different issues. Regarding to the policy role, the effectiveness of the entrepreneurship policy measures has been largely criticized; and related to the academic performance policy implications derived from entrepreneurship research have been defined in many cases as unaware of the context and not possible to be easily adopted in practical terms and the research has been focused on the latter stages of the policy cycle.

5.3 Are research and policy priorities related? The case of entrepreneurship policy in the EU as a realization for the discussion

The results of the combined examination of the analyses conducted with corpus Academia and corpus EU Policy are summarized in Table 14. In addition, Fig. 39 displays the evolution of the main themes of entrepreneurship policy from the point of view of the two corpuses. Comparison of key themes and concepts that have formed respectively the academic and EU policy entrepreneurship-support agendas shows an incremental mutual coincidences between them during the last twenty five years, especially since the 2010s. In addition, comparison of academic production in this field at country level offers some interesting differences among EU affiliated researchers.

Besides, with respect to the evolution of the entrepreneurship policy agenda in the EU, results suggest a new and more granular and complete view about the evolution of the entrepreneurship policy agenda in the EU than previous attempts. This thesis proposes a division of the learning curve into three main stages that, in turn, are separated into six sub-stages. These six stages coincide, at large, with the different EU Commissions in office since 1990.

A. Latent EU entrepreneurship policy (up to late 1990s)

This first stage is hardly characterized by any specific entrepreneurship initiative. Only general enterprise-encouraging policy is applied to support SMEs and entrepreneurs. Almost up to the end of the 1990s, entrepreneurship was not even explicitly stated. This period would essentially correspond, in time, to the four consecutive stages of 'denial', 'recognition', 'envy' and 'consensus' that previous authors have identified (Audretsch and Thurik 2010), however, with some particular notes. Those stages are splitted into two sub-stages.

a.1. Oblivion (up to mid 1990s)

At the time, European policymakers aimed to promote the EU industry and large companies within traditional sectors, as a way to face unemployment challenges. From the point of view of economic policy principles, the ideas of Jean-Jacques and Servan-Schreiber (1968)—about the promotion of larger companies as the way to increase European competitiveness—were, at some extent, still present when the Cecchini Report (1988) made the economic case for the Single Market, thus, emphasizing gains due to the economies of scale.⁵⁶

Entrepreneurship, although already known at the time⁵⁷, including its potential on employment and economic growth⁵⁸, is not only unconsidered within the core strategy, but it is almost not even mentioned as such. The geographic dimension of the policy measures is strictly European and, as much, at national level. In this context, technology is considered as the key production factor. However, the relevance of ICT, as a whole, is still limited, despite the high consideration about the relevance of telecommunications as infrastructures for the future.⁵⁹ It is also, at some extent, relevant in the role of research, although it is still far from the idea of innovation as a core engine in economic growth.

From the point of view of academia, the main geographical dimension of interest, for policy intervention analysis, is national—as in the case of the EU policy—although regional dimension is also considered. In the latter case, however, it is essentially related to vertical industries—in particular, those innovative and technology-based telecommunications or electronics. Regarding to role of the agents, individual entrepreneurs surpass the firms' studies, and there are also relevant works about venture capital and entrepreneurship policy.

Therefore, while the academia widely recognised the relationship between entrepreneurship and economic development and already studied key elements of entrepreneurship such as innovation—although confined to

⁵⁶ The industrial policy developed by Delors' Commissions was mainly based on the aim of capitalising the opportunities offered by the Single Market. Even the *White Paper on Growth, Competitiveness, and Employment* (1993) was a late attempt, developed by Delors' cabinet, to include new approaches for the European economy development, which were not supported by the Member States (Ross and Jenson 2017).

⁵⁷ Since the late 1980s there were some references to the need of improving the business environment and promoting the development of enterprises, with particular references to SMEs; for example, the Council Decision of 28 July 1989.

⁵⁸ The conclusions of the Edinburgh European Council (1992) already mentioned the principles of 'an action plan by the Member States and the Community to promote growth and to combat unemployment'. They also emphasised the role of SMEs for 'creating jobs and stimulating growth'. These principles were even amplified by the conclusions of the Copenhagen European Council of 1993. These ideas were also gathered and, at some extent, developed by the *White Paper on Growth, Competitiveness, and Employment* (1993).

⁵⁹ As an example, the Commission Directive, in *Competition in the Markets for Telecommunications Services* (1990) already stated the essential role of telecommunications for the development of economic activities in the community.

vertical industries and in specific regions—and venture capital, the EU policymakers were rather focused on large companies and traditional employment growth policies.

This sub-stage is largely coincident with the ‘*denial*’ stage presented in previous works (Audretsch and Thurik 2010)). This thesis prefers the term *oblivion* since denial seems to imply a conscious decision on the side of EU policymakers, which is an intention difficult to prove from the text mining analysis.

a.2. Discovery (from mid 1990s to late 1990s)

The mid 1990s were a turning point in the valuation that EU policymakers attached to the contribution of entrepreneurship to the European competitiveness. For the first time, SMEs and entrepreneurs gained their own space, but they were still incipient and, therefore, not always ingrained in the enterprise-support general discourse. The strategic change can be linked to the adoption of the plan, *Small and Medium Sized Enterprises: A Dynamic Source of Employment, Growth and Competitiveness in the European Union* (1995). Then, *The Green Paper on Innovation* (1995) introduced the principles that were developed later by *The First Action Plan for Innovation in Europe* (1996), *Employment Guidelines* (1998) and *Fostering Entrepreneurship in Europe: Priorities for the Future* (1998). All of them, together, constitute the genesis of an entrepreneurship policy in Europe, and they laid the foundations that later led to the Lisbon Agenda. Regarding other relevant features, technology continued to be viewed as a key production factor, and the relevance of ICT grew compared to the previous sub-stage.

Contrary to the EU policy, after previous examination of entrepreneurship policy basics, the interest of academia was more focused on sophisticated themes. The main examples in this period are the geographic impact of the entrepreneurship, in terms of employment and growth, and the link between scientific research and entrepreneurship. In the latter issues, like technology transfers between universities and industry and the relationship between university-based research and innovation, will start here and remain stable for the rest of the periods. Academia also started to examine internationalisation, as a relevant aspect of entrepreneurial development—a topic that, again, will only grow for the rest of the periods.

As a consequence, this thesis argues that academia was already studying specific effects of entrepreneurship and policies—such as technology transfers from research into innovation and internationalisation—while the EU policymakers were still laying the bases to launch policies aimed at entrepreneurship. Also, it can be argued that some of the concepts and results from academia—of the previous stage—permeate the policy discourse, such as the close connection between technology and entrepreneurship and the increasing attention to SMEs and entrepreneurs. This sub-stage is approximately coincident with the ‘recognition’ and ‘envy’ stages presented in previous works (Audretsch and Thurik 2010). However, this thesis prefers to insist in the relevance of ‘awareness’, as it was in this period where the key concepts of the links between entrepreneurship and economy were rediscovered by EU policymakers.

B. Emergent EU entrepreneurship policy (from early 2000s to 2010)

The second stage gathers the initial steps of a practical entrepreneurship policy in the EU. From the previous stage, political vision, SMEs and entrepreneurs are considered for the first time as standalone and relevant objectives of policy-making—being that the Lisbon Agenda (2000) is the key milestone. After an initial period featured by the political hype under the assumption of the theoretical outputs of entrepreneurship but hardly any implementation up to mid 2000s, EU policymakers tried to initially launch specific actions based on previous diagnosis. Despite these efforts, the result was mainly a mixed bag of measures that combined protection to traditional SMEs and the creation of an enabling entrepreneurial environment, aimed at the increase of the number of this type of firms. From the analysis, this thesis suggests distinguishing two sub-stages.

b.1. Hype (from early 2000s to mid 2000s)

This period is characterized by an optimistic political vision on the benefits of entrepreneurship.⁶⁰ European policymakers seemed convinced, at the time, about the need to develop a proper framework where European entrepreneurs, in a broad sense, could thrive, and this was seen as a means to boost European competitiveness. From the analysis, the focus of the EU Communications was on identifying the options on how to shape a conducive entrepreneurship policy from a top-down approach.

The topics and the approach of the EU Policy seem to relate with the work of academia in the previous stage, in particular, about the interest on more sophisticated themes—such as, the relationship between entrepreneurship and employment, or the influence of innovation and research on growth. Besides, policymakers bring up new issues, unbeknownst to academia—such as the role of digital technologies—and they also begin to broaden the scope of entrepreneurship as a way to achieve economic and social objectives, like gender equality or inclusion. However, through this theoretical advance, the analysis reveals that almost no relevant, specific initiatives were developed in this period. Also, although the role of knowledge continues to be acknowledged, apparently education does not have a crucial function yet.

In the case of academia, the analysis on particular innovative industries is still a main topic. Nevertheless, geography stops being an issue only related to industrial or sectorial specialisation. Now, the dimension of ‘location’ acquires a research interest as a key influence for the development of ventures, and this attention is shared with new themes—such as all the support issues around entrepreneurship. As a main example of this tendency, there is an increasing number of studies about understanding the influence of creating scientific parks or the influence of incubators related to location.

⁶⁰ Giving continuity to the ambitions of the Lisbon Agenda (2000), Romano Prodi—President of the EC—delivered a speech in 2002, aiming to achieve a ‘new European entrepreneurship’ as the way to recover economic and social progress.

Other works (Audretsch and Thurik 2010)) mention a stage of ‘consensus’—about the need of shifting the European economy to be more entrepreneurial at about the same period—followed by a stage of ‘attainment’ to implement it in the early 2000s. The authors consider that *consensus* is represented at a particular point in time with the Lisbon Agenda (2000), and that *attainment* only happened later (see below).

b.2. Pivot (from mid 2000s to 2010)

After having recognised the lack of success for a range of policies, up to the start of this period, and the need of a new stimulus to the Lisbon Agenda⁶¹ for a stronger position of the EU on innovation, the analysis of this period is characterised by the launch of specific initiatives to promote small businesses with an emphasis on the regional approach, in addition to the previous national and European dimensions. The aim seems to establish the proper conditions—mainly legislative and regulatory—which favour the launch and survival of SMEs under the principle, ‘*Think Small First*’.⁶² Consequently, the analysis highlights SMEs’ policies as transversal and the distinct nature of the new ventures and entrepreneurs. The analysis also portrays education as a relevant theme for the first time. In fact, Oslo Agenda (2006) represents the first systematic policy approach to provide a framework for the entrepreneurship education in the EU, fostering the entrepreneurial mind-set in society and in all levels of education.

In addition, there are innovative elements in the policies that were not taken into account in previous stages. From the view of this thesis, policymakers truly start to learn about the previous failures through a trial-and-error-process. Nevertheless, despite these initial steps towards the implementation of practical initiatives, the analysis indicates a mix of purposes, maintaining the traditional protection of small businesses while promoting the creation of an enabling entrepreneurial environment with the aim to increase the number of small firms.

Similar to the case of the EU Policy in the previous sub-stage (early 2000s), the interest of academia on the relation between entrepreneurship and inclusion appears relevant for the first time, and the social dimension of entrepreneurship becomes recognisable. From this result, this thesis argues for a reactive role of academia from the challenges posed previously by EU policies in the social domain.

⁶¹ The Report from the High-Level Group—coordinated by Wim Kok (2004)—about the progress of the Lisbon Agenda (2000), concluded with a call for action aimed at EU policymakers to change the course of implementation to prevent its failure. It was the base for the *New Start for the Lisbon Agenda*, launched by the EC in 2005, which attempted to give a new impetus that allows the EU to achieve the pending goals.

⁶² The Community Lisbon Programme (2005) was the EC’s contribution to the partnership for growth and employment, which had been established by the new start for the Lisbon Agenda in 2005. To implement it, the EC launched the EC Communication, *Modern SME policy for growth and Employment* (2005), which aimed to ‘provide a coherent framework for the various enterprise policy instruments and at making the ‘*Think Small First*’ principle effective across all EU policies’.

Internationalisation continued being an important topic for the academia—particularly related to the expansion of business ventures and exports—and an element that starts to be considered as a key for start-up growth. On the contrary, and aligned to policies, regional and local geographical dimensions overcome previous national studies of entrepreneurship, and the geography dimension, in the sense of agglomeration, takes a leading role in entrepreneurship development.

In the case of innovation, the academia takes the lead, judging it more relevant for entrepreneurship than mere technology. Regulation on intellectual property rights and taxation also start to be a matter of interest for the academia, anticipating new areas for policy. From this sub-stage onwards there are no previous works from other authors that explain the learning curve of entrepreneurship policy in the EU and the present work is a novelty.

C. The new normal for EU entrepreneurship policy (from early-2010s to 2016)

After the worst of the financial crisis and having acknowledged the failure in meeting the objectives of the Lisbon Agenda,⁶³ European policymakers started to set up more targeted initiatives with a focus on both economic growth and the efficiency in the usage of available resources. At this time, and as evidenced in the analysis of the corpus Academia, there was an increasing amount of information that allowed a more evidence-based policy-making in this field. Accordingly, and as pointed out in the analysis, quality of the start-ups and quantity of the business became relevant. Important elements from the text mining exercise, for this stage, are innovation and technology-based approaches to business creation. It is also remarkable how the focus increased on financial needs of business ventures and, consequently, the implementation of dedicated budgets and a range of instruments—such as, tax incentives, loans or even non-recoverable funds. The roots of these measures can be traced back to key concepts in the academia analysis from previous stages.

In the case of academia, the central theme of this stage lies in the geographic dimension, considering both the notion of agglomeration and the international expansion of successful ventures. In addition, there is also an intense attention to managerial studies and to the analysis of the key elements for business development with particular emphasis in finance issues. From the analysis of the evolution of the main themes, this thesis depicts two distinct sub-stages.

⁶³ The official evaluation of the Lisbon Agenda occurred in March 2010 at the European Summit, where the new [Europe 2020](#) strategy was also launched; however, there were already voices highlighting the existing problems. See, for instance, the Swedish Prime Minister Fredrik Reinfeldt, who declared—just prior to assuming over the revolving EU presidency in 2009—that ‘Lisbon Agenda has been a failure and should to be rebooted’ (Euroactiv 2009).

c.1. Minimum viable policy (from early 2010s to mid 2010s)

Entrepreneurship policy in the EU starts to shift from generic approaches and SME-oriented policies to a more targeted entrepreneurial policy and, at the same time, there is a definitive reinforcement of European dimension specifically addressing previous failures. Thus, in addition to the aim of increasing the gross number of entrepreneurs in the EU, the quality of the entrepreneurial ventures starts to be evaluated. The analysis of the EU Policy documents points to the main examples of this latter trend: (i) the efficiency on the allocation of resources; (ii) giving priority to specific sectors; and (iii) an approach to entrepreneurship education that is focused on learning outcomes in terms of attitudes, knowledge and skills. Also, sustainability is, for the first time, a key element of the EU policymakers' discourse. Finally, and also for the first time, social entrepreneurship becomes a core objective, in itself, and entrepreneurship is definitively considered as a tool to promote the inclusion among disadvantaged social groups.

The analysis shows that there is a similarity of main themes from the academia, in which internationalisation continues to increase its relevance within this period, while education also appears to be a relevant feature of entrepreneurship. From the geographical point of view, regional prevails national, and the study of local conditions decreases. Also, beyond the individual dimension of entrepreneurship, the role of the immediate environment—such as family and friends—also became a new aspect of entrepreneurship examined from academia. On the contrary, the interest on vertical industries keeps declining. Besides, investment issues became a central theme and new concepts—such as crowdfunding or bootstrapping—appear for the first time. Management and culture aspects recover their relevance, since organisation and strategic aspects are considered essentials for entrepreneurial growth.

The choice for the name of this sub-stage in this thesis tries to reflect the achievement of a targeted entrepreneurial policy and, therefore, similar to the minimum viable product of the lean approach to entrepreneurship—a welcome novelty in policy-making of this domain and a true result of the learning process.

c.2. Market launch (from mid 2010s to 2016)

In this next sub-stage, the EU policy approach to entrepreneurship continues to evolve with even more elaborated instruments and sophisticated evaluation processes based on the rising amount of available data on previous successes and failures. In particular, the analysis displays that fostering high impact and digital-based entrepreneurship has become central in this last sub-stage. Innovation and improving connectivity among the start-ups and the rest of the agents in the ecosystem—such as investors or research centres—are increasingly considered, despite the role of universities as such declines. The relevance of the generic denomination of SMEs becomes diluted and, on the contrary, start-ups and new technology-based ventures are considered as the main entrepreneurial agents. This brings to the forefront new policy challenges, such as regulations on collaborative economy, the role of platforms and privacy related issues.

Furthermore, an examination of the EU policy documents reveals that, from previous focus on the creation of new ventures, the support now gravitates towards growth performance while siloed regional approaches lose momentum. In this sense, EU policymakers seem to consider that the EU entrepreneurial spirit has reached a sufficient level, but that it is needed to improve the context to help European start-ups to scale, first by easing the access to the internal market by means of promoting the investments and simplifying cross country tax systems and, second, by aiming to become worldwide leaders.

The evolution of entrepreneurship education continues through the consideration of entrepreneurship as a key competence for every EU citizen. Youth challenges continues to consolidate since the mid 2000s, as a strategic aspect and migration, and external affairs are also gathered in EU entrepreneurship related policy documents.

Comparing the text analysis from the point of view of the academia, location continued to be a crucial element to analyse entrepreneurial success and the interest on agglomeration both at regional and local level and the associated spillovers is multiplied. Related to venture development, there is a deeper granularity of topics ranging from the influence of exports as a key growth lever, the interest on finance requirements for business to grow or the internal corporate dimension about the management and cultural approaches. Finally, social dimension of entrepreneurship and the relationship with inclusion definitely consolidate as essential themes for academic studies and also the attention on intellectual property issues continues to increase since mid-2000s with patents related aspects turn into a relevant theme in this period.

This last sub-stage is still very short to be fully evaluated but in author's opinion, EU policy and interests from Academia are increasingly aligned, a symptom of early maturity as both now can rely on data to study the impact of different types of learning, increasing the speed and depth of the learning process. For this reason, the name of this sub-stage tries to represent the influence of the existence of a real market for entrepreneurship.

Fig. 39 - Evolution of the Entrepreneurship policy main themes (1990–2016)

Table 14 - Stages of evolution of the entrepreneurship policy in the EU (1990–2016)

STAGE	Main features	SUBSTAGE	Main features
1. Latent entrepreneurship policy EU	<u>EU POLICY</u> <ul style="list-style-type: none"> General enterprise policy is applied also to SME and entrepreneurs. European and, at less extend, national dimensions. <u>ACADEMIA</u> <ul style="list-style-type: none"> Study of specific effects of entrepreneurship and policies. National and, at less extend, regional dimensions. 	a. Oblivion (Early 1990s-Mid 1990s)	<u>EU POLICY:</u> <ul style="list-style-type: none"> No specific measures for entrepreneurship. <u>ACADEMIA.</u> <ul style="list-style-type: none"> Relationship between entrepreneurship and economic development are highlighted. Key elements of entrepreneurship are studied (Innovation, VC).
		a2. Discovery (Mid 1990s-Late 1990)	<u>EU POLICY</u> <ul style="list-style-type: none"> Preliminary mentions up to the end of the period. <u>ACADEMIA</u> <ul style="list-style-type: none"> More sophisticated themes (geography, internationalization, growth/employment...)
2. Emergent entrepreneurship policy EU	<u>EU POLICY</u> <ul style="list-style-type: none"> Focus more on the diagnosis of the proper framework for SMEs and entrepreneurs than implementation. <u>ACADEMIA</u> <ul style="list-style-type: none"> Increase diversity of themes. Regional and even local approaches start to dominate. 	b1. Hype (Early 2000- Mid 2000s)	<u>EU POLICY</u> <ul style="list-style-type: none"> SME and entrepreneurship as specific agents of public intervention. Entrepreneurship starts to be considered not only as an economic but also a social engine. Diagnosis on the needs, but still lack of specific initiatives. <u>ACADEMIA</u> <ul style="list-style-type: none"> Location and Support issues acquire relevance as research level. Geography stops being an issue only related to industrial or sectorial specialisation.
		b2. Pivot (Mid 2000s - Late 2000s)	<u>EU POLICY:</u> <ul style="list-style-type: none"> From hype to implementation. SME Policy. First policy approach to provide a framework for entrepreneurship education (entrepreneurial mindsets) <u>ACADEMIA</u> <ul style="list-style-type: none"> Geographical dimension include agglomeration as key element of venture development. Internationalization continue to be relevant, related to ventures growth.
3. The New Normal for EU	<u>EU POLICY</u>	c1. Minimum Viable Policy (Early 2010s-Mid 2010s)	<u>EU POLICY:</u> <ul style="list-style-type: none"> Revising the essentials.

entrepreneurship policy	<ul style="list-style-type: none"> • Growing interest on environmental issues and the efficiency in resources consumption, not only economic growth • Quality of the ventures begins to be relevant. <p><u>ACADEMIA</u></p>		<ul style="list-style-type: none"> • Environmental issues and sustainability gain momentum. Consolidation of the social goals of entrepreneurship. • Entrepreneurship education approach widens the scope (attitudes, knowledge and skills). <p><u>ACADEMIA</u></p> <ul style="list-style-type: none"> • Education also gains relevance. • Management and culture aspects gain momentum.
	<ul style="list-style-type: none"> • Coincidences between policy and academic themes increase. • Consolidation of regional approaches 	c2. Market launch (Mid 2010s – In progress)	<p><u>EU POLICY</u></p> <ul style="list-style-type: none"> • Targeted support to high growth entrepreneurship, mainly digital based. • Broad focus on agglomeration and also in internationalisation of business ventures (both EU internal market and also worldwide). <p><u>ACADEMIA</u></p> <ul style="list-style-type: none"> • Internationalisation and agglomeration continue to increase their importance. • Consolidation of inclusion as relevant thread of research.

6 CONCLUSIONS, LIMITATIONS AND FURTHER WORKS

This final chapter summarizes the main conclusions of the thesis. Particularly, section 6.4.1. outlines the main contributions of the investigation in addressing the research questions, resulting from the five flows of knowledge depicted in Fig. 2. Then, section 6.4.2. compiles the implications from the point of view of theory, policy and practice. After that, section 6.4.3. describes the main limitations of the study and section 6.4.4. sets out some avenues for further research to conclude the thesis.

6.1 Thesis contributions: answering the research questions

The entrepreneurial and innovation ecosystem approaches are growing topics in both policy and research arenas. Both concepts emerge as an answer to the previous limited knowledge on how complex interactions among different agents/domains/conditions influence the entrepreneurial outcome of a certain area (Neck *et al.* 2004).

Despite this interest, there are some controversies about the shortcomings when studying innovation ecosystems (Autio & Llewellyn 2014) and entrepreneurial ecosystems (Audretsch *et al.* 2018), both from research and policy perspectives. First, the time dimension is not commonly considered. Second, there is not a structured analysis about the dynamic relationships among the agents of the ecosystem, especially analyzing the role of policy, which, on the other hand, has been stated as one of the key factors to foster and/or undermine the health of an ecosystem. And, in fact, there is limited knowledge about this policy domain in both market-oriented economies and planned economies.

This thesis intends to contribute to the understanding of entrepreneurial and innovation ecosystems and the role of public policy in their formation, evolution and performance. Particular contributions from the theoretical, empirical and methodological perspectives are detailed below, and related with the research objectives described in section 1.4.1.

From the theoretical perspective, this thesis has four main contributions.

As the first theoretical contribution, this thesis proposes two specific and previously unknown frameworks to characterize respectively entrepreneurial ecosystems in market-oriented economies and innovation ecosystem(s) in the case of China. This contribution is linked with the first objective established in section 1.4.1.:

- First, it is possible to propose an advanced conceptual framework for the analysis of entrepreneurial ecosystems in market-oriented economies from the literature review in Chapter 2. The model shown in Fig. 40 is the result of merging the domains in the frameworks proposed by Babson College in The Babson Entrepreneurship Ecosystem Project (BEEP) and also drawing from the framework developed by the OECD's Statistics Directorate within the context of the OECD-Eurostat Entrepreneurship Indicators Programme (Ahmad and Hoffmann 2008; OECD 2008). The framework in this thesis is a

high-level representation of the ecosystem, so it is not sufficient to address the complex dynamics of the ecosystem. To this aim, this thesis has studied the evolution of one key domain /dimension (policy) that influences the development of the whole ecosystem.

Fig. 40 - Common framework based on the entrepreneurial model of BEEP (fine border) and EIP (thick border). Own elaboration.

- In addition, building on Cai and Liu's (2014) Triple Helix model, this thesis proposes a revisited Asymmetric Triple Helix (ATH) model for the study of the innovation ecosystem(s) in China, as presented in Fig. 41 below. The ATH model in this thesis is used to study the AI ecosystem at a country and industry level, while Cai and Liu's (2014) model is focused on a regional innovation system. Further, the ATH is also a government-led TH model, but it also considers, as main novelties, a particular role for (i) the regional and local governments conducting their own policy experiments, fuelling the whole innovation process with a certain degree of autonomy; (ii) the startups that commercialize new business models in addition to larger digital companies; and (iii) universities and R&D centres producing new knowledge and training people. The development of AI is paradigmatic and reaches multiple key technological industries (Baccala *et al.* 2018). So, even considering that the model has been applied only to study the case of AI ecosystem, it could potentially be applied to other complex and emerging industries in China.

Fig. 41 - Asymmetric Triple Helix (ATH) model for the AI ecosystem in China. Source: Own elaboration adapted from Cai (2013) and Cai and Liu (2014).

The second theoretical contribution is related to entrepreneurship policy as a research field. Results from phase 1 contribute to enrich the existing literature in the field of entrepreneurship policy through the identification of the main threads that have configured the research priorities, putting them in a temporal and geographical framework and unveiling the main trends and shifts within the academic discourse.

The main general trends in entrepreneurship policy research are the growing number of articles, especially since the mid-2000s, and the increasing maturity of this field, including more sophisticated and complex themes and concepts over the years. Results from the text mining show that the conceptual framework of the discipline has largely been dominated by studies related to inclusion (social perspective), employment (economic perspective)

and regulation (legal perspective). However, other key constituents of the entrepreneurial ecosystem have been less researched, mainly the human capital perspective, the infrastructures perspective and early stage finances. In addition, there is also a gap in the study of the relationships between relevant elements, such as knowledge production, market relationships, government role, location and cluster effects, and overall governance. From the policy cycle point of view, the identified gaps could be especially helpful in its initial stages, which precisely have been noted as a barrier for informed policy based on research in the case of entrepreneurship (Lundstrom and Stevenson 2006; Arshed *et al.* 2014).

Regarding the themes addressed, the distribution of papers within the different clusters over time shows that research has expanded and evolved from an initial classical approach to the relationship between entrepreneurship and employment as a direct impact on economic growth to a wider and multidisciplinary scope, not directly linked to conventional policies, including, lately, some governance issues and advanced economic views on agglomeration instead of previous narrower sectorial approaches. However, cross-disciplinary research, and the link between local, regional, national and multi-national dimensions are under-investigated.

Research is also increasing the use of data, although more in the form of partial evidence or case studies. However, new data techniques such those used in this thesis – text mining, data visualization or knowledge graphs – are still largely missing in the study and shaping of entrepreneurial policies.

From the geographical perspective, the regional analysis shows that researchers affiliated to the US and the EU dominate the scientific production in the analyzed journals. In the case of the EU, there is a major influence of UK-affiliated researchers, while the contributions of the Netherlands and Sweden are also significant in relative terms. This is coherent with previous studies about entrepreneurship as an independent field in social sciences, clearly dominated by Anglo-Saxon countries, particularly by those from North America and the UK, with the relatively solid position of Nordic countries and the Netherlands (Meyer *et al.*, 2014). These results align with what was mentioned specifically by Welter and Lasch (2008) in relation to the national or international orientation of European research communities in the entrepreneurship field and how aspects such as language and the size of national scenes might play a role in the case of Germany or France. Despite the advances, the internationalization of the research community in the field is still limited. Furthermore, results from this thesis illustrate that themes and topics addressed across different regional affiliations are somewhat heterogeneous, probably linked to diverse development priorities. One of the most significant findings is the additional level of complexity that this amalgam of priorities suggests for the transfer of knowledge from academia to policymakers and vice versa. At the same time, outward collaboration seems to encourage the diversification of research themes; promoting connections among researchers from different affiliations should therefore be a challenging priority in order to enrich the field.

All in all, research on entrepreneurship policy has evolved through topics increasingly close to those used in practice and a growing community of international researchers willing to cooperate and reach outwards.

The third theoretical contribution is related to the results of the evolution of the policy domain in the EU. Results of phase 2 provide a sufficient granular analysis on the evolution of the EU approach to entrepreneurship, able to identify main themes and foundational concepts of each stage while establishing which ideas have shaped the policy agenda and why, moving from one type of policy to the next. These results support the identification of relevant milestones, concepts and the categorization of main themes of this agenda, identifying the key constructs of each of the different policies and establishing appropriate stages for coherent sets of policies.

In conclusion, the analyses and results gathered in phase 2 show that the EU entrepreneurship policy agenda can be considered to have started in the early 2000s, coinciding with the launch of the Lisbon Agenda, and has followed a learning curve during the last two decades, moving from general enterprise policy to increasingly entrepreneurship targeted measures. These results offer hints about the temporal dimension of the emergence, development and decline of the key topics and concepts that has formed the entrepreneurship policy conceptual framework in the EU along the period. Policy rationales for public intervention within the field have evolved from general issues to confronting specific market failures (e.g., lack of access to sufficient investment, lack of skilled labour, or lack of support infrastructure) or systemic failures (e.g., the absence of entrepreneurial values in European society). The initial lack of information, due to the novelty of the field, has forced a trial-and-error process to expand knowledge on the context and specific needs of entrepreneurship, which has resulted in innovative policy ideas.

In addition, EU policy-making documents were compared for the main categories and through their evolution over time, considering the evolution of the EU policy cycle. In general, the focus of policymakers' discourse shifts every five years, coinciding with the EU policy cycle, suggesting that every new College of Commissioners aims to bring their ideas to the agenda. This evolution has not been completely homogenous: initially, themes appeared disconnected in time and scope, but later displayed potential influences and continuity from previous stages.

The fourth theoretical contribution is related to the understanding of the dynamics of innovation in China, the role played by main stakeholders and the key influence and support of government at different levels.

The bottom line of the existing successful implementation of AI solutions in China consists of the three components of the TH aligned on top of a very unique and favourable environment. The government at different levels has contributed with the conditions – plans, strategies, regulations, room for experimentation – and the practical support – venture capital, purchases, access to data – for AI innovation to happen, favouring (national) security, stability, positive impact on social welfare and a strict control of cyberspace over privacy and individual rights. China's technology industry, led by Internet giants Alibaba, Tencent and Baidu, are building research centres, deploying applications and hiring all the available AI talent. A middle-class of AI-based companies with high impact applications is burgeoning. In addition, increasingly excellent universities are

launching educational programmes and research opportunities in AI and China's performance in terms of AI patents and publications is improving significantly.

The overall result is a strong alignment of companies and government interests as a whole with the ecosystem most developed in the areas of image, face and voice recognition, together with their supporting techniques, such as machine and deep learning, as revealed by the analysis. Consequently, the most developed AI application domains in China are security, healthcare, transportation and traffic management, and from the perspective of cities, commerce, payments and driverless cars, all of them belonging to the B2C domain, and most of them with a public slant. The analysis also shows the main gaps of the ecosystem in the shape of low adoption of AI within traditional industries, patchy implementation, the gap between the quantity and the quality of the pool of AI talent, the dependence on foreign industries, and the relatively low quality and diversity of the data. Last but not least in terms of importance, AI presents practical risks and ethical issues in terms of social governance.

Particular notes of interest from the analysis are the particular approach to policy making, and the clustering of the innovation ecosystem. In fact, the approach to policy making is radically practical, based on several different – sometimes barely compatible – strategies, all of them based on a trial-and-error approach by testing new policies in starting projects. Depending on the outcomes of these tests, AI policies and strategies are either abandoned, refined or rolled out across the country. Also because of the head start of these experiments, major opportunities tend to concentrate in some regional/local specialized clusters competing for talent and investments across the country.

An additional insight from the analysis is that the ecosystem is developing relatively independently from that of other countries, with the exception of the strategic pledge for the internationalization of research institutions. TH outward connections are made between researchers based at universities and research centres in different countries, as well as through major Chinese technology companies that have set up basic research centres and funding in the US and, vice versa, via a number of US technology companies that have established research centres in China to tap into local talent and developments. The presence of the EU and other countries such as Japan, Russia or South Korea in China's AI ecosystem is low, with some minor exceptions through companies, university collaboration and individuals working in startups and venture capital.

These lessons are particularized in the case of AI, but could be extended to other innovative industries in China.

As empirical contribution, the examination presented in the discussion in Chapter 5 offers a comprehensive and combined timeline of the evolution of the entrepreneurship policy agenda from the perspective of European Union policy and the research perspective. Connected with the last objective related to ecosystems theory and the policy domain listed in section 1.4.1, it allows establishing patterns and finding temporal and contextual relations between EU policies and academic themes, contributing to the debate about knowledge utilization in policy-making, an area where there are considerable controversies (Daviter 2015). EU policymaking documents

and academic papers were compared through main themes that, initially, appeared disconnected in time and scope, but that lately displayed potential mutual influences. In particular, the results in the thesis offer hints about the temporal dimension of the emergence, development and decline of the key themes and concepts in each case. As a broad summary, during 1990–1999, the Academia corpus led in the entrepreneurial policy domain starting with simple analysis and providing increasingly complex topics, such as the links between entrepreneurship and employment or innovation and research, which were later incorporated in EU policy documents from the early 2000s. Equally, the Lisbon Agenda also included some topics – such as inclusion and the interest on ICT – that, in turn, began to capture the attention of researchers during the late 2000s. Also, during the mid-2000s, education became relevant for EU policymakers, and academia took on the challenge of going deeper into the topic during the early 2010s. Similarly, the interest of researchers in themes such as the relationship between entrepreneurship, research and innovation; the role of new digital technology; or the role of investment on the development of entrepreneurial ventures, was high during the late 2000s, and those same topics surfaced in EU policy documents during the 2010s. Common occurrences between relevant themes in the corpora grew more common during the 2010s. Since then, the inclusion and social dimension of entrepreneurship, the role of investment and new legislative approaches on ventures development and the relationship between innovation and the new digital-based paradigm and entrepreneurship have continued to be key topics for both academia and EU policymakers.

Finally, the methodological contributions of this thesis are twofold, connected with the two objectives related to the methodology established in section 1.4.1.:

- First, text mining analyses in phases 1 and 2 of this thesis and the combined examination in section 5 are a realization on how these data/text mining techniques can be a helpful alternative to complement qualitative approaches to review the evolution of policy fields. The exploratory nature of text mining techniques permits to obtain new knowledge and/or reveal hidden patterns from large quantities of documents/text data, impossible to process individually. So these techniques can be useful to examine research dynamics in a particular field, contributing to the challenge of linking research and policy, an open debate in many fields as in the case of entrepreneurship (Steffens *et al.* 2014).
- Secondly, the study of the AI ecosystem shows how a qualitative approach could be a valid alternative to analyze the entrepreneurial and/or innovation ecosystem(s) in China in which the availability and reliability of statistical data have sometimes been controversial (Koch-Weser 2013). The combination of desk research and experts' surveys was suitable for identifying the key players in the ecosystem, describing their roles, and framing their relationships in a novel and emerging context of innovation, as is the case of AI development

To sum up the contributions of this thesis, the following paragraphs provide an answer to the research questions established in section 1.4.1.

RQ1: How does ecosystem development depend on the economic model and the agents? Are all ecosystems similar?

While the more obvious answer is that not all ecosystems are similar, the results and findings of the analysis confirm this and contribute to extending the common knowledge of ecosystem theory.

It is commonly accepted that there are a range of elements of the ecosystem (agents, domains, relationships, dynamics) that allow an understanding of their development and performance. In addition, ecosystem theory is built on the Schumpeterian conception of innovation, that is, unleashed by creative-destructive forces. However, the study of the AI ecosystem in China as a paradigmatic example of a non-Western perspective shows a different and apparently successful approach in terms of the performance of the ecosystem. Innovation in China combines a comprehensive top-down approach, from different government/policy levels, with limited individual initiatives. This system represents a very different approach to that of liberal economies/democracies in Western economies, also in terms of the ecosystem dynamics and how the different domains are related, especially considering the role of policy. While it is undisputed that there are a range of controversies and challenges ahead regarding human and civil rights, civil liberties and political freedoms, from the author's point of view and from a strictly practical stance, there is now an open debate on which of these two competing models will become predominant across the political systems in the world.

RQ2: How policy do domain/approaches impact on the development of entrepreneurial activity?

The outcomes of phase 3 are exploratory in nature and support the theoretical research on the current successful (apparently) AI ecosystem in China that updates previous attempts at characterization to provide a conceptual scheme of analysis in a more systematic way. The overall result can be summarized as China's AI plan for leveraging the momentum provided by both the government and private companies to move beyond the outcome that the market alone – either before or after regulation – could provide. While it seems obvious that the context in China is different from market-oriented economies, the results of phase 3 provide some insights that should be considered by policymakers when implementing strategies to support the development of innovation and entrepreneurial ecosystems:

- There is strong government support for companies, universities and research centres, providing favourable economic and regulatory conditions on three axes: acting as an investor, as a consumer of digital technologies, and as a provider of key data for companies experiencing advantageous conditions.
- Secondly, although China continues to operate on a centrally planned system, with innovation initiatives following a top-down approach, in many instances, regional and local governments have the mandate to develop their own innovative activities independently from the rest of the country. This situation is an evolution of the traditional cross-regional competition in economic terms (Li *et al.* 2000).

Contrary to common understanding, from a policy point of view the Chinese context provides a path for how bottom-up initiatives through the regional and local governments could be integrated with top-down plans.

- Besides, while it is true that governments play a leading role, the three helices are strongly related and aligned and their very dynamic interactions are driving the evolution of the whole ecosystem.

This is not the same situation as in the EU (and also the US), dominated by different combinations of regulation and market forces and very dependent on the policy cycle, as shown by the results of the text mining analysis in phase 2. This is mainly because China has been able to mobilize resources for technology sectors aimed at final consumers such as AI in a way in which democracies are simply unable to do because of the limits of government power or popular mandate, combined with a long-term vision of technological development that is independent of the policy cycle.

This does not mean that China should be considered as the model to follow by Western economies. In addition to the significant issues above related to human and civil rights, civil liberties and political freedoms, the analysis also shows the main practical gaps of the ecosystem in the form of low adoption of AI within traditional industries, patchy implementation, the gap between the quantity and the quality of the AI talent pool, the dependence on foreign industries as in the case of the microchips industry, and the relatively low quality and diversity of the data. In addition, AI presents practical risks and ethical issues in terms of social governance that cannot be ignored.

But, in practical terms, the combination of a comprehensive long-term vision with the possibility of experimenting rapidly are two key principles for China to develop successful innovation ecosystem(s) that should not be ignored.

6.2 Implications

Building on the results and discussions presented respectively in chapters 4 and 5 and also considering the contributions in the previous section, this thesis provides a range of main implications for research and policy that could be summarized as follows:

Research implications

- As a main conclusion from the research point of view, this thesis suggests a less Western-centric approach when analyzing the development of China.
- Further, based on the specific results of phase 1, entrepreneurship policy researchers could benefit from the results in this thesis. Particularly, as cross-disciplinary research and the link between local, regional, national and multi-national dimensions are under-investigated in entrepreneurship policy, this provides

further avenues for researchers on the topic. In addition, cooperation outwards and proximity to the practice are current tendencies that should be maintained.

- This thesis is also significant in showing how text mining could complement and add value to other qualitative approaches when reviewing a policy field both from academic and policy perspectives. As demonstrated, text mining permits identifying key patterns, trends and shifts within the most relevant concepts and topics that have configured a policy/research discourse; thus, it can contribute to complex research tasks.

Policy implications

- As main policy implication for those policymakers related to entrepreneurship policies, especially in the EU, this thesis strongly advocates for both a long-term vision combined with a better understanding of the learning curve in policymaking and, from here, for an entrepreneurial (lean) approach to policymaking in new domains. The main objective should be gathering enough – and sufficiently rapid – iterations with the available resources, so as to effectively approach the real needs of customers, in the case of the EU, entrepreneurial ecosystem stakeholders.
- Results of the analysis of the Academia corpus also have practical implications for policymakers. Given the multidisciplinary and dynamic nature of entrepreneurship, and its global relevance but local specificities, the definition and adoption of a certain policy agenda in entrepreneurship should consider multiple aspects in order to be comprehensive and aligned with its complexity.
- As in the case of research implications, while policy domain is also increasing the use of data, it is still more in the form of partial evidence or case studies. However, new data techniques such as text mining, data visualization and knowledge graphs, as employed in this thesis, are still largely missing in the study and shaping of entrepreneurial policies. In the particular case of the EU entrepreneurship policy agenda, the results of this thesis accumulate relevant knowledge that could help current policymakers to look back and compare former theoretical priorities in the field with later policy realizations.

6.3 Limitations

The results, outcomes and findings in this thesis have a number of limitations that should be considered when reviewing the conclusions and research implications. In addition, these limitations suggest some avenues for further research work, as described in the following section 2.4.

On the one hand, results from the text mining analyses have some limitations by their own nature.

- First, results are a simplification of the evolution of the research agenda for entrepreneurship policy (phase 1) and the policy agenda on entrepreneurship in the EU (phase 2), mainly due to the nature of the samples (corpora under analysis). Particularly, phase 1 only considers research articles in English

in ten leading entrepreneurship related journals included in Scopus and therefore has a biased emphasis on mainstream entrepreneurship research. Other important databases and research documents such as book chapters, conference proceedings or different types of event, and of course other types of journal could be considered to obtain new insights that would complement the results obtained in phase 1. Similarly, phase 2 only considers communications from the European Commission. Further analyses could include other types of policy documents, such as legislative acts (directives, decisions, regulations); other non-binding documents (recommendations, opinions or non-papers); or discussion documents (green papers or white papers) that potentially could add new insights.

- In addition, results from the text mining present some limitations due to the inherently subjective nature of some of the researcher's choices and interpretations during the text mining analysis. The main issues are the selection of the k-means algorithm for the cluster analysis, the decision about the parameters and the interpretation of the results. To deal with the potential biases associated with these choices, clustering results have been checked for a range of values of the k parameter as part of the cluster analysis. And the analysis also includes the Davies-Bouldin index as an objective statistical measure to check the suitability of the different cluster partitions.

On the other hand, the analysis in phase 3 presents as main limitations those arising from the qualitative nature of the study. Document analysis has been mainly conducted through documents written in English, so an important part of the literature, that is, those documents written in Chinese, have not been included to obtain the outcomes. In addition, experts for the survey were selected from the available contacts in the China AI ecosystem, through the China Association of Artificial Intelligence, Chinaccelerator and the main universities devoted to AI in China. In this sense, the sample is balanced, being equally distributed among the three main areas identified in the Triple Helix framework (government, industry and universities); and the representativeness of the sample is adequate, considering that one of the supervisors of this thesis is based in Shanghai and he has a relevant network with the entrepreneurship/innovation ecosystem in China, and also considering that the doctoral researcher has visited China twice during the thesis period.

Finally, the comparability among the results of phases 1-2 (Academia and EU Policy) and phase 3 (AI ecosystem in China) is a limitation of the thesis due to the different methodological approaches and periods considered for the analysis. However, the lack of available and/or reliable policy documents written in English by the government in China complicate the possibility of conducting a text mining analysis, so mixed methods represent a fair alternative for the analysis.

6.4 Avenues for future research

The ecosystem approach as a way to conceptualize the context of innovation and entrepreneurship are an emergent and hot topic from both research and policy perspectives. This interest and the relative novelty of the field suggest new opportunities for further research. Based on the learnings and findings of this thesis and also

aiming to address some of its limitations, it is possible to propose the following non-exclusive avenues for further research:

First, considering the two theoretical frameworks to characterize entrepreneurial and innovation ecosystems, there are some lines to be developed. In the case of the framework characterizing the entrepreneurial ecosystem, future works could aim to deepen the model in terms of quantification. Particularly, the goal would be to trace a path to characterize entrepreneurial activity from a quantitative perspective to evaluate and monitor the progress of the ecosystem. These works could answer the question on how to evaluate ecosystem performance using datasets and indicators that allow to analyze, measure and support decision-making in the field. The reliability, measurability and comparability of the model would be the main challenges to face.

The case of China deserves specific research attention. The focus of this thesis has been on developing an ATH theoretical framework for the innovation ecosystem in China and applying it to the AI landscape from a descriptive and qualitative perspective, but it still requires a further quantitative review to evaluate/validate its explanatory capacity. Besides, future research could develop the framework further to enhance its generalizability to other fields/industries in China and/or geographies. And, in addition, it could use further developments of the Triple Helix to include the interrelations with citizens (Quadruple Helix) and/or the environment (Quintuple Helix), identifying potential differences with respect to other geographies.

In addition, connected with the research on the ecosystem dynamics, further research could be developed to include the concept of ‘coevolution’, an idea already introduced by Moore (1993b) in the case of business ecosystems to point out the development of companies around a new innovation. While it is accepted that the concept is useful to answer the question about how the ecosystems change over time, the study of the evolutionary processes within the ecosystems has been note as one of the main research gaps of the ecosystems literature (Thomas and Autio, 2019).

A second stream of further research is related to the study of the policy domain by using text mining techniques. Within the EU sphere, future works could add country-based policy documents in national languages to study cross-national similarities and differences between the EU policy approach and the different national approaches. Similar studies could also be conducted in other relevant geographies, as in the main case of the US to compare the evolution of key concepts and themes with respect to the EU and academia approaches.

A third line is related to the research on entrepreneurship policy and considering the limitations due to the sample used in this research, other important databases and research documents such as book chapters, conference proceedings or different types of event, and of course other types of journal could be considered to obtain new insights that would complement the results obtained in phase 1 that are only a representation of the mainstream academic discussion on the topic.

Finally, from the researcher’s view, there are still considerable opportunities to better understand the agenda-setting stage in the policy cycle in the case of entrepreneurship; and then, there is still room to improve the

adoption of research results in the policymaking process. In this line, further analysis could also include the synchronous analysis of other stakeholders, such as the knowledge of think tanks in this field, trying to establish potential links of influence between policymaking–academia–industry, contributing to the debate about what knowledge is being used in entrepreneurship policymaking. In this sense, the main limitation could be the lack of an official database, as in the case of EU policy documents, or at least a group of universally acknowledge databases, as in the case of academic papers (Scopus, WoS as main examples).

6.5 Last thoughts / Epilogue

It is May 1st and I have started to write this epilogue section in the middle of the COVID-19 shock, so it will be quite different with respect to the type of epilogue I would have written two months ago.

This situation first brings to my mind how fragile we are as individuals in an increasingly complex and interconnected world. Under normal conditions, we overestimate our own capabilities, contributions and self-sufficiency. And that, as life shows, is often at odds with objective reality. Suddenly, an individual or collective shock emerges and we realize that we all have mutual dependencies. In this context, the role of policy and States, often denied in favour of more pro-market approaches, is suddenly considered essential to overcome not only the health crisis but also the economic and societal consequences, as we are seeing in the current days.

We are probably not aware yet, but this shock will have some positive side-effects that we as a society should not miss. The COVID-19 crisis has unleashed an unprecedented wave of innovation and collaboration around the world. Universities, corporates, SMEs and startups and individual ‘makers’ have reorganized and repurposed their facilities and equipment to help fight the disease with a very entrepreneurial approach. In addition, we have seen possibly 5 years of digital transformation in less than two months and this could involve some positive externalities in terms of climate change, for example.

Under this uncertain context, an ecosystem approach is more necessary than ever. The epic battle of the individual entrepreneur derived from the current notion of Schumpeterian entrepreneurship is worthless. On the contrary, the idea of entrepreneurship as a systemic phenomenon should be even more consolidated.

The complexity and interdependence of our modern societies require more than ever an entrepreneurial approach at different levels, especially at the policy domain. In fact, a new normal of experimentation with policies in those domains with little prior knowledge is not only unavoidable but rather a logical consequence and an efficient path to successful implementation. But this should not neglect the need for a long-term vision for the whole ecosystem to align our objectives as a society, as we are doing now to face the pandemic. In contrast, liberal democracies continue to lose momentum in the search for solutions to the challenges ahead.

7 REFERENCES

- Acs, Z., Estrin, S. Mickiewicz, T., & Szerb, L. (2014) 'The Continued Search for the Solow Residual : The Continued Search for the Solow Residual : The Role of National Entrepreneurial Ecosystem', *IZA Discussion Paper Series.*, (8652).
- Acs, Z. *et al.* (2016) 'Public policy to promote entrepreneurship: a call to arms', *Small Business Economics*, 47(1), pp. 35–51. doi: 10.1007/s11187-016-9712-2.
- Acs, Z. J. *et al.* (2012a) 'Growth and entrepreneurship', *Small Business Economics*, 39(2), pp. 289–300.
- Acs, Z. J. *et al.* (2012b) 'Growth and entrepreneurship', *Small Business Economics*.
- Ács, Z. J., Autio, E. and Szerb, L. (2014) 'National Systems of Entrepreneurship: Measurement issues and policy implications', *Research Policy*.
- Acs, Zoltan J. and Szerb, L. (2007) 'Entrepreneurship, economic growth and public policy', *Small Business Economics*, 28(2–3), pp. 109–122. doi: 10.1007/s11187-006-9012-3.
- Acs, Zoltan J and Szerb, L. (2007) 'Entrepreneurship, Economic Growth and Public Policy', *Small Business Economics*. Springer, 28(2/3), pp. 109–122. doi: 10.1007/s11187-006-9012-3.
- Adner, R. (2006) 'Match your innovation strategy to your innovation ecosystem', *Harvard Business Review*, 84(4), pp. 98–107. doi: 10.1007/978-1-4614-3858-8_100487.
- Adner, R. and Kapoor, R. (2010) 'Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations', *Strategic Management Journal*, 31(3), pp. 306–333. doi: 10.1002/smj.821.
- Ahmad, N. and Hoffmann, A. N. (2008) *A Framework for Addressing and Measuring Entrepreneurship. OECD Statistics Working Paper*.
- Allee, V. (2011) 'Chapter Thirteen Value Network Examples Rewriting the Rules of Knowledge Sharing', in *The Future of Knowledge: Increasing Prosperity through Value Networks*. Boston: Butterworth-Heinemman, pp. 1–12.
- Almpanopoulou, A., Ritala, P. and Blomqvist, K. (2019) 'Innovation Ecosystem Emergence Barriers: Institutional Perspective', in Inno, T. I. S. for P. (ed.) *ISPIM Innovation Symposium*; Manchester: Manchestervation Management, pp. 1–11.
- ANDE (2013) *Entrepreneurial Ecosystem Diagnostic Toolkit*, Aspen Network of Development Entrepreneurs.
- Arbelaitz, O. *et al.* (2013) 'An extensive comparative study of cluster validity indices', *Pattern Recognition*, 46(1), pp. 243–256. doi: 10.1016/j.patcog.2012.07.021.

- Arndt Wonka (2008) ‘Decision-making dynamics in the European Commission: partisan, national or sectoral?’, *Journal of European Public Policy*. Routledge, 15(8), pp. 1145–1163. doi: 10.1080/13501760802407656.
- Arshed, N. (2017) ‘The origins of policy ideas: The importance of think tanks in the enterprise policy process in the UK’, *Journal of Business Research*, 71, pp. 74–83. doi: <https://doi.org/10.1016/j.jbusres.2016.10.015>.
- Arshed, N., Carter, S. and Mason, C. (2014) ‘The ineffectiveness of entrepreneurship policy: is policy formulation to blame?’, *Small Business Economics*, 43(3), pp. 639–659. doi: 10.1007/s11187-014-9554-8.
- Asheim, B. T. and Isaksen, A. (2002) ‘Regional Innovation Systems: The Integration of Local “Sticky” and Global “Ubiquitous” Knowledge’, *Journal of Technology Transfer*, 27(1), pp. 77–86.
- Audretsch, D. B. *et al.* (2002) ‘Understanding Entrepreneurship across Countries and over Time’, in *Entrepreneurship: determinants and policy in a European-US comparison*, pp. 4–6. doi: 10.1007/b109395.
- Audretsch, D. B., Bönte, W. and Keilbach, M. (2008) ‘Entrepreneurship capital and its impact on knowledge diffusion and economic performance’, *Journal of Business Venturing*, 23(6), pp. 687–698.
- Audretsch, D. B., Grilo, I. and Thurik, a R. (2007) ‘Explaining entrepreneurship and the role of policy: A framework’, *Handbook of research on entrepreneurship policy*, pp. 1–17.
- Audretsch, D. B. and Thurik, R. (2010) ‘Unraveling the Shift to the Entrepreneurial Economy’, pp. 2–23.
- Audretsch, D., Grilo, I. and Thurik, a. (2007) ‘Handbook of Research on Entrepreneurship Policy’, *Handbook Of Research On Entrepreneurship Policy*, pp. 18–36. doi: 10.4337/9781847206794.
- Audretsch, D. and Thurik, R. (2004) ‘A Model of the Entrepreneurial Economy’, *International Journal of Entrepreneurship Education*, 2(2), pp. 143–166.
- Auerswald, P. E. (2015) *Enabling Entrepreneurial Ecosystems*.
- Autio, A. E. *et al.* (2018) *The European Index of Digital Entrepreneurship Systems*. Edited by D. Nepelski, F. Rossetti, and V. Van Roy. Joint Resarch Center EC. doi: 10.2760/39256.
- Autio, E. (2016) *Entrepreneurship Support in Europe: Trends and Challenges for EU Policy*. doi: 10.13140/RG.2.1.1857.1762.
- Autio, E. and Cao, Z. (2019) ‘Fostering Digital Start-ups: Structural Model of Entrepreneurial Ecosystems’, in *Proceedings of the 52nd Hawaii International Conference on System Sciences*. Hawaii,

p. 10. doi: <http://hdl.handle.net/10125/59979>.

Autio, E. and Levie, J. (2017a) 'Management of entrepreneurial ecosystems', in *The Wiley Handbook of Entrepreneurship*. Wiley-Blackwell, pp. 423–449. doi: 10.1002/9781118970812.

Autio, E. and Levie, J. (2017b) 'Management of Entrepreneurial Ecosystems', pp. 423–449.

Autio, E. and Llewellyn T., D. W. (2014) 'Innovation ecosystems: Implications for innovation management', in *The Oxford handbook of innovation management*. Oxford: Oxford University Press, pp. 204–228. doi: 10.1093/oxfordhb/9780199694945.013.012.

Autio, E. and Rannikko, H. (2016) 'Retaining winners: Can policy boost high-growth entrepreneurship?', *Research Policy*, 45(1), pp. 42–55. doi: 10.1016/j.respol.2015.06.002.

Baccala, M. *et al.* (2018) '2018 AI predictions: 8 insights to shape business strategy'. PwC, p. 25.

Baptista, R. (1998) 'Clusters, innovation, and growth: a survey of the literature', in Swann, P. G. M., Prevezer, M., and Stout, D. (eds) *The Dynamics of Industrial Clustering International Comparisons in Computing and Biotechnology*. Oxford University Press, pp. 13–51.

Baptista, R. and Leitao, J. (2009) *Public Policies for Fostering Entrepreneurship*. London New York: Springer Dordrecht Heidelberg. doi: 10.1007/978-1-4419-0249-8.

Basole, R. C., Seuss, C. D. and Rouse, W. B. (2013) 'IT innovation adoption by enterprises: Knowledge discovery through text analytics', *Decision Support Systems*, 54(2), pp. 1044–1054. doi: 10.1016/j.dss.2012.10.029.

Baumol, W. J. (1996a) 'Entrepreneurship: Productive, unproductive, and destructive', *Journal of Business Venturing*, 11(1), pp. 3–22.

Baumol, W. J. (1996b) 'Entrepreneurship: Productive, unproductive, and destructive', *Journal of Business Venturing*.

Bennett, R. J. (2014) *Entrepreneurship, small business and public policy: Evolution and revolution, Entrepreneurship, Small Business and Public Policy: Evolution and Revolution*. New Yoork and Geneva: Routledge. doi: 10.4324/9780203078624.

Berkhin, P. (2002) *Survey Of Clustering Data Mining Techniques, A Survey of Clustering Data Mining Techniques. Grouping Multidimensional Data: Recent Advances in Clustering*. doi: 10.1007/3-540-28349-8_2.

Birch, D. G. W. (1979) 'The Job Generation Process', *MIT Program on Neighborhood and Regional Change*, 302, p. 1979. Available at: <http://ssrn.com/abstract=1510007>.

Bloom, P. N. and Dees, G. (2008) 'Cultivate your Ecosystem', *Stanford Social Innovation Review*,

Winter, pp. 47–53.

Boswell, C. and Smith, K. (2017) ‘Rethinking policy “impact”: four models of research- policy relations’, *Palgrave Communications*, 3, p. 44. doi: 10.1057/s41599-017-0042-z.

Brock, W. A. and Evans, D. S. (1989) ‘Small business economics’, *Small Business Economics*, 1(1), pp. 7–20. doi: 10.1007/BF00389913.

Brown, R. and Mason, C. (2017) ‘Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems’, *Small Business Economics*, 49(1), pp. 11–30. doi: 10.1007/s11187-017-9865-7.

Brush, C. G., Manolova, T. S. and Edelman, L. F. (2008) ‘Separated by a common language? Entrepreneurship research across the atlantic’, *Entrepreneurship: Theory and Practice*, pp. 249–266. doi: 10.1111/j.1540-6520.2007.00225.x.

Bryman, A. (2012) *Social research methods*. London: Oxford University Press. doi: 10.1017/CBO9781107415324.004.

Bughin, J. *et al.* (2018) *Notes From The AI Frontier: Modeling the Impact of AI on the World Economy*.

Busenitz, L. (2003) ‘Entrepreneurship Research in Emergence: Past Trends and Future Directions’, *Journal of Management*. doi: 10.1016/S0149-2063(03)00013-8.

Busenitz, L. W. *et al.* (2014) ‘Entrepreneurship Research (1985-2009) and the Emergence of Opportunities’, *Entrepreneurship: Theory and Practice*, (September 2015). doi: 10.1111/etap.12120.

Cai, Y. (2013) ‘Enhancing context sensitivity of the Triple Helix model: An institutional logics perspective’, in *The Triple Helix XI International Conference*. London, pp. 8– 10 July.

Cai, Y. (2014) ‘Implementing the Triple Helix model in a non-Western context: an institutional logics perspective’, *Triple Helix*, 1(1). doi: 10.1186/s40604-014-0001-2.

Cai, Y. and Liu, C. (2014) ‘The roles of universities in fostering knowledge-intensive clusters in Chinese regional innovation systems’, *Science and Public Policy*, 42(1), pp. 15–29. doi: 10.1093/scipol/scu018.

Cao, Y. (2018) *Lawyers urge more privacy protection, China Daily*. Available at: <http://www.chinadaily.com.cn/a/201808/14/WS5b721921a310add14f3858a1.html> (Accessed: 28 November 2018).

Carayannis, E. G., Barth, T. D. and Campbell, D. F. (2012) ‘The Quintuple Helix innovation model: global warming as a challenge and driver for innovation’, *Journal of Innovation and Entrepreneurship*, 1(2), pp. 1–12. doi: 10.1186/2192-5372-1-2.

Carayannis, E. G. and Campbell, D. F. J. (2009) “Mode 3” and “Quadruple Helix”: toward a 21st

century fractal innovation ecosystem', *International Journal of Technology Management*, 46(3–4), pp. 201–234. doi: 10.1504/IJTM.2009.023374.

Carlsson, B. (1992) *The Rise of Small Business: Causes and Consequences*.

Carlsson, B. (1999) 'Small Business, Entrepreneurship, and Industrial Dynamics', in *Are Small Firms Important? Their Role and Impact*, pp. 99–110.

Carlsson, B. *et al.* (2013) 'The evolving domain of entrepreneurship research', *Small Business Economics*.

Chang, W. J. and Katrichis, J. M. (2016) 'A literature review of tourism management (1990–2013): a content analysis perspective', *Current Issues in Tourism*, 9(8), pp. 791–823. doi: 10.1080/13683500.2016.1167177.

Chen, W. and Li, Y. (2019) 'The internationalization process of Chinese research institutions since the reform and opening-up: Theory and practice', *Journal of Industry-University Collaboration*. Emerald, 1(1), pp. 2–16. doi: 10.1108/JIUC-02-2019-001.

Chinta R.; Sussan F. (2018) 'A Triple-Helix Ecosystem for Entrepreneurship: A Case Review', in *Entrepreneurial Ecosystems. International Studies in Entrepreneurship*. Springer, Cham, pp. 67–80. doi: 10.1007/978-3-319-63531-6_4.

Cohen, B. (2006a) 'Sustainable valley entrepreneurial ecosystems', *Business Strategy and the Environment*, 15(1), pp. 1–14.

Cohen, B. (2006b) 'Sustainable valley entrepreneurial ecosystems', *Business Strategy and the Environment*.

Cole, R. J., Oliver, A. and Robinson, J. (2013) 'Regenerative design, socio-ecological systems and co-evolution', *Building Research and Information*, 41(2), pp. 237–247. doi: 10.1080/09613218.2013.747130.

Cooke, P., Uranga, M. G. and Etxebarria, G. (1997) 'Regional innovation systems: Institutional and organizational dimensions', *Research Policy*, 26, pp. 475–491.

Cotteleur, M. and Sniderman, B. (2018) *Forces of change: Industry 4.0*.

Credit Suisse (2019) *China unicorns: preparing to gallop*.

Daniel Isenberg (2011) 'The Entrepreneurship Ecosystem Strategy as a New Paradigm for Economic Development : Daniel Isenberg , Ph . D . Professor of Management Practice , Babson Global Executive Director , the Babson Entrepreneurship Ecosystem Project', 1(781).

Daniel Isenberg (2014) *What an Entrepreneurship Ecosystem Actually Is - HBR, Harvard Business*

Review. Available at: <https://hbr.org/2014/05/what-an-entrepreneurial-ecosystem-actually-is/> (Accessed: 24 June 2015).

Davies, D. L. and Bouldin, D. W. (1979) 'A Cluster Separation Measure', *IEEE Transactions on Pattern Analysis and Machine Intelligence*, PAMI-1(2), pp. 224–227. doi: 10.1109/TPAMI.1979.4766909.

Daviter, F. (2015) 'The political use of knowledge in the policy process', *Policy Sciences*, 48(4), pp. 491–505. doi: 10.1007/s11077-015-9232-y.

Delage, F. (2017) 'China: diplomacia económica, consecuencias geopolíticas', *Cuadernos de Estrategia*, (187), pp. 55–92.

Delen, D. and Crossland, M. D. (2008) 'Seeding the survey and analysis of research literature with text mining', *Expert Systems with Applications*. doi: 10.1016/j.eswa.2007.01.035.

Dennis Jr., W. J. (2011) 'Entrepreneurship, Small Business and Public Policy Levers', *Journal of Small Business Management*. doi: 10.1111/j.1540-627X.2010.00316.x.

Drucker, P. F. (1985a) *Innovation and Entrepreneurship*, NY Harper a Row. doi: 10.1023/B:BUSI.0000043501.13922.00.

Drucker, P. F. (1985b) *Innovation and Entrepreneurship*, NY Harper a Row. Edited by H. & Row. New York. doi: 10.1023/B:BUSI.0000043501.13922.00.

Elsevier (2018) *Artificial Intelligence: How knowledge is created, transferred, and used*. Available at: <https://www.elsevier.com/?a=827872>.

Ertek, G., Tapucu, D. and Arin, I. (2013) *Text mining with rapidminer, RapidMiner: Data Mining Use Cases and Business Analytics Applications*. doi: 10.1201/b16023-21.

Etzkowitz, H. (2008) *The triple helix: university-industry-government innovation in action*. New York; London: Routledge. doi: 10.4324/9780203929605.

Etzkowitz, H. and Leydesdorff, L. (1995) 'The Triple Helix - University-Industry-Government Relations: A Laboratory for knowledge-based Economic Development', *EASST Review*, 14, pp. 14–19.

Etzkowitz, H. and Leydesdorff, L. (2000) 'The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university...', *Research Policy*, 29(2), p. 109. doi: 10.1016/S0048-7333(99)00055-4.

Etzkowitz, H. and Zhou, C. (2006) 'Triple Helix twins: Innovation and sustainability', *Science and Public Policy*, 33(1), pp. 77–83. doi: 10.3152/147154306781779154.

European Commission (1998) *Fostering Entrepreneurship in Europe: priorities for the future, Communication from the Commission to the Council*.

- European Commission (2002) *Industrial Policy in an Enlarged Europe*.
- European Commission (2003a) *GREEN PAPER Entrepreneurship in Europe*, Enterprise publications. doi: 10.1017/CBO9781107415324.004.
- European Commission (2003b) *Innovation policy: updating the Union's approach in the context of the Lisbon strategy*. Brussels.
- European Commission (2004) *Action Plan : The European agenda for Entrepreneurship*.
- European Judicial Network (no date) *European Judicial Network Glossary*. Available at: http://ec.europa.eu/civiljustice/glossary/glossary_en.htm (Accessed: 5 November 2017).
- European Union (2014) *The European Union explained: How the EU works*. doi: 10.2775/11255.
- Feijoo, C. *et al.* (2012) 'Mobile Gaming: Industry Challenges and Policy Implications', *Telecommun. Policy*. Tarrytown, NY, USA: Pergamon Press, Inc., 36(3), pp. 212–221. doi: 10.1016/j.telpol.2011.12.004.
- Feijóo, C. (2020) *Tecno-socialismo con características chinas*. Madrid.
- Feld, B. (2012) *Startup communities : building an entrepreneurial ecosystem in your city* /. John Wiley & Sons, Inc.
- Feldman, M. (2001) 'The entrepreneurial event revisited: Firm Formation in a Regional Context', pp. 861–891.
- Felizardo, K. R. *et al.* (2011) 'Using Visual Text Mining to Support the Study Selection Activity in Systematic Literature Reviews', *2011 International Symposium on Empirical Software Engineering and Measurement*, pp. 77–86. doi: 10.1109/ESEM.2011.16.
- Ferreira, M. P., Reis, N. R. and Miranda, R. (2015) 'Thirty years of entrepreneurship research published in top journals: analysis of citations, co-citations and themes', *Journal of Global Entrepreneurship Research*. Journal of Global Entrepreneurship Research, 5(1), p. 17. doi: 10.1186/s40497-015-0035-6.
- Figuerola-Armijos, M. and Johnson, T. G. (2016) 'Entrepreneurship policy and economic growth: Solution or delusion? Evidence from a state initiative', *Small Business Economics*. Springer US, 47(4), pp. 1–15. doi: 10.1007/s11187-016-9750-9.
- Foxon, T. J. (2011) 'A coevolutionary framework for analysing a transition to a sustainable low carbon economy', *Ecological Economics*. Elsevier, 70(12), pp. 2258–2267. doi: 10.1016/j.ecolecon.2011.07.014.
- Fransman, M. (2014) *Models of Innovation in Global ICT Firms: The Emerging Global Innovation Ecosystems*. doi: 10.2791/10679.

- Fransman, M. (2018) *Innovation Ecosystems: Increasing Competitiveness*. Edited by C. U. Press. Cambridge. doi: 10.1017/9781108646789.
- Freeman, C. (1995) 'The ' National System of Innovation ' in historical perspective', *Cambridge Journal of Economics*, 19, pp. 5–24.
- Frenkel, A. and Maital, S. (2014) *Mapping national innovation ecosystems: Foundations for policy consensus*. Edward Elg, *Mapping National Innovation Ecosystems: Foundations for Policy Consensus*. Edward Elg. London. doi: 10.4337/9781782546818.
- Gaikwad, S., Chaugule, A. and Patil, P. (2014) 'Text Mining Methods and Techniques', *International Journal of Computer Applications*, 85(17), pp. 42–45. doi: 10.5120/14937-3507.
- Gamboa, E. C. and Brouthers, L. E. (2008) 'How international is entrepreneurship?', *Entrepreneurship: Theory and Practice*. doi: 10.1111/j.1540-6520.2008.00240.x.
- Garfinkel, S. *et al.* (2017) 'Toward algorithmic transparency and accountability', *Communications of the ACM*, 60(9), pp. 5–5. doi: 10.1145/3125780.
- Gartner, W. B. (1988) 'Is an Entrepreneur ?" Is the Wrong Question', *Entrepreneurship: Theory and Practice*.
- Gartner, W. B. (1989) 'Is an Entrepreneur ?" Is the Wrong Question', *Entrepreneurship: Theory and Practice*. New York, 12(4), pp. 47–67. Available at: <http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=5331834&site=ehost-live>.
- Gilbert, B. A., Audretsch, D. B. and McDougall, P. P. (2004) 'The Emergence of Entrepreneurship Policy', *Small Business Economics*, 22(3–4), pp. 313–323. doi: 10.1023/B:SBEJ.0000022235.10739.a8.
- Glanzel, W. (2012) 'Bibliometric Methods for Detecting and Analysing Emerging Research Topics', *Profesional De La Informacion*, 21(2), pp. 194–201. doi: 10.3145/epi.2012.mar.11.
- Godement, F. *et al.* (2018) *The China dream goes digital: Technology in the age of Xi*.
- Gómez-Barroso, J. L. (2019) *Economia y Politica*. Edited by UNED. UNED. Available at: http://portal.uned.es/portal/page?_pageid=93,23377989&_dad=portal&_schema=PORTAL&IdArticulo=6901107GR01A01.
- Gordijn, J., Akkermans, H. and Van Vliet, H. (2000) 'What's in an Electronic Business Model?', in *12th Int. Conf. on Knowledge Engineering and Knowledge Management*, pp. 257–273. doi: 10.1007/3-540-39967-4_19.
- Grimm, H. (2006) 'Entrepreneurship Policy and Regional Economic Growth BT - Innovative Comparative Methods for Policy Analysis: Beyond the Quantitative-Qualitative Divide', in Rihoux, B.

- and Grimm, H. (eds). Boston, MA: Springer US, pp. 123–144. doi: 10.1007/0-387-28829-5_6.
- Grin, J., Rotmans, J. and Schot, J. (2010) *Transitions to sustainable development: New directions in the study of long term transformative change, Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*. Routledge Taylor & Francis Group. doi: 10.4324/9780203856598.
- HaCohen-Kerner, Y. (2003) ‘Automatic Extraction of Keywords from Abstracts’, in Palade, V., Howlett, R. J., and Jain, L. (eds) *Knowledge-Based Intelligent Information and Engineering Systems: 7th International Conference, KES 2003, Oxford, UK, September 2003. Proceedings, Part I*. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 843–849. doi: 10.1007/978-3-540-45224-9_112.
- Haltiwanger, J., Jarmin, R. S. and Miranda, J. (2012) ‘Who Creates Jobs? Small vs. Large vs. Young’, *Review of Economics and Statistics*, p. 120515125242009. doi: 10.1162/REST_a_00288.
- Hart, D. M. (2003) ‘The emergence of entrepreneurship policy: Governance, start-ups, and growth in the U.S. knowledge economy’, in *The Emergence of Entrepreneurship Policy: Governance, Start-Ups, and Growth in the U.S. Knowledge Economy*, pp. 1–16.
- Hechavarria, D. and Ingram, A. (2014) ‘A Review of the Entrepreneurial Ecosystem and the Entrepreneurial Society in the United States: An Exploration with the Global Entrepreneurship Monitor Dataset’, *Journal of Business and Entrepreneurship*, 26(1), pp. 1–35.
- Henrekson, M. and Sanandaji, T. (2014) ‘Small business activity does not measure entrepreneurship.’, *Proceedings of the National Academy of Sciences of the United States of America*, 111(5), pp. 1760–5. Available at: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3918828&tool=pmcentrez&rendertype=abstract>.
- Hölzl, W. (2010) ‘The Economics of Entrepreneurship Policy: Introduction to the Special Issue’, *Journal of Industry, Competition and Trade*, 10(3), pp. 187–197. doi: 10.1007/s10842-010-0088-8.
- Hotho, A., Nürnberger, A. and Paaß, G. (2005) ‘A Brief Survey of Text Mining’, *LDV Forum - GLDV Journal for Computational Linguistics and Language Technology*, 20, pp. 19–62. doi: 10.1111/j.1365-2621.1978.tb09773.x.
- Huang, Y., Pagano, M. and Panizza, U. (2017) *Local Crowding Out in China*. Einaudi Institute for Economics and Finance (EIEF). Available at: <https://ideas.repec.org/p/eie/wpaper/1707.html>.
- Hwang, V. (2013) *The Rainforest Blueprint: How to Design Your Own Silicon Valley*. Edited by Regenwald.
- Iansiti, M. and Levien, R. (2004) ‘Strategy as Ecology’, *Harvard Business Review*.

IEG World Bank (2013) *World Bank Group Support for Innovation and Entrepreneurship. An Independent evaluation.*

Irani, J., Pise, N. and Phatak, M. (2016) 'Clustering Techniques and the Similarity Measures used in Clustering: A Survey', *International Journal of Computer Applications*, 134(7), pp. 0975 – 8887. doi: 10.5120/ijca2016907841.

Isenberg, D. J. (2010a) 'The big idea: How to start an entrepreneurial revolution', *Harvard Business Review*, 88(6). Available at: <https://hbr.org/2010/06/the-big-idea-how-to-start-an-entrepreneurial-revolution/ar/1>.

Isenberg, D. J. (2010b) 'The big idea: How to start an entrepreneurial revolution', *Harvard Business Review*.

Jackson, D. J. (2011) 'What is an Innovation Ecosystem?' Arlington: National Science Foundation, pp. 1–13. doi: 10.1017/CBO9781107415324.004.

Jacobides, M. G., Cennamo, C. and Gawer, A. (2018) 'Towards a theory of ecosystems', *Strategic Management Journal*, 39(8), pp. 2255–2276. doi: 10.1002/smj.2904.

Jain, A. K. (2010) 'Data clustering: 50 years beyond K-means', *Pattern Recognition Letters*, 31(8), pp. 651–666. doi: 10.1016/j.patrec.2009.09.011.

JFGagne (2018) *Global AI talent report 2018*.

Jin, J. and McKelvey, M. (2019) 'Building a sectoral innovation system for new energy vehicles in Hangzhou, China: Insights from evolutionary economics and strategic niche management', *Journal of Cleaner Production*. Elsevier Ltd, 224, pp. 1–9. doi: 10.1016/j.jclepro.2019.03.118.

Jongwanich, J., Kohpaiboon, A. and Yang, C.-H. (2014) 'Science park, triple helix, and regional innovative capacity: province-level evidence from China', *Journal of the Asia Pacific Economy*. Routledge, 19(2), pp. 333–352. doi: 10.1080/13547860.2014.880285.

Jucevičius, G. and Grumadaitė, K. (2014) 'Smart Development of Innovation Ecosystem', *Procedia - Social and Behavioral Sciences*, 156, pp. 125–129. doi: 10.1016/j.sbspro.2014.11.133.

Katz, B. and Wagner, J. (2014) 'The Rise of Innovation Districts: A New Geography of Innovation in America'. Metropolitan Policy Program. Brookings Institution.

Kelly, K. (2014) *The three breakthroughs that have finally unleashed AI on the world*, *Wired*. Available at: <https://www.wired.com/2014/10/future-of-artificial-intelligence/> (Accessed: 21 November 2018).

Kelly, K. (2017) *The myth of a superhuman AI*, *Wired*. Available at: <https://www.wired.com/2017/04/the-myth-of-a-superhuman-ai/> (Accessed: 12 December 2018).

Kenny, C. *et al.* (2017) 'Legislative science advice in Europe: the case for international comparative research', *Palgrave Communications*, 3. doi: 10.1057/palcomms.2017.30.

Kirzner, I. M. (1973) *Competition and Entrepreneurship*.

Kleibrink, A. and Magro, E. (2018) 'The making of responsive innovation policies: varieties of evidence and their contestation in the Basque Country', *Palgrave Communications*, 4(1), p. 74. doi: 10.1057/s41599-018-0136-2.

Knight, F. (1921) 'Risk, Uncertainty, and Profit', *Hart Schaffner Marx prize essays*.

Koch-Weser, I. N. (2013) *The reliability of China's economic data: An analysis of national output*, US-China Economic and Security Review Commission Staff Research Project.

Koirala, B. P., van Oost, E. and van der Windt, H. (2018) 'Community energy storage: A responsible innovation towards a sustainable energy system?', *Applied Energy*. Elsevier Ltd, 231, pp. 570–585. doi: 10.1016/j.apenergy.2018.09.163.

Kolloch, M. and Dellermann, D. (2018) 'Digital innovation in the energy industry: The impact of controversies on the evolution of innovation ecosystems', *Technological Forecasting and Social Change*, 136, pp. 254–264. doi: 10.1016/j.techfore.2017.03.033.

KPMG Enterprise (2019) *Venture Pulse Q4 2018*. Available at: <https://home.kpmg/xx/en/home/insights/2019/01/venture-pulse-q4-18-global-analysis-of-venture-funding.html>.

Krugman, P. (1991) 'Increasing Returns and Economic Geography', *Journal of Political Economy*, p. 483. doi: 10.1086/261763.

Kuhlmann, S. and Ordóñez-Matamoros, G. (2017) 'Introduction: governance of innovation in emerging countries: understanding failures and exploring options', in *Handbook on Innovation Governance for Emerging Economies*. Cheltenham, UK: Edward Elgar Publishing. doi: <https://doi.org/10.4337/9781783471911.00005>.

Landström, H. (2015) 'What makes scholarly works "interesting" in entrepreneurship research? Learning from the past', in *Rethinking Entrepreneurship: Debating Research Orientations*, pp. 147–170. doi: 10.4324/9781315754154.

Landström, H., Harirchi, G. and Åström, F. (2012) 'Entrepreneurship: Exploring the knowledge base', *Research Policy*, pp. 1154–1181.

Lawton Smith, H. and Leydesdorff, L. (2014) 'The Triple Helix in the context of global change: dynamics and challenges', *Prometheus (United Kingdom)*, 32(4), pp. 321–336. doi: 10.1080/08109028.2014.972135.

- Lee, S. Y., Florida, R. and Acs, Z. (2004) 'Creativity and Entrepreneurship: A Regional Analysis of New Firm Formation', *Regional Studies*, pp. 879–891. doi: 10.1080/0034340042000280910.
- Lerner, J. (2013) 'Entrepreneurship, Public Policy, and Cities', *World Bank Sixth Urban Research and Knowledge Symposium*, (November), pp. 1–19. doi: 10.1596/1813-9450-6880.
- Lew, L. (2018) *How Tencent's medical ecosystem is shaping the future of China's healthcare, Technode*.
- Li, Shaomin, Li, Shuhe and Zhang, W. (2000) 'The Road to Capitalism: Competition and Institutional Change in China', *Journal of Comparative Economics*, 28(2), pp. 269–292. doi: 10.1006/jcec.2000.1653.
- Lindmark, S. *et al.* (2006) 'Innovation system dynamics in the Swedish telecom sector', *The journal of policy, regulation and strategy for telecommunications*, 8(4), pp. 49–66. doi: 10.1108/14636690610676540.
- Liu, X. *et al.* (2010) 'Weighted hybrid clustering by combining text mining and bibliometrics on a large-scale journal database', *Journal of the American Society for Information Science and Technology*, 61(6), pp. 1105–1119. doi: 10.1002/asi.21312.
- Loon, Y. van (2014) *The Javelin Experiment Board*.
- Loveman, G. and Sengenberger, W. (1991) 'The re-emergence of small-scale production: An international comparison', *Small Business Economics*, 3(1), pp. 1–37. doi: 10.1007/BF00389842.
- Lu, L. and Etzkowitz, H. (2008) 'Strategic challenges for creating knowledge-based innovation in China: Transforming triple helix university-government-industry relations', *Journal of Technology Management in China*. Emerald, 3(1), pp. 5–11. doi: 10.1108/17468770810851476.
- Lucas, D. S. *et al.* (2018) 'Visions of entrepreneurship policy', *Journal of Entrepreneurship and Public Policy*. Edited by F. C. S. Emerald Publishing Limited, 7(4), pp. 336–356. doi: 10.1108/JEPP-D-18-00034.
- Lucas, L. (2018) *China's artificial intelligence ambitions hit hurdles*, *Financial Times*. Available at: <https://www.ft.com/content/8620933a-e0c5-11e8-a6e5-792428919cee> (Accessed: 20 April 2019).
- Lundström, A. and Stevenson, L. (2002a) 'On the road to entrepreneurship policy', *Volume 1 of the Entrepreneurship Policy for the Future Series*, 1, p. 256. Available at: <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:On+the+Road+to+Entrepreneurship+Policy#0>.
- Lundström, A. and Stevenson, L. (2002b) *On the road to entrepreneurship policy*. Edited by Stockholm: Swedish Foundation for Small Business Research.

- Lundstrom, A. and Stevenson, L. A. (2006) *Entrepreneurship Policy: Theory and Practice*. Springer US (International Studies in Entrepreneurship). Available at: <https://books.google.es/books?id=7jHQqGzoiAC>.
- Lundström, A. and Stevenson, L. A. (2005) *Entrepreneurship Policy: Theory and Practice*. Boston: Kluwer Academic Publishers (International Studies in Entrepreneurship). doi: 10.1007/b104813.
- Lundvall, B.-Å. (1992) *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning, National systems of innovation Towards a theory of innovation and interactive learning*. Available at: <http://books.google.com/books?id=iDXGwacw-4oC&pgis=1>.
- Lynch, S. (2017) *Andrew Ng: Why AI is the new electricity*, *Stanford News*. Available at: <https://www.gsb.stanford.edu/insights/andrew-ng-why-ai-new-electricity> (Accessed: 20 June 2018).
- Malecki, E. J. (1993) 'Entrepreneurship in Regional and Local Development', *International Regional Science Review*, pp. 119–153. doi: 10.1177/016001769401600107.
- Malecki, E. J. (2011) 'Connecting local entrepreneurial ecosystems to global innovation networks: open innovation, double networks and knowledge integration', *International Journal of Entrepreneurship and Innovation Management*, p. 36.
- Malecki, E. J. (2018) 'Entrepreneurship and entrepreneurial ecosystems', *Geography Compass*, 12(3), p. e12337. doi: 10.1111/gec3.12359.
- Manning, C. D., Ragahvan, P. and Schutze, H. (2009) 'An Introduction to Information Retrieval - Chapter 16: Flat clustering', *Information Retrieval*. doi: 10.1109/LPT.2009.2020494.
- Mark Purdy, Qiu, S. and Chen, F. (2017) *How artificial intelligence can drive China's growth*.
- Mårtensson, P. *et al.* (2016) 'Evaluating research: A multidisciplinary approach to assessing research practice and quality', *Research Policy*, 45(3), pp. 593–603. doi: 10.1016/j.respol.2015.11.009.
- Martin, R. L. and Osberg, S. (2007) *Social Entrepreneurship: The Case for Definition*, *Stanford Social Innovation Review*.
- Mason, Colin; Brown, R. (2014) *Entrepreneurial ecosystems and growth oriented entrepreneurship, Paper prepared for a workshop of the OECD LEED Programme and the Dutch Ministry of Economic Affairs, The Hague Netherlands 7th November 2013*.
- Mason, C. and Brown, R. (2014) *Entrepreneurial ecosystem and growth oriented entrepreneurship*. The Hague.
- Mazzarol, T. and Volery, T. (2015) 'The Evolution of the Small Business and Entrepreneurship Field : A Bibliometric Investigation of the Articles Published ...', *International Small Business Journal*, 33

(4)(June), pp. 374–396. doi: 10.1177/0266242613516139.

Mazzucato, M. (2011) *The Entrepreneurial State*. London: Demos.

Mercan, B. and Götkas, D. (2011) ‘Components of Innovation Ecosystems’, *International Research Journal of Finance and Economics*, 76(76), pp. 102–112. doi: 1450-2887.

Meyer, M. *et al.* (2014) ‘Origin and emergence of entrepreneurship as a research field’, *Scientometrics*, 98(1), pp. 473–485. doi: 10.1007/s11192-013-1021-9.

Miner, G. D., Elder, J. and Nisbet, R. A. (2012) *Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications*, *Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications*. doi: 10.1016/C2010-0-66188-8.

Minniti, M. (2008) ‘The role of government policy on entrepreneurial activity: Productive, unproductive, or destructive?’, *Entrepreneurship: Theory and Practice*, pp. 779–790. doi: 10.1111/j.1540-6520.2008.00255.x.

von Mises, L. (1949) *Human action: A treatise on Economics*.

Misuraca, G., Broster, D. and Centeno, C. (2012) ‘Digital Europe 2030: Designing scenarios for ICT in future governance and policy making’, *Government Information Quarterly*, 29, pp. S121–S131. doi: <https://doi.org/10.1016/j.giq.2011.08.006>.

Moore, J. F. (1993a) ‘Predators and prey: a new ecology of competition.’, *Harvard Business Review*.

Moore, J. F. (1993b) ‘Predators and prey: a new ecology of competition.’, *Harvard Business Review*, 71(3), pp. 75–86.

Moore, J. F. (1996) *The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems*, *Leadership*. Available at: <http://books.google.com/books?id=At7HQgAACAAJ&pgis=1>.

Morrison, E. (2013) *Universities as Anchors for Regional Innovation Ecosystems*. Available at: <http://www.edmorrison.com/universities-as-anchors-for-regional-innovation-ecosystems> (Accessed: 2 February 2019).

Motoyama, Y. (2008) ‘What Was New About the Cluster Theory?: What Could It Answer and What Could It Not Answer?’, *Economic Development Quarterly*, pp. 353–363.

Natário, M. M., Pedro Almeida Couto, J. and Fernandes Roque de Almeida, C. (2012) ‘The triple helix model and dynamics of innovation: a case study’, *Journal of Knowledge-based Innovation in China*, 4(1), pp. 36–54. doi: 10.1108/17561411211208758.

Neck, H. M. *et al.* (2004) ‘An entrepreneurial system view of new venture creation’, *JOURNAL OF SMALL BUSINESS MANAGEMENT*.

- Nelson, R. R. (1993) *National Innovation Systems: A Comparative Analysis*. New York.: Oxford University Press.
- NESTA (2019) *Mapping global approaches to AI governance*. Available at: <https://www.nesta.org.uk/blog/mapping-global-approaches-ai-governance/> (Accessed: 6 April 2019).
- Ng, L. (2018) *US vs China in AI — A Realistic, No B.S. Assessment, Medium*. Available at: <https://medium.com/behind-the-great-wall/us-vs-china-in-ai-a-realistic-no-b-s-assessment-a9cef7909eb6> (Accessed: 15 December 2018).
- Ngai, E. W. T. and Lee, P. T. Y. (2016) ‘A Review of the Literature on Applications of Text Mining in Policy Making’, *20th Pacific Asia Conference on Information Systems (PACIS 2016)*.
- Nill, J. and Kemp, R. (2009) ‘Evolutionary approaches for sustainable innovation policies: From niche to paradigm?’, *Research Policy*, 38(4), pp. 668–680. doi: 10.1016/j.respol.2009.01.011.
- O’Connor, A. (2013) ‘A conceptual framework for entrepreneurship education policy: Meeting government and economic purposes’, *Journal of Business Venturing*, 28(4), pp. 546–563. doi: 10.1016/j.jbusvent.2012.07.003.
- OECD (1993) *Regional characteristics affecting small business formations. A cross national comparison*.
- OECD (2004) ‘Fostering Entrepreneurship and Firm Creation as a Driver of Growth in a Global Economy’, *2nd OECD conference of ministers responsible for SMEs*, (June). Available at: http://www.odc.public.lu/actualites/2005/11/colloque_entrepr/Fostering_Entrepreneurship.pdf.
- OECD (2008) ‘Defining Entrepreneurial Activity: Definitions Supporting Frameworks for Data Collection’, (January), pp. 1–18.
- OECD (2015a) *Entrepreneurship at a Glance 2015, Entrepreneurship at a Glance*. doi: 10.1787/9789264097711-en.
- OECD (2015b) ‘Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists’, *OECD Science, Technology and Industry Policy Papers*, (21), p. 49. doi: <http://dx.doi.org/10.1787/5js3311jcpwb-en>.
- Oh, D. S. *et al.* (2016) ‘Innovation ecosystems: A critical examination’, *Technovation*, 54, pp. 1–6. doi: 10.1016/j.technovation.2016.02.004.
- Parrish, B. D. (2010) ‘Sustainability-driven entrepreneurship: Principles of organization design’, *Journal of Business Venturing*, 25(5), pp. 510–523.
- People’s Daily (2018) *人民日报：网络时代应如何规范“算法”* (People’s Daily: How to standardize

'algorithms' in the Internet age), 人民日报 (People's Daily).

Pettis, M. (2018) *The GDP of Bridges to Nowhere*, Carnegie Endowment for International Peace. Available at: <https://carnegieendowment.org/chinafinancialmarkets/75355> (Accessed: 22 February 2018).

Pinchot, G. (1987) 'Innovation Through Intrapreneuring', *Research Management*, xxx(2).

Pique, J. M., Berbegal-Mirabent, J. and Etzkowitz, H. (2018) 'Triple Helix and the evolution of ecosystems of innovation: the case of Silicon Valley', *Triple Helix*, 5(1), p. 11. doi: 10.1186/s40604-018-0060-x.

Porter, M. (2001) 'Snowball: A language for stemming algorithms', *Snowball*, pp. 1–15. Available at: <http://snowball.tartarus.org/texts/introduction.html>.

Porter, M. E. (1990a) 'The Competitive Advantage of Nations. (cover story)', *Harvard Business Review*, 68, pp. 73–93. doi: Article.

Porter, M. E. (1990b) 'The Competitive Advantage of Nations. (cover story)', *Harvard Business Review*, 68, pp. 73–93. doi: Article.

Prahalad, C. K. (2004) *The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*. Barnes & Noble. Available at: <http://www.barnesandnoble.com/w/fortune-at-the-bottom-of-the-pyramid-c-k-prahalad/1102112584> (Accessed: 28 September 2015).

PwC and CB Insights (2019) *MoneyTree Report Q4 2018*.

Ramlogan, R. and Rigby, J. (2012) *The impact and effectiveness of entrepreneurship policy. Compendium of Evidence on the Effectiveness of Innovation Policy Intervention*. Manchester. Available at: <http://research.mbs.ac.uk/innovation/>.

Renda, A. (2019) *Artificial Intelligence Ethics, governance and policy challenges*.

Reynolds, P. D. et al. (2002) *Global Entrepreneurship Monitor 2002: Executive Report, Global Entrepreneurship Monitor*.

Reynolds, P. D., Hay, M. and Camp, M. S. (1999) 'Global Entrepreneurship Monitor 1999 Executive Report', *Babson College; London Business School*, pp. 1–46.

Richard Cantillon (1755) *Essai sur la nature du commerce*.

Ritala, P. and Almpanopoulou, A. (2017) 'In defense of "eco" in innovation ecosystem', *Technovation*, 60–61, pp. 39–42. doi: 10.1016/j.technovation.2017.01.004.

Rokach, L. and Maimon, O. (2005) 'Clustering Methods', in Maimon, O. and Rokach, L. (eds) *Data*

Mining and Knowledge Discovery Handbook. Boston, MA: Springer US, pp. 321–352. doi: 10.1007/0-387-25465-X_15.

Román, C., Congregado, E. and Millán, J. M. (2013) ‘Start-up incentives: Entrepreneurship policy or active labour market programme?’, *Journal of Business Venturing*. Elsevier Inc., 28(1), pp. 151–175. doi: 10.1016/j.jbusvent.2012.01.004.

Rosa, P. J. (2013) ‘Recent Trends in Leading Entrepreneurship Research: The Challenge for European Researchers : Entrepreneurship Research Journal’, *Entrepreneurship Research Journal*, 3(1), pp. 35–43. doi: 10.1515/erj-2012-0031.

Ross, G. and Jenson, J. (2017) ‘Reconsidering Jacques Delors’ leadership of the European union’, *Journal of European Integration*, 39(2), pp. 113–127. doi: 10.1080/07036337.2016.1277718.

Van Roy, Vincent & Vertesy, Daniel & Damioli, G. (2019) *AI and Robotics Innovation: a Sectoral and Geographical Mapping using Patent Data*.

Rydin, Y. *et al.* (2013) ‘Mapping the Coevolution of Urban Energy Systems: Pathways of Change’, *Environment and Planning A: Economy and Space*. SAGE PublicationsSage UK: London, England, 45(3), pp. 634–649. doi: 10.1068/a45199.

Saunders, M., Lewis, P. and Thornhill, A. (2009) *Research methods for business students.*, Pearson Education, UK. Pearson Education, UK.

Scaringella, L. and Radziwon, A. (2018) ‘Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?’, *Technological Forecasting and Social Change*, 136, pp. 59–87. doi: 10.1016/j.techfore.2017.09.023.

Schildt, H. A., Zahra, S. A. and Sillanpää, A. (2006) ‘Scholarly communities in entrepreneurship research: A co-citation analysis’, *Entrepreneurship: Theory and Practice*.

Schot, J. and Kanger, L. (2018) ‘Deep transitions: Emergence, acceleration, stabilization and directionality’, *Research Policy*. Elsevier B.V., 47(6), pp. 1045–1059. doi: 10.1016/j.respol.2018.03.009.

Schumpeter, J. A. (1934) *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle*, *Harvard economic studies*.

Schumpeter, J. A. (1942) ‘The process of creative destruction’, *Capitalism Socialism and Democracy*.

Shane, S. (2009) ‘Why encouraging more people to become entrepreneurs is bad public policy’, *Small Business Economics*, 33(2), pp. 141–149. doi: 10.1007/s11187-009-9215-5.

Shane, S. and Venkataraman, S. (2000a) ‘The promise of entrepreneurship as a field of research’,

Academy of Management Review.

Shane, S. and Venkataraman, S. (2000b) 'The promise of entrepreneurship as a field of research', *Academy of Management Review*, 25(1), pp. 217–226.

Shoham, Y. *et al.* (2018) 'Artificial intelligence index. 2018 annual report'. Human-Centered AI Initiative, Stanford University, pp. 1–94.

Sobel, R. S. (no date) *Entrepreneurship, The Concise Encyclopedia of Economics | Library of Economics and Liberty*.

Spigel, B. (2016) 'Developing and governing entrepreneurial ecosystems: The structure of entrepreneurial support program in Edinburgh, Scotland', *International Journal of Innovation and Regional Development*, 7(2), pp. 141–160. doi: 10.1504/IJIRD.2016.077889.

Spigel, B. (2017) 'The Relational Organization of Entrepreneurial Ecosystems', *Entrepreneurship: Theory and Practice*, 41(1), pp. 49–72. doi: 10.1111/etap.12167.

Spigel, B. and Harrison, R. (2018) 'Toward a process theory of entrepreneurial ecosystems', *Strategic Entrepreneurship Journal*, 12(1), pp. 151–168. doi: 10.1002/sej.1268.

Spilling, O. R. (1996) 'The entrepreneurial system: On entrepreneurship in the context of a mega-event', *Journal of Business Research*, 36(1), pp. 91–103.

Stam, E. (2014a) *The Dutch entrepreneurial ecosystem*. Utrecht. doi: dx.doi.org/10.2139/ssrn.2473475.

Stam, E. (2014b) *The Dutch entrepreneurial ecosystem*. Utrecht. Available at: ssrn.com/abstract=2473475.

Stam, E. (2015) 'Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique', *European Planning Studies*, 23(9), pp. 1759–1769. doi: 10.1080/09654313.2015.1061484.

Starkey, K. and Madan, P. (2001) 'Bridging the Relevance Gap: Aligning Stakeholders in the Future of Management Research', *British Journal of Management*, 12(s1), pp. S3–S26. doi: 10.1111/1467-8551.12.s1.2.

Steffens, P. R. *et al.* (2014) 'Shouting From the Ivory Tower: A Marketing Approach to Improve Communication of Academic Research to Entrepreneurs', *Entrepreneurship: Theory and Practice*, 38(2), pp. 399–426. doi: 10.1111/etap.12079.

Van Stel, A., Storey, D. J. and Thurik, A. R. (2007) 'The effect of business regulations on nascent and young business entrepreneurship', *Small Business Economics*, 28(2–3), pp. 171–186. doi: 10.1007/s11187-006-9014-1.

Stepan, M. and Duckett, J. (2018) 'Serve the People. Innovation and IT in China's social development

agenda'. Merics - Papers on China.

Storey, D. J. (1994) *Understanding the Small Business Sector*, Thomson Learning Emea. doi: 10.1016/0024-6301(95)90953-2.

Tan, H. (谭华霖) (2018) *夯实建设科技强国的法治基础 (Consolidate the rule of law foundation for building a strong country in Science and Technologies)*, 人民日报 (People's Daily).

Tansley, A. G. (1935) 'The use and abuse of vegetational concepts and terms', *Ecology*, 16(3), pp. 284–307. doi: 10.2307/1930070.

Thomas, G., Demski, C. and Pidgeon, N. (2019) 'Deliberating the social acceptability of energy storage in the UK', *Energy Policy*. Elsevier Ltd, 133, p. 110908. doi: 10.1016/j.enpol.2019.110908.

Thomas, L. and Autio, E. (2019) 'Innovation Ecosystems', *SSRN Electronic Journal*. doi: 10.2139/ssrn.3476925.

Thurik, R. (2009a) 'Entrepreneurship: Entrepreneurship, economic growth and policy', in Acs, Z. J., Audretsch, D. B., and Strom, R. J. (eds) *Entrepreneurship, Growth, and Public Policy*. Cambridge University Press, pp. 219–249.

Thurik, R. (2009b) 'Entrepreneurship: Entrepreneurship, economic growth and policy', in *Entrepreneurship, Growth, and Public Policy*.

Timmons, J. A. (1999) *New Venture Creation: Entrepreneurship for the 21st Century*, Business. Available at: <http://www.amazon.com/dp/0071276327>.

Tsujimoto, M. *et al.* (2018) 'A review of the ecosystem concept — Towards coherent ecosystem design', *Technological Forecasting and Social Change*, 136, pp. 49–58. doi: <https://doi.org/10.1016/j.techfore.2017.06.032>.

United Nations (1992) *Convention on biological diversity, Diversity*. Available at: <http://www.cbd.int/doc/legal/cbd-en.pdf>.

United Nations Conference on Trade and Development (2011) *Information Economy Report 2011. ICTs as an Enabler for Private Sector Development*, United Nations publication. New York and Geneva. Available at: http://www.unctad.org/en/docs/ier2011_en.pdf <http://books.google.com/books?hl=en&lr=&id=kZ4vc0ABNY4C&oi=fnd&pg=PR4&dq=INFORMATION+ECONOMY+REPORT&ots=q9GERGCN1x&sig=AIL5Me8AxKSuHApYk8IUUwrM6VU>.

US National Science and Technology Council (2016) *The national artificial intelligence research and*

development strategic plan. Washington DC. Available at:
https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/national_ai_rd_strategic_plan.pdf.

Valkokari, K. (2015) 'Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them', *Technology Innovation Management Review*, 5(8), pp. 17–24. doi: 10.22215/timreview/919.

Vasconcelos Gomes, L. A. de *et al.* (2016) 'Unpacking the innovation ecosystem construct: Evolution, gaps and trends', *Technological Forecasting and Social Change*, 136, pp. 30–48. doi: 10.1016/J.TECHFORE.2016.11.009.

Van De Ven, H. (1993) 'The development of an infrastructure for entrepreneurship', *Journal of Business Venturing*, pp. 211–230.

Verheul, I. *et al.* (2001) 'An Eclectic Theory of Entrepreneurship', *Erasmus*, p. 48. doi: 10.1007/0-306-47556-1_2.

Verheul, I. *et al.* (2002) 'An eclectic theory of entrepreneurship: policies, institutions and culture', in *Entrepreneurship: Determinants and policy in a European-US comparison*, pp. 11–81. doi: 10.1007/0-306-47556-1_2.

Vogel, P. (2013) 'The Employment Outlook for Youth: Building Entrepreneurship Ecosystems as a Way Forward', *Conference Proceedings of the G20 Youth Forum*. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2357856.

Warwick, K. (2013) 'Beyond Industrial Policy: Emerging Issues and New Trends', *OECD Science, Technology and Industry Policy Papers*, (2), p. 57.

WEF (2011) 'Accelerating Entrepreneurship in the Arab World'.

Weiss, C. H. (1977) 'Research for Policy's Sake: The Enlightenment Function of Social Research', *Policy Analysis*, 3(4), pp. 531–545. doi: 10.2307/42783234.

Weiss, C. H. (1979) 'The Many Meanings of Research Utilization', *Public Administration Review*, 39(5), p. 426. doi: 10.2307/3109916.

Welch, D. and Behrmann, E. (2018) *Who's Winning the Self-Driving Car Race?*, Bloomberg.

Welter, F. (2011) 'Contextualizing Entrepreneurship—Conceptual Challenges and Ways Forward', *Entrepreneurship: Theory and Practice*, 35(1), pp. 165–184. doi: 10.1111/j.1540-6520.2010.00427.x.

Welter, F. and Lasch, F. (2008) 'Entrepreneurship research in europe: Taking stock and looking forward', *Entrepreneurship: Theory and Practice*, pp. 241–248. doi: 10.1111/j.1540-

6520.2007.00224.x.

Wennekers, Sander; Thurik, R. (1999) 'Linking Entrepreneurship and Economic Growth', *Small Business Economics*, 13, pp. 27–55. doi: 10.1023/A:1008063200484.

Wennekers, S., Uhlaner, L. M. and Thurik, R. (2002) 'Entrepreneurship and Its Conditions : A Macro Perspective', *International Journal of Entrepreneurship Education*, 1(1), pp. 25–68. Available at: [http://people.few.eur.nl/thurik/Research/Articles/Entrepreneurship and its Conditions_ a Macro Perspective.pdf](http://people.few.eur.nl/thurik/Research/Articles/Entrepreneurship_and_its_Conditions_a_Macro_Perspective.pdf).

Werner, S. and Brouthers, L. (2002) *How International is Management?*, *Journal of International Business Studies*. doi: 10.1057/palgrave.jibs.8491033.

WILLIS, A. J. (1997) 'Forum', *Functional Ecology*, 11(2), pp. 268–271. Available at: <http://doi.wiley.com/10.1111/j.1365-2435.1997.00081.x> (Accessed: 28 September 2015).

WIPO (2019) *WIPO Technology Trends 2019: Artificial Intelligence*. Geneva: World Intellectual Property Organization.

Woetzel, J. *et al.* (2017) *Digital China: Powering the Economy To Global Competitiveness*.

World Economic Forum (2014) *Entrepreneurial Ecosystems Around the Globe and Early-Stage Company Growth Dynamics*. Switzerland.

World Economic Forum (2017) *The Global Competitiveness Report The Global Competitiveness Report 2017-2018*, *World Economic Forum*. doi: 92-95044-35-5.

Xi, J. (2014) *The governance of China*. 1st edn. Beijing: Foreign Languages Press.

Xu, G. *et al.* (2018) 'Exploring innovation ecosystems across science, technology, and business: A case of 3D printing in China', *Technological Forecasting and Social Change*, 136, pp. 208–221. doi: 10.1016/j.techfore.2017.06.030.

Xu, Z. and Dobson, S. (2019) 'Challenges of building entrepreneurial ecosystems in peripheral places', *Journal of Entrepreneurship and Public Policy*. Edited by D. Stephen. Emerald Publishing Limited, 8(3), pp. 408–430. doi: 10.1108/JEPP-03-2019-0023.

Xu, Z. and Maas, G. (2019) 'Innovation and Entrepreneurial Ecosystems as Important Building Blocks BT - Transformational Entrepreneurship Practices: Global Case Studies', in Maas, G. and Jones, P. (eds). Cham: Springer International Publishing, pp. 15–32. doi: 10.1007/978-3-030-11524-1_2.

Zacharakis, A. L., Shepherd, D. A. and Coombs, J. E. (2003) 'The development of venture-capital-backed internet companies: An ecosystem perspective', *Journal of Business Venturing*, 18(2), pp. 217–231. doi: 10.1016/S0883-9026(02)00084-8.

Zahra, S. A. and Wright, M. (2011) 'Entrepreneurship's Next Act', *Academy of Management Perspectives*, 25(4), pp. 67–83. doi: 10.5465/amp.2010.0149.

Zhang Jun (2018) *The Western Illusion of Chinese Innovation*, Project Syndicate. Available at: <https://www.project-syndicate.org/commentary/myth-of-chinese-innovation-capacity-by-zhang-jun-2018-07> (Accessed: 6 September 2018).

Zhang, Y. *et al.* (2014) 'Triple Helix innovation in China's dye-sensitized solar cell industry: hybrid methods with semantic TRIZ and technology roadmapping', *Scientometrics*, 99(1), pp. 55–75. doi: 10.1007/s11192-013-1090-9.

Zhou, C. (2008) 'Emergence of the entrepreneurial university in evolution of the triple helix: The case of Northeastern University in China', *Journal of Technology Management in China*. Emerald, 3(1), pp. 109–126. doi: 10.1108/17468770810851539.

8 ANNEXES

Annex 1: Scientific impact and dissemination resulting from this thesis.

Annex 2: Cluster analysis: other inputs and results (phase 1- corpus Academia; and phase 2 – corpus EU Policy).

Annex 3: Additional EU regional results (phase 1).

Annex 4: Extended summary of some main case studies within the AI ecosystem in China.

Annex 1 - Scientific impact & dissemination resulting from this thesis

▪ Journal papers

- Feijóo, C., Ramos, S., Armuña, C., Arenal, A., José-Luis Gómez-Barroso (2018), A study on the deployment of high-speed broadband networks in NUTS3 regions within the framework of digital agenda for Europe, *Telecommunications Policy*, 42 (9), 682-699.
- Arenal, A., Armuña, C., Ramos, S., Feijóo, C. (2018). Ecosistemas emprendedores y startups, el nuevo protagonismo de las pequeñas organizaciones. *Economía industrial*, (407), 85-94.
- Arenal, A., Feijóo, C., Moreno, A., Armuña, C. and Ramos, S. (2019), An academic perspective on the entrepreneurship policy agenda: themes, geographies and evolution, *Journal of Entrepreneurship and Public Policy*, 9 (1), 65-93.
- Armuña, C., Ramos, S., Juan, J., Feijóo, C. and Arenal, A. (2020), From stand-up to start-up: exploring entrepreneurship competences and STEM women's intention, *International Entrepreneurship and Management Journal*, 16, 69–92.
- Arenal, A., Armuña, C., Feijóo, C., Ramos, S., Xu, Z., Moreno, A. (2020), Innovation ecosystems theory revisited: The case of artificial intelligence in China, *Telecommunications Policy*, 2020, 101960,
- Arenal, A., Feijóo, C., Moreno, A., Armuña, C. and Ramos, S. (2020, forthcoming), Entrepreneurship policy agenda in the European Union: a text mining perspective, submitted to the *Review of Policy Research*.
 - Forthcoming. Accepted, now in publishing process.

▪ Conference papers

- Armuña, C., Arenal, A., Ramos, S., Gómez-Barroso, JL., Analysis of Entrepreneurial Ecosystem Frameworks: The Need to Quantify Entrepreneurial Activity, 9th International Scientific Conference Riga University, Riga (Estonia), 18-20th May 2017
- Ramos, S., Arenal, A., Armuña, C., From App Economy to Web Entrepreneurship: analyzing the socio-economic impact of mobile applications and web-based entrepreneurs in Europe under the entrepreneurial ecosystem framework, 28th European Regional Conference of the International Telecommunications Society (ITS) -, Passau (Germany), 30 July – 2 August 2017
- Arenal, A., Feijóo, C., Moreno, A., Armuña, C., Ramos, S., An Investigation of the Evolution of the Entrepreneurship Policy Agenda in the EU – Relevant milestones, key areas and the way

forward, 40^a Conference Institute for Small Business and Entrepreneurship (ISBE) – “‘Borders’, prosperity and entrepreneurial responses”, Belfast – UK, 8-9th November 2017

- Article awarded as best paper within the Business Support, Policy and Practice track
- Arenal, A., Feijóo, C., Moreno, A., Ramos, S., Armuña, C., An Investigation of the Evolution of the Entrepreneurship Policy Agenda in the EU – Relevant milestones, key areas and the way forward, - XXXI Conference RENT - "Relevance in Entrepreneurship Research", Research and Entrepreneurship and Small Business (RENT), Lund (Sweden), 16-17th November 2017 –
 - Article selected for inclusion in the RENT Anthology book 2017, but finally refused by the author in order not to avoid further options of publication
- Armuña, C., Feijóo, C., Ramos, S., Arenal, A., Feijóo, C., From stand-up to start-up: the influence of the perceived entrepreneurial competences and the potential role of entrepreneurial education, - XXXI Conference Research and Entrepreneurship and Small Business (RENT) - "Relevance in Entrepreneurship Research", , Lund (Sweden), 16-17th November 2017
- Feijóo, C., Jie, S., Ramos, S., Arenal, A., Armuña, C., de Prato, G., The Industrial Innovation Ecosystem of Artificial Intelligence in China: Status and prospects, - 22nd ITS Biennial Conference -, (Seoul, South Korea) (24-27th June 2018)
- Arenal, A., Feijóo, C., Moreno, A., Ramos, S., Armuña, C., Leading or Lagging? an Analysis about the business Media Views on the Configuration of the Entrepreneurship Policy Agenda (poster)- XXXII Conference Research and Entrepreneurship and Small Business (RENT) -, Toledo (Spain), 15-16th November 2018
- Armuña, C., Ruíz, JJ, Ramos, S., Arenal, A., Feijóo, C., Entrepreneurial competences and the intention to startup: a cross-regional analysis of Chinese university students (poster), - XXXII Conference Research and Entrepreneurship and Small Business (RENT) Toledo (Spain), 15-16th November 2018
- Arenal, A., Feijóo, C., , Ramos, S., Armuña, C., Text mining the entrepreneurship policy agenda in the EU: From naïveté into reality, 30th European Conference of the International Telecommunications Society (ITS), Helsinki (Finland) 16th-19th June, 2019
- Book chapters
 - Ramos, S., Armuña, C., Arenal, A., Ferrandis, J (2015), Mobile Communications and the Entrepreneurial Revolution in: Emerging Perspectives on the Mobile Content Evolution, IGI Glonal, pp.32-43

- Other contributions
 - Contributor at TELOS nº 105 - “Smart Cities” (November 2016 – January 2017)
 - Co-author of a dossier about entrepreneurial ecosystems under the title “Entrepreneurial ecosystems: the relevance of the Urban Environment”

Annex 2 – Cluster analysis: other inputs and results (phase 1 and phase 2)

Annex 2 compiles additional inputs for the cluster analysis conducted during the phases 1 and 2. Particularly:

- Phase 1: corpus Academia
 - Description of the five more relevant papers per cluster.
 - Rest of the k-means partitions considered during the analysis (k = 4-13).
- Phase 2: corpus EU Policy
 - Rest of the k-means partitions considered during the analysis (k = 4-12).

Phase 1 – Corpus Academia

- *Description of the most relevant papers per cluster.*

Table 15 - Top 5 more relevant papers per cluster according to Scopus ranking.

Cluster	Title	Author (s)	Journal	Year	TC ¹
1	Entrepreneurship and regional competitiveness: The role and progression of policy	Huggins R., Williams N.	Entrepreneurship and Regional Development	2011	84
	SME policy implementation as a relational challenge	Niska M., Vesala K.M.	Entrepreneurship and Regional Development	2013	13
	Cultural diversity and entrepreneurship: Policy responses to immigrant entrepreneurs in Australia	Collins J.	Entrepreneurship and Regional Development	2003	64
	Self-employment policies and migrants' entrepreneurship in Germany	Kontos M.	Entrepreneurship and Regional Development	2003	44
	Innovative milieux and new generations of regional policies	Maillat D.	Entrepreneurship and Regional Development	1998	93
2	Towards a new technology policy: The integration of generation and diffusion	Hahn Y.-H., Yu P.-I.	Technovation	1999	20
	Government policy and technological innovation - A suggested typology	Dolfsma W., Seo D.	Technovation	2013	45
	Policy principles for the creation and success of corporate and academic spin-offs	Gilsing V.A., van Burg E., Romme A.G.L.	Technovation	2010	43
	The development of technology infrastructure in Portugal and the need to pull innovation using proactive intermediation policies	Laranja M.	Technovation	2009	24
	Science policy vs. technology policy?	Szántó B.	Technovation	1996	1
3	Foreign subsidiary top manager nationality and language policy: The moderating effects of subsidiary age and size	Peltokorpi V.	International Business Review	2015	3
	Host country national reactions to expatriate pay policies: A model and implications	Toh S.M., Denisi A.S.	Academy of Management Review	2003	143
	Facilitation of links between multinational subsidiaries and SMEs: The Scottish Technology and Collaboration (STAC) initiative	Prashantham S., McNaughton R.B.	International Business Review	2006	25

¹ Total citations. Results from the original query in Scopus database on October 11, 2019.

Cluster	Title	Author (s)	Journal	Year	TC ¹
	When do firms divest foreign operations?	Berry H.	Organization Science	2013	51
	Smaller may be beautiful but is it more risky? Assessing and managing political and economic risk in Costa Rica	Oetzel J.	International Business Review	2005	38
4	Municipal demand-side policy tools and the strategic management of technology life cycles	Cohen B., Ernesto Amorós J.	Technovation	2014	18
	Indigenous metal casting in Nigeria: Its technology, attendant problems, business prospects and policy implications	Ibitoye S.A., Ilori M.O.	Technovation	1998	1
	The nano-revolution of Schumpeter's Kondratieff cycle	Wonglimpiyarat J.	Technovation	2005	42
	Local development and flexibility in accumulation and regulation of capital	Vázquez-Barquero A.	Entrepreneurship and Regional Development	1990	10
	Institutional endowment, localized capabilities and the emergence of SMEs: From mining to recycling, the case of Freiberg (Saxony)	Musyck B.	Entrepreneurship and Regional Development	2003	6
5	National systems of Advanced Manufacturing Technology (AMT): Hierarchical classification scheme and policy formulation process	Park Y.-T.	Technovation	2000	14
	Technology policy and the development of small and medium scale enterprises in contemporary Nigeria	Oladeji S.I.	Technovation	1998	2
	Nigeria's technology policy: Is it adequate in the globalizing world?	Sanni S.A., Ilori M.O., Opaleye A.O., Oyewale A.A.	Technovation	2001	2
	Technology policy between 'diversity' and 'one best practice' - A comparison of Korean and German promotion schemes for new production technologies	Chung S., Lay G.	Technovation	1997	9
	Linking learning with governance in networks and clusters: Key issues for analysis and policy	Parrilli M.D., Sacchetti S.	Entrepreneurship and Regional Development	2008	48
6	Policies to benefit from the globalization of corporate R&D: An exploratory study for EU countries	Guimón J.	Technovation	2011	15
	Foreign investment impact and incentive: A strategic approach to the relationship between the objectives of foreign investment policy and their promotion	Lim S.-H.	International Business Review	2005	14
	An export promotion model for India: Implications for public policy	Naidu G.M., Cavusgil S.T., Murthy B.K., Sarkar M.	International Business Review	1997	25
	Firm dynamics and industrialization in the Chinese economy in transition: Implications for small business policy	Wing C.C.K., Yiu M.F.K.	Journal of Business Venturing	1996	24
	The impact of economic reform on business performance: A study of foreign and domestic firms in Ghana	Appiah-Adu K.	International Business Review	1999	23
7	Determinants for an entrepreneurial milieu: Science Parks and business policy in growing firms	Löfsten H., Lindelöf P.	Technovation	2003	62
	The evolution of Business incubators: Comparing demand and supply of business incubation services across different incubator generations	Bruneel J., Ratinho T., Clarysse B., Groen A.	Technovation	2012	153
	Technology Business Incubation: An overview of the state of knowledge	Mian S., Lamine W., Fayolle A.	Technovation	2016	66
	Analyzing yachting patterns in the Biesbosch National Park using GIS technology	Landré M.	Technovation	2009	5

Cluster	Title	Author (s)	Journal	Year	TC ¹
	Specialization as strategy for business incubators: An assessment of the Central German Multimedia Center	Schwartz M., Hornyach C.	Technovation	2008	73
8	Policies for design and policies for innovation: Contrasting perspectives and remaining challenges	Hobday M., Boddington A., Grantham A.	Technovation	2012	31
	The problem of private under-investment in innovation: A policy mind map	Peneder M.	Technovation	2008	49
	A system failure framework for innovation policy design	Klein Woolthuis R., Lankhuizen M., Gilsing V.	Technovation	2005	332
	The national innovation policy effect according to firm location	Herrera L., Nieto M.	Technovation	2008	40
	Transitions in thinking: Changing the mindsets of policy makers about innovation	Acha V., Balazs K.	Technovation	1999	6
9	Entrepreneurship policy and economic growth: Solution or delusion? Evidence from a state initiative	Figueroa-Armijos M., Johnson T.G.	Small Business Economics	2016	5
	Variance decomposition of the country, industry, firm, and firm-year effects on dividend policy	Erkan A., Fainshmidt S., Judge W.Q.	International Business Review	2016	3
	Creating good public policy to support high-growth firms	Mason C., Brown R.	Small Business Economics	2013	170
	Large, entrepreneurship and regional development policy: 'growth poles' in the mezzogiorno over 40 years	Florio M.	Entrepreneurship and Regional Development	1996	18
	R&D policies for young SMEs: input and output effects	Czarnitzki D., Delanote J.	Small Business Economics	2015	21
10	Can experiential knowledge and localised learning in start-up policy and practice be transferred between regions? The case of the START network	Atherton A., Price L.	Entrepreneurship and Regional Development	2008	3
	Knowledge networks and dynamic capabilities as the new regional policy milieu. A social network analysis of the Campania biotechnology community in southern Italy	Vittoria M.P., Lubrano Lavadera G.	Entrepreneurship and Regional Development	2014	9
	An institutional perspective of public policy and network effects in the renewable energy industry: enablers or disablers of entrepreneurial behaviour and innovation?	Doblinger C., Dowling M., Helm R.	Entrepreneurship and Regional Development	2016	12
	Technological competition in network markets with policy implications	Lim K.-S., Hahn Y.-H., Yu P.-I.	Technovation	2004	3
	Policy Interventions for Industrial Network Formation: Contrasting Historical Underpinnings of the Small Business Policy in Japan and the United States	Aoyama Y.	Small Business Economics	1999	17
11	Dormancy as a Strategic Response to Detrimental Public Policy	Kozhikode R.K.	Organization Science	2016	3
	Decisions, decisions! How judgment policy studies can integrate macro and micro domains in management research	Priem R.L., Walters B.A., Li S.	Journal of Management	2011	20
	Outcomes of Absence Control Initiatives: A Quasi-Experimental Investigation Into the Effects of Policy and Perceptions	Johnson M.D., Holley E.C., Morgeson F.P., LaBonar D., Stetzer A.	Journal of Management	2014	6
	Multinational companies and the natural environment: Determinants of global environmental policy standardization	Christmann P.	Academy of Management Journal	2004	364

Cluster	Title	Author (s)	Journal	Year	TC ¹
	Congruence between pay policy and competitive strategy in high-performing firms	Montemayor E.F.	Journal of Management	1996	68
12	Government policies towards Israel's high-tech powerhouse	Wonglimpiyarat J.	Technovation	2016	6
	Policy evaluation and Australian support for innovation	Ryan N.	Technovation	1990	1
	Government policy towards entrepreneurial finance: Innovation investment funds	Cumming D.	Journal of Business Venturing	2007	127
	Informal investors - A categorization, with policy implications	Sørheim R., Landström H.	Entrepreneurship and Regional Development	2001	73
	The risk-return attributes of publicly traded venture capital: Implications for investors and public policy	Kleiman R.T., Shulman J.M.	Journal of Business Venturing	1992	11

- *Corpus Academia: rest of the k-means partitions considered during the analysis (k = 4-13)*

See Tables 16 –24.

Table 16 - Top 20 more relevant words for four cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4
1	entrepren	technolog	foreign	network
2	growth	innov	polit	cluster
3	firm	industri	organiz	region
4	employ	transfer	invest	knowledg
5	busi	univers	manag	innov
6	ventur	system	corpor	industri
7	smes	patent	subsidiari	entrepren
8	capit	firm	strategi	firm
9	export	research	organ	social
10	tax	product	intern	district
11	start	incub	academi	develop
12	region	develop	firm	local
13	enterpris	govern	institut	spillov
14	econom	knowledg	cultur	global
15	size	technov	environment	learn
16	market	nation	strateg	institut
17	credit	biotechnolog	respons	growth
18	self	process	countri	system
19	develop	scienc	perform	framework
20	perform	countri	china	analysi

Table 17 - Top 20 more relevant words for five cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5
1	entrepren	smes	cluster	organiz	technolog

2	region	export	network	manag	innov
3	employ	innov	region	polit	univers
4	ventur	firm	innov	organ	transfer
5	growth	invest	knowledg	corpor	industri
6	start	foreign	industri	academi	patent
7	busi	size	firm	environment	system
8	capit	market	global	famili	knowledg
9	firm	enterpris	entrepren	perform	research
10	econom	credit	agglomer	theori	incub
11	self	product	develop	respons	biotechnolog
12	social	medium	analysi	strategi	learn
13	develop	growth	framework	firm	park
14	rural	countri	local	cultur	develop
15	educ	subsidiari	structur	institut	govern
16	institut	guarante	type	work	project
17	activ	sme	learn	employe	firm
18	job	subsidi	evolut	chang	manag
19	women	industri	competit	owner	nation
20	tax	financ	system	resourc	scienc

Table 18 - Top 20 more relevant words for six cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6
1	entrepren	network	technolog	foreign	organiz	smes
2	ventur	cluster	innov	invest	manag	export
3	capit	region	transfer	subsidiari	patent	firm
4	busi	biotechnolog	industri	domest	polit	growth
5	start	innov	system	direct	univers	employ
6	region	knowledg	incub	china	organ	tax
7	growth	industri	firm	multin	institut	credit
8	educ	local	park	countri	research	size
9	women	develop	develop	intern	strategi	subsidi
10	rural	firm	learn	spillov	corpor	medium
11	social	entrepren	process	host	firm	busi
12	activ	social	product	knowledg	perform	enterpris
13	econom	global	nation	japanes	spin	guarante
14	owner	district	scienc	outward	govern	market
15	firm	learn	manag	local	strateg	job
16	decis	agglomer	research	firm	theori	bank
17	cultur	econom	countri	locat	intelectu	self
18	develop	structur	govern	economi	cultur	product
19	immigr	institut	competit	corpor	journal	rate
20	invest	process	knowledg	industri	knowledg	loan

Table 19 - Top 20 more relevant words for seven cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7
1	smes	export	innov	entrepren	technolog	organiz	network
2	employ	invest	energi	busi	transfer	cultur	cluster
3	growth	foreign	system	manag	univers	logic	region
4	tax	ventur	product	firm	industri	workplac	knowledg
5	firm	capit	region	perform	innov	intent	innov
6	credit	trade	smes	social	patent	manag	industri
7	size	subsidiari	firm	institut	incub	respons	social
8	subsidi	firm	technolog	environment	research	strategi	entrepren
9	self	countri	process	econom	biotechnolog	chang	firm
10	medium	investor	design	famili	park	integr	spillov
11	busi	intern	enterpris	region	govern	polit	learn
12	guarante	market	market	rural	scienc	employ	local
13	job	direct	nation	ventur	develop	ident	global
14	start	financ	instrument	women	spin	job	develop
15	loan	china	manufactur	activ	project	structur	district
16	enterpris	decis	develop	educ	firm	typolog	competit
17	bank	japanes	industri	develop	commerci	break	agglomer
18	region	capitalist	approach	polit	manag	understand	endogen
19	market	domest	competit	chang	base	corpor	peripher
20	financi	multin	increment	corpor	knowledg	behavior	growth

Table 20 - Top 20 more relevant words for eight cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8
1	entrepren	biotechnolog	technolog	subsidiari	patent	smes	export	network
2	ventur	firm	innov	multin	organiz	tax	foreign	cluster
3	capit	polit	transfer	knowledg	univers	employ	invest	region
4	busi	market	industri	japanes	spin	growth	domest	knowledg
5	start	industri	system	foreign	research	firm	direct	innov
6	region	competit	park	tourism	knowledg	credit	intern	entrepren
7	famili	telecommun	incub	local	intellectu	subsidi	spillov	industri
8	women	environment	firm	invest	institut	size	firm	social
9	rural	govern	learn	intern	properti	job	outward	firm
10	educ	strateg	develop	top	innov	guarante	china	develop
11	growth	manag	process	strateg	project	medium	countri	global
12	invest	trade	product	manag	manag	busi	perform	endogen
13	social	servic	scienc	agenc	corpor	self	chines	growth
14	firm	strategi	govern	polit	collabor	enterpris	review	agglomer
15	owner	countri	nation	theori	cultur	bank	young	local

16	econom	product	manag	parent	academ	loan	trade	district
17	activ	electron	research	strategi	interact	financ	host	spillov
18	decis	compani	model	host	work	rate	impact	learn
19	inform	develop	countri	cultur	privat	effect	manufactur	competit
20	develop	local	energi	risk	technolog	econom	price	geograph

Table 21 - Top 20 more relevant words for nine cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	entrepren	univers	subsidiari	cycl	network	export	incub	technolog	employ
2	venture	organiz	multin	life	cluster	foreign	park	innov	smes
3	region	patent	knowledg	scrap	biotechnolog	invest	technolog	transfer	growth
4	capit	manag	foreign	technolog	region	domest	scienc	industri	firm
5	busi	polit	japanes	metal	innov	china	univers	system	tax
6	rural	research	invest	product	knowledg	intern	innov	region	credit
7	women	corpor	local	cluster	firm	firm	tenant	firm	size
8	start	institut	host	recycl	industri	spillov	locat	product	busi
9	develop	strategi	expatri	local	learn	enterpris	firm	develop	subsidi
10	econom	academi	risk	stage	social	direct	multimedia	process	self
11	educ	spin	polit	curv	global	countri	servic	nation	job
12	social	knowledg	divest	nanotechnolog	entrepren	outward	custom	model	garante
13	activ	perform	oversea	market	technolog	trade	base	govern	market
14	enterpris	privat	acquisit	energi	develop	market	manag	competit	financ
15	cultur	intellectu	intern	constraint	collabor	perform	link	research	medium
16	growth	govern	typolog	simul	district	review	promot	countri	effect
17	institut	respons	strateg	cast	structur	economi	linkag	learn	bank
18	invest	strateg	embedded	accumul	local	intens	virtual	smes	loan
19	immigr	project	review	innov	competit	busi	analog	manag	start
20	decis	firm	frontier	industri	analysi	young	ventur	technic	cost

Table 22 - Top 20 more relevant words for ten cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	entrepreneur	cluster	technolog	subsidiari	univers	smes	export	network	polit	employ
2	ventur	biotechnolog	innov	multin	patent	firm	foreign	region	academi	self
3	capit	industri	industri	knowledg	spin	growth	invest	knowledg	environment	incub
4	busi	innov	transfer	japanes	knowledg	tax	domest	innov	corpor	work
5	start	region	system	foreign	intellectu	credit	china	district	decoupl	organiz
6	region	firm	firm	parent	propterti	size	direct	entrepren	manag	theori
7	rural	network	develop	local	research	subsidi	spillov	develop	institut	manag
8	women	framework	product	invest	technolog	employ	intern	social	logic	organ
9	famili	global	govern	acquisit	innov	busi	outward	industri	stakehold	cultur

10	educ	agglomer	process	strateg	academ	guarante	firm	endogen	govern	job
11	econom	learn	nation	typolog	collabor	product	countri	firm	organiz	human
12	growth	resourc	park	embedded	transfer	medium	perform	growth	respons	individu
13	activ	research	competit	risk	organiz	market	young	territori	bank	resourc
14	institut	knowledg	model	host	off	enterpris	host	local	strategi	servic
15	firm	peripher	technov	intern	project	financi	review	spillov	journal	firm
16	privat	nano	scienc	top	invent	rate	trade	institut	organ	respons
17	social	case	learn	polit	privat	bank	impact	cluster	pressur	team
18	develop	technolog	research	review	commerci	loan	enterpris	creativ	field	worker
19	decis	geograph	countri	outflow	interact	cost	manufactur	econom	regul	pay
20	cultur	nation	manag	strategi	ip	job	industri	global	conting	strategi

Table 23 - Top 20 more relevant words for eleven cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	smes	polit	cycl	entrepren	technolog	entrepren	ventur	foreign	export	network	innov
2	employ	organiz	life	famili	univers	intellectu	capit	invest	price	region	cluster
3	growth	manag	product	women	transfer	social	invest	subsidiari	trade	tie	region
4	firm	environment	scrap	start	industri	minor	capitalist	rural	smes	knowledg	system
5	tax	corpor	recycl	busi	innov	gem	investor	knowledg	firm	innov	knowledg
6	region	institut	cluster	ventur	patent	busi	equiti	spillov	size	social	firm
7	credit	strategi	technolog	owner	incub	educ	fund	direct	manufactur	firm	smes
8	size	theori	behaviour	femal	knowledg	properti	vc	china	nonexport	entrepren	product
9	enterpris	academi	market	job	research	internationalis	bootstrap	locat	servic	bridg	process
10	busi	organ	stage	immigr	biotechnolog	enterpris	financ	intern	orient	organ	industri
11	medium	perform	local	gender	project	econom	inform	host	perform	learn	nation
12	self	firm	model	educ	spin	stage	market	firm	young	collabor	framework
13	subsidi	respons	curv	cultur	learn	institut	decis	countri	intern	communiti	technolog
14	entrepren	chang	biotechnolog	firm	park	definit	criteria	local	medium	world	competit
15	sector	social	firm	individu	govern	issu	entrepren	region	intens	technolog	model
16	innov	regul	simul	work	scienc	research	vcs	domest	india	theori	enterpris
17	econom	journal	process	human	commerci	rule	privat	outward	product	district	develop
18	market	cultur	accumul	nascent	develop	ethnic	human	multin	distributor	structur	research
19	guarante	govern	restructur	male	technov	theori	australian	review	immigr	divers	network
20	industri	bank	develop	founder	manag	innov	govern	industri	promot	inter	local

Table 24 - Top 20 more relevant words for thirteen cluster analysis in the corpus Academia (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
1	smes	export	cycl	environment	patent	organiz	cluster	polit	employ	ventur	entrepren	technolog	foreign
2	credit	price	life	manag	innov	intent	network	firm	self	capit	region	innov	subsidiari
3	guarante	trade	scrap	academi	project	workplac	region	corpor	job	entrepren	enterpris	transfer	invest
4	innov	smes	recycl	perform	collabor	organ	innov	market	growth	invest	rural	univers	direct
5	tax	firm	energi	field	cooper	manageri	knowledg	biotechnolog	women	decis	innov	industri	china
6	medium	size	metal	institut	technolog	cultur	tie	govern	tax	vc	develop	incub	host
7	loan	manufactur	technolog	theori	japan	logic	firm	trade	firm	start	econom	park	spillov
8	size	nonexport	product	telecommun	univers	ident	industri	manag	start	fund	local	system	domest
9	bank	servic	market	adopt	invent	employe	learn	countri	busi	financ	growth	develop	intern
10	enterpris	orient	sustain	pay	govern	break	social	effect	entrepren	equiti	busi	spin	knowledg
11	firm	perform	curv	strategi	research	chang	entrepren	invest	unemploy	bootstrap	district	learn	outward
12	financ	young	plant	energi	system	integr	technolog	capit	founder	portfolio	social	firm	multin
13	growth	intern	behaviour	decoupl	nation	rule	global	busi	creation	serial	sector	research	countri
14	debt	medium	simul	firm	privat	alloc	analysi	strateg	work	human	knowledg	scienc	review
15	lend	intens	innov	journal	knowledg	strategi	structur	cost	state	inform	industri	knowledg	firm
16	region	india	substitut	resourc	industri	typolog	type	risk	effect	nascent	institut	manag	locat
17	subsidi	product	cast	pressur	competit	behavior	local	intern	famili	busi	firm	commerci	impact
18	busi	distributor	constraint	relationship	instrument	norm	framework	subsidi	rate	market	privat	base	acquisit
19	support	immigr	section	social	firm	lever	agglomer	uncertainti	up	criteria	educ	process	local
20	sba	promot	stage	complex	orient	crime	develop	product	size	risk	servic	competit	industri

Phase 2: Corpus EU Policy:

- Cluster analysis: rest of the k -means partitions considered during the analysis ($k = 4-12$)

See Tables 25 – 33.

Table 25 - Top 20 more relevant words for four cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4
1	ict	migrat	tax	youth
2	digit	energi	eur	educ
3	industri	immigr	smes	gender
4	research	asylum	ventur	unemploy
5	innov	migrant	pension	women
6	smes	tourism	bank	learn
7	internet	turkey	capit	labour
8	standardis	refuge	investor	teacher
9	patent	visa	energi	lifelong
10	lisbon	maritim	debt	school
11	biotechnolog	agricultur	loan	poverti
12	environment	africa	crisi	men
13	onlin	crime	payment	student
14	cluster	sea	vat	esf
15	manufactur	fisheri	reform	skill
16	space	climat	equiti	peopl
17	energi	corrupt	eib	train
18	technolog	water	singl	adult
19	interoper	food	fiscal	worker
20	transport	solidar	consum	employ

Table 26 - Top 20 more relevant words for five cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5
1	ict	energi	tax	youth	migrat
2	digit	tourism	euro	educ	immigr
3	research	environment	smes	learn	asylum
4	internet	eco	ventur	unemploy	gender
5	innov	rural	energi	young	women
6	patent	wast	bank	teacher	migrant
7	lisbon	urban	capit	lifelong	poverti
8	standardis	water	crisi	school	solidar
9	biotechnolog	maritim	investor	student	refuge
10	industri	green	pension	labour	men
11	onlin	carbon	reform	skill	visa
12	smes	agricultur	debt	train	pension

13	interop	emiss	loan	teach	turkey
14	space	marin	payment	esf	enlarg
15	scientif	land	singl	adult	equal
16	textil	raw	vat	peopl	crime
17	cluster	farm	eib	languag	traffick
18	scienc	biodivers	fiscal	univers	corrupt
19	manufactur	fisheri	equiti	mobil	children
20	electron	sea	consum	qualif	acqui

Table 27 - Top 20 more relevant words for six cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6
1	migrat	energi	smes	youth	tax	energi
2	digit	carbon	research	unemploy	ventur	reform
3	internet	eco	ict	gender	eur	euro
4	tourism	environment	sme	women	pension	crisi
5	onlin	green	innov	educ	investor	stabil
6	euro	wast	cluster	learn	capit	tax
7	asylum	emiss	univers	young	loan	singl
8	ict	raw	excel	labour	equiti	lisbon
9	standardis	climat	patent	esf	eib	fiscal
10	cultur	renew	enterpris	lifelong	taxat	enlarg
11	space	maritim	panel	men	EIF	consum
12	interop	marin	scientif	school	asset	deficit
13	transport	water	industri	poverti	payment	citizen
14	biotechnolog	biodivers	lisbon	teacher	amount	labour
15	ecu	sea	manufactur	peopl	liabil	unemploy
16	audiovisu	electr	student	immigr	debt	macroeconom
17	textil	recycl	knowledg	employ	revenu	turkey
18	languag	ecosystem	educ	skill	compani	bank
19	safeti	materi	technolog	train	smes	solidar
20	migrant	industri	entrepren	worker	cash	enforc

Table 28 - Top 20 more relevant words for seven cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6	C7
1	ict	energi	tax	youth	migrat	tourism	gender
2	digit	environment	euro	educ	asylum	maritim	unemploy
3	research	eco	smes	learn	immigr	cultur	women
4	internet	wast	ventur	teacher	migrant	heritag	labour
5	innov	carbon	sme	young	refuge	marin	poverti
6	patent	green	bank	student	visa	sea	pension
7	standardis	raw	energi	school	solidar	coastal	men
8	biotechnolog	urban	investor	lifelong	turkey	ecu	employ
9	industri	water	capit	languag	enlarg	fish	esf

10	interop	emiss	crisi	teach	crime	creativ	worker
11	onlin	land	eib	univers	corrupt	erdf	wage
12	smes	electr	payment	skill	balkan	farm	age
13	space	forest	loan	train	acqui	biodivers	lisbon
14	scientif	climat	singl	peopl	traffick	travel	older
15	textil	agricultur	vat	adult	neighbour	art	children
16	scienc	recycl	consum	mobil	justic	destin	equal
17	cluster	poverti	equiti	graduat	mediterranean	local	tax
18	manufactur	rural	debt	qualif	stabilis	anim	reform
19	panel	materi	pension	erasmus	irregular	agricultur	rate
20	lisbon	renew	reform	vocat	western	urban	incom

Table 29 - Top 20 more relevant words for eight cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6	C7	C8
1	ict	gender	tax	youth	migrat	tourism	unemploy	energi
2	digit	women	euro	educ	immigr	maritim	labour	eco
3	research	poverti	smes	learn	asylum	heritag	lisbon	carbon
4	internet	men	ventur	teacher	migrant	cultur	pension	environment
5	innov	equal	bank	young	refuge	marin	wage	raw
6	biotechnolog	children	investor	student	visa	sea	reform	emiss
7	standardis	inclus	capit	school	turkey	farm	employ	green
8	patent	mainstream	eib	lifelong	enlarg	rural	tax	wast
9	industri	discrimin	taxat	languag	solidar	fish	worker	renew
10	onlin	exclus	crisi	univers	crime	coastal	older	recycl
11	interop	disabl	loan	skill	corrupt	ecu	age	materi
12	scientif	health	payment	train	balkan	fisheri	esf	electr
13	space	inequ	singl	peopl	acqui	erdf	rate	climat
14	smes	decent	vat	adult	neighbour	agricultur	gdp	industri
15	textil	famili	equiti	mobil	traffick	creativ	women	smes
16	scienc	erad	consum	graduat	justic	urban	expensur	clean
17	transport	incom	energi	qualif	stabilis	anim	guidelin	water
18	cluster	pension	debt	erasmus	irregular	biodivers	gender	bio
19	manufactur	labour	cash	vocat	western	esf	job	fuel
20	panel	esf	border	apprenticeship	energi	local	cohes	consumpt

Table 30 - Top 20 more relevant words for nine cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	ict	gender	tax	youth	migrat	tourism	unemploy	energi	transport
2	digit	women	smes	educ	immigr	maritim	labour	carbon	safeti
3	internet	poverti	eur	learn	asylum	cultur	lisbon	eco	energi
4	research	men	ventur	young	migrant	heritag	pension	environment	space
5	biotechnolog	equal	investor	teacher	refuge	marin	reform	emiss	turkey
6	innov	children	capit	student	visa	sea	tax	raw	textil

7	patent	mainstream	taxat	school	irregular	coastal	wage	green	standardis
8	onlin	inclus	eib	languag	traffick	fish	employ	wast	enlarg
9	interop	esf	bank	lifelong	return	creativ	crisi	renew	solidar
10	scientif	discrimin	loan	univers	resid	ecu	worker	recycl	justic
11	scienc	disabl	payment	train	illeg	fisheri	age	materi	negoti
12	cluster	exclus	vat	skill	admiss	erdf	gdp	electr	trade
13	panel	famili	equiti	peopl	recept	biodivers	older	climat	satellit
14	industri	inequ	singl	adult	seeker	travel	fiscal	smes	agricultur
15	excel	decent	consum	graduat	origin	farm	esf	industri	court
16	smes	health	cash	mobil	arriv	anim	rate	water	judici
17	electron	incom	currenc	qualif	eastern	destin	job	clean	reform
18	lisbon	pension	compani	erasmus	host	local	expenditur	fuel	food
19	comput	labour	asset	apprenticeship	labour	urban	women	bio	aid
20	broadband	care	entrepren	vocat	border	water	energi	consumpt	crime

Table 31 - Top 20 more relevant words for ten cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	ict	gender	euro	youth	migrat	tourism	unemploy	energi	textil	safeti
2	digit	women	tax	educ	immigr	maritim	labour	carbon	space	transport
3	internet	poverti	smes	learn	asylum	cultur	lisbon	eco	standardis	singl
4	research	men	eur	young	migrant	heritag	reform	environment	turkey	energi
5	biotechnolog	equal	ventur	teacher	refuge	urban	pension	raw	satellit	citizen
6	onlin	children	sme	student	visa	marin	tax	emiss	trade	consum
7	innov	mainstream	investor	school	irregular	sea	wage	green	court	solidar
8	patent	inclus	capit	lifelong	traffick	coastal	crisi	wast	corrupt	enlarg
9	scientif	discrimin	eib	languag	return	citi	employ	electr	wto	legisl
10	scienc	exclus	loan	univers	resid	erdf	worker	renew	judici	transposit
11	cluster	disabl	equiti	train	illeg	fish	age	recycl	export	health
12	interop	famili	bank	skill	admiss	ecu	gdp	materi	ecu	migrat
13	panel	inequ	cash	peopl	recept	rural	older	climat	parti	justic
14	smes	health	payment	adult	seeker	creativ	fiscal	gas	acqui	enforc
15	excel	decent	eif	graduat	origin	fisheri	rate	smes	africa	border
16	industri	incom	asset	mobil	arriv	farm	esf	industri	balkan	rail
17	lisbon	pension	entrepren	qualif	eastern	biodivers	macroeconom	water	justic	surveil
18	electron	labour	currenc	erasmus	host	anim	energi	clean	mediterranean	simplif
19	comput	esf	vat	apprenticeship	labour	art	expenditur	fuel	reform	extern
20	broadband	care	enterpris	vocat	border	local	job	consumpt	food	negoti

Table 32 - Top 20 more relevant words for eleven cluster analysis in the corpus EU Policy (1990-2016).

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	ict	gender	tax	youth	migrat	Tourism	unemploy	energi	space	standardis	smes
2	euro	women	eur	educ	immigr	Maritime	labour	carbon	turkey	transport	ventur
3	research	poverti	onlin	learn	asylum	Culture	lisbon	eco	energi	safeti	investor
4	biotechnolog	men	digit	teacher	migrant	heritag	pension	environment	justic	navig	capit
5	innov	equal	consum	young	refuge	urban	reform	emiss	enlarg	railway	equiti
6	patent	children	vat	student	visa	marin	tax	raw	negoti	rail	entrepreneur
7	internet	mainstream	singl	school	irregular	sea	wage	green	textil	africa	eib
8	scientif	inclus	payment	lifelong	traffick	fish	crisi	wast	trade	port	eif
9	scienc	discrimin	border	languag	return	coastal	worker	electr	judici	logist	loan
10	industri	exclus	commerc	univers	resid	rural	age	renew	corrupt	accid	insolv
11	smes	disabl	liabil	skill	host	ecu	older	recycl	food	road	enterpris
12	lisbon	famili	transact	train	illeg	erdf	employ	materi	solidar	aviat	up
13	cluster	inequ	asset	peopl	admiss	creativ	gdp	climat	migrat	african	bankruptci
14	excel	health	electron	adult	humanitarian	citi	fiscal	gas	wto	health	entrepren
15	panel	decent	revenu	mobil	recept	farm	esf	smes	reform	surveil	tax
16	digit	incom	transposit	graduat	origin	agricultur	rate	industri	agricultur	mode	debt
17	manufactur	pension	amount	qualif	seeker	biodivers	women	water	crime	infrastructur	craft
18	interop	labour	citizen	erasmus	arriv	travel	expenditur	clean	acqui	galileo	stock
19	knowledg	esf	procur	vocat	eastern	local	cent	consumpt	neighbourhood	satellit	seed
20	technolog	care	internet	apprenticeship	labour	art	energi	fuel	court	traffic	compani

Table 33 - Top 20 more relevant words for twelve cluster analysis in the corpus EU Policy (1990-2016)

Order	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
-------	----	----	----	----	----	----	----	----	----	-----	-----	-----

1	euro	gender	tax	youth	migrat	tourism	unemploy	energi	turkey	standardis	smes	ict
2	research	women	eur	educ	immigr	maritim	labour	carbon	enlarg	transport	ventur	digit
3	biotechnolog	poverti	vat	learn	asylum	cultur	lisbon	eco	energi	safeti	capit	internet
4	patent	men	payment	young	migrant	heritag	pension	environment	negoti	navig	investor	onlin
5	innov	equal	singl	teacher	refuge	marin	reform	emiss	corrupt	railway	equiti	space
6	textil	children	consum	student	visa	sea	tax	raw	migrat	rail	eib	interoper
7	scientif	mainstream	asset	school	irregular	coastal	wage	green	solidar	africa	entrepren	broadband
8	scienc	inclus	liabil	lifelong	traffick	fish	worker	wast	trade	port	eif	commerc
9	panel	discrimin	transact	languag	return	creativ	employ	electr	crime	logist	loan	satellit
10	industri	exclus	border	univers	resid	ecu	age	renew	reform	road	insolv	electron
11	cluster	disabl	transposit	train	host	erdf	older	recycl	acqui	aviat	enterpris	comput
12	excel	famili	amount	skill	illeg	biodivers	crisi	materi	stabil	accid	up	telecom
13	lisbon	erad	revenu	peopl	admiss	travel	esf	climat	balkan	health	bankruptci	spectrum
14	manufactur	inequ	cash	adult	humanitarian	farm	gdp	gas	neighbourhood	african	tax	user
15	ict	health	statement	graduat	recept	anim	fiscal	smes	wto	surveil	debt	copyright
16	knowledg	decent	loss	mobil	origin	destin	rate	industri	agricultur	mode	craft	data
17	smes	incom	expens	qualif	seeker	local	women	clean	justic	infrastructur	seed	deploy
18	firm	pension	pension	erasmus	arriv	esf	cent	consumpt	neighbour	galileo	stock	platform
19	technolog	labour	citizen	apprenticeship	eastern	urban	job	water	freedom	satellit	compani	telecommun
20	aid	esf	bank	vocat	labour	water	retir	fuel	stabilis		bank	privaci

Annex 3 - EU Regional Results⁶⁵

Descriptive statistics

For the purpose of the analysis, corpus Academia is also splitted to analyze those papers authored by researchers affiliated in the European Union. From the whole corpus Academia, there are 561 documents corresponding to 640 European Union affiliations. Fig. 42 shows the distribution of these EU articles per authors' affiliation.

This analysis is only a snapshot of the whole entrepreneurship research in EU and it is obviously limited by the sample and the fact that authors' affiliation is only one of the aspects of the context, which is much more complex. But it aims to give some additional insights to enrich the debate about how national contexts relates to EU research communities in this field, showing how have been configured the research on entrepreneurship policy per country since the early 1990s and the contributions to the whole EU regional research picture.

Fig. 42 -Distribution of authors' country affiliations in EU Corpus Academia

⁶⁵⁶⁵ For this analysis, this thesis has only considered those countries with at least ten papers (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom). For those countries with least than ten papers, the size of the sample is not a sufficiently representative to firmly support conclusions from the cluster analysis

United Kingdom largely leads the research in this field for the period under study with more than 35.2% of the total number of affiliations, followed by Netherlands, Spain, Italy, Germany, Sweden and France, all of them together adding up to almost half of the EU authors' affiliations. Then follows a group of six countries with at least ten affiliated papers (Belgium, Finland, Denmark, Greece and Austria), and finally a long tail of countries up to complete the twenty four countries with at least one affiliated paper. Slovakia, Latvia, Lithuania and Malta do not count with any affiliated researcher within the Corpus during 1990-2016.

General results from EU Corpus Academia

Fig. displays the most frequent terms in the EU-Corpus Academia. Words in the top ten are very similar to the Global Corpus Academia with the minor exceptions of *innovation*, that rises from 7th up to 4th position when considering only papers with EU authors; and also *technology* that goes down from 6th position considering all the papers to the 8th position when considering papers with just EU authors.

A more detailed analysis about the performance of entrepreneurial agents in the corpuses offers interesting insights. While there are no differences for the 1st position of *firm-enterprise-company* and 3rd position of *entrepreneur*, positions of the terms *startup* and overall *smes* are higher when considering papers with authors with EU affiliations. However, *size* is at 49th within the analysis of the whole Corpus Academia and at 66th from the EU Academia point of view, showing a potential less interest from authors affiliated to EU institutions on firm's size in the context of entrepreneurship policies.

Other significant differences within the most frequent words are *employment* that ranks at 27th in the EU Corpus Academia and 35th at Global Corpus Academia and *knowledge*, *science* and *transfer*, ranking 16th, 18th and 44th in the EU Academia and 18th, 22nd and 64th respectively within the whole Corpus Academia. Similarly, terms related to finance are more relevant for EU Academia, with *venture*, *investment* and *finance* at 22nd, 23rd and 24th when considering papers related to EU authors and the same terms at 26th, 28th and 31st, respectively within the whole Corpus Academia.

On the contrary, the business dimension underperforms when analysing the EU Academia comparing to the global analysis, with *business* and *management* ranking 5th and 14th versus 4th and 11th within the whole corpus

Regarding to institutional perspective, terms such as *govern*, *system*, *competition* ranks at 16th, 34th and 42nd in Global Corpus Academia, while the same words descend to 34th, 35th and 61st within the EU Corpus Academia.

The comparative analysis of words related to geography and context also offers interesting differences between EU Academia and Global Academia. While terms referring to geographical level such as *international*, *nation-country* and *region* are in slightly in an upper position in the case of EU Academia, differences are bigger when considering both generic terms related to context and/or location such as *context*, *agglomeration* or *geography* and also a greater level of detail with terms such *local*, *cluster*, *network* or *relationship*.

Adding all together, these differences between EU and Global Academia papers depict a regional research environment for entrepreneurship policies in the EU where innovation, employment, financing, knowledge transfer and the governance of the whole ecosystem appear as more relevant, all within a framework of research into local and regional clusters of startups and small companies.

Fig. 43 - Top 50 frequent words within the corpus EU Academia by absolute number of occurrences

Country clusters' results from EU Corpus Academia

The analysis⁶⁶ of the particularities of the research papers on entrepreneurship policy from specific country affiliations in comparison to EU Corpus Academia as a whole also draws additional interesting regional insights. The analysis considers just the top 50 most frequent words unless other cases specified below, both in between countries and with regard to the average of the EU. The analysis is based both from text mining per individual (affiliation to a) country and from a twelve cluster partition of the EU Corpus Academia Table 34 shows the

⁶⁶ For this analysis this thesis only considered those countries with at least ten papers. For those countries with least than ten papers, the size of the sample is not a sufficiently representative to firmly support conclusions from the cluster analysis

number of papers per cluster and country affiliation and for the whole EU; and Table 35 5 shows the percentage of country affiliated papers included in each cluster and also for the whole EU.

A first cluster of countries, composed by Belgium, Portugal and Sweden, displays a higher interest in the *regional* perspective, with Sweden adding *growth* and *venture capital*. A second cluster, with Greece, Italy and Spain as prominent examples, attach more relevance to *innovation* and less to *technology* and *research*, maybe a consequence of the service-orientation of their economies. Interestingly, in the case of Italy there is also less importance to *business* and *management* compared to the general EU research scene and more to the *local* perspective, while Greece also pays less attention to *industry* and Spain seems to focus on *sme* and *employment*. Note that in addition Sweden and Spain share the *inclusion* and *employment-regulation-finance* themes. A third non-exclusive cluster would share features from both the clusters above, this is, regional and innovation relevance, and would include Belgium and Denmark with the former also underlining the role of *networks*. The case of Finland would be somewhat different, and its research focus highlights the studies on *growth* and *creativity* and not only *innovation* as key drivers of the economic engine in the country. UK will be also in a class of its own with distinctive features in the attention to *venture capital*, *management* and *inclusion*. The case of the Netherlands is also relatively unique with a special stress on the role of *patents* and *spin-off*. Germany would belong with the wide cluster of UK and the Netherlands, sharing the relevance of *capital*, *employment-regulation-finance* and *patent*, and adding the importance of *research*. A final cluster will be composed just by France, with its unique accent on the combination of the *international* approach, *research-knowledge*, *management* and also the *service* and *social* dimensions.

Looking to terms instead of countries an alternative cluster would be composed around research-knowledge by France and Italy and, in a minor proportion, from the UK. If the focus is into internationalization, then a cluster appears with Italy and the UK. Regionalization creates a broader cluster with Germany, France, Italy and Netherlands, while support brings about a cluster composed by Belgium, Sweden and Germany.

Table 34 - Number of EU country-affiliated papers per cluster

	AT	BL	DK	ES	FI	FR	GER	GRE	IT	NL	PT	SW	UK	TOTAL UE
<i>C1 - Inclusion</i>	1	2	4	14	3	6	10	0	6	13	0	12	51	129
<i>C2 - Research - knowledge</i>	1	3	1	3	4	6	5	3	8	9	3	2	32	82
<i>C3 - Internationalization-Investment</i>	0	0	1	0	0	0	1	0	4	0	0	0	5	11
<i>C4 - Geography/Location-Lifecycle</i>	0	0	0	1	0	1	1	0	0	4	0	0	1	8
<i>C5 - Geography/Location-Industry</i>	0	1	1	3	0	2	6	1	6	4	0	1	15	41
<i>C6 - Internationalization-Export</i>	3	0	1	4	1	2	2	1	2	4	2	1	23	48
<i>C7 - Support</i>	0	1	0	0	0	1	2	1	0	2	0	3	4	15
<i>C8 - Innovation - Technology</i>	2	1	1	10	0	5	2	3	6	4	1	4	18	63
<i>C9 - Employment-Regulation-Finance</i>	3	9	2	16	5	6	13	2	13	13	2	13	38	137
<i>C10 - Geography/Location - Agglomeration</i>	0	2	1	1	0	2	3	0	2	6	1	3	10	31
<i>C11 - Management</i>	0	2	0	4	0	6	2	0	6	5	0	2	19	47
<i>C12 - Venture Capital</i>	0	2	0	1	1	1	1	0	2	2	1	4	10	25
TOTAL	10	23	12	57	14	38	48	11	55	66	10	45	226	637

Table 35 - Number of EU country-affiliated papers per cluster Percentage of EU country-affiliated papers per cluster

	AT	BL	DK	ES	FI	FR	GER	GRE	IT	NL	PT	SW	UK	TOTAL UE
<i>C1 - Inclusion</i>	10.0%	8.7%	33.3%	24.6%	21.4%	15.8%	20.8%	0.0%	11.1%	19.7%	0.0%	26.7%	22.7%	20.2%
<i>C2 - Research - knowledge</i>	10.0%	13.0%	8.3%	5.3%	28.6%	15.8%	10.4%	27.3%	14.8%	13.6%	30.0%	4.4%	14.2%	12.9%
<i>C3 - Internationalization-Investment</i>	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	2.1%	0.0%	7.4%	0.0%	0.0%	0.0%	2.2%	1.7%
<i>C4 - Geography/Location-Lifecycle</i>	0.0%	0.0%	0.0%	1.7%	0.0%	2.6%	2.1%	0.0%	0.0%	6.1%	0.0%	0.0%	0.4%	1.3%
<i>C5 - Geography/Location-Industry</i>	0.0%	4.3%	8.3%	5.3%	0.0%	5.3%	12.5%	9.1%	11.1%	6.1%	0.0%	2.2%	6.7%	6.4%
<i>C6 - Internationalization-Export</i>	30.0%	0.0%	8.33%	7.0%	7.1%	5.3%	4.2%	9.1%	3.7%	6.0%	20.0%	2.2%	10.2%	7.6%
<i>C7 - Support</i>	0.0%	4.3%	0.0%	0.0%	0.0%	2.6%	4.2%	9.1%	0.0%	3.0%	0.0%	6.7%	1.8%	2.3%
<i>C8 - Innovation - Technology</i>	20.0%	4.3%	8.3%	17.5%	0.0%	13.2%	4.2%	27.3%	11.1%	6.1%	10.0%	8.9%	8.0%	9.9%
<i>C9 - Employment-Regulation-Finance</i>	30.0%	39.1%	16.7%	28.1%	35.7%	15.8%	27.1%	18.2%	24.1%	19.7%	20.0%	28.9%	16.9%	21.5%
<i>C10 - Geography/Location -Agglomeration</i>	0.0%	8.7%	8.3%	1.7%	0.0%	5.3%	6.2%	0.0%	3.7%	9.1%	10.0%	6.7%	4.4%	4.9%
<i>C11 - Management</i>	0.0%	8.7%	0.0%	7.0%	0.0%	15.8%	4.2%	0.0%	11.1%	7.6%	0.0%	4.4%	8.4%	7.4%
<i>C12 - Venture Capital</i>	0.0%	8.7%	0.0%	1.7%	7.1%	2.6%	2.1%	0.0%	3.7%	3.0%	10.0%	8.9%	4.4%	3.9%

Annex 4 – Extended summary of some main case studies

This annex provides further details about five main case studies in the AI innovation ecosystem in China, delving into how the interactions influence the development of technology and the strategic positioning of firms.

Alibaba - City Brain (smart cities)

A flagship project of Alibaba's cloud AI tools is a suite called City Brain, designed for tasks in the field of smart cities like managing traffic data and analyzing footage from city video cameras with the ultimate goal of creating a computerized, automated public services infrastructure. By 2018, it has been deployed in Hangzhou, Guangzhou and Suzhou.

From the ATH perspective is worth to mention that the project was started in Hangzhou, where Alibaba was originated, is headquartered, and where Alibaba is contributing to create a particular innovation ecosystem. The alliance between the local government and the company allowed to build and showcase the solution to other interested cities in a sort of joint venture for marketing providing early evidence in the advantages of the solution. It is a win-win agreement, where the city gains in innovation prestige and the company can implement solutions, test them and present real life impacts. The cooperation between the local government and the company has extended to launch a new innovation district and a private university.

Tencent - AIMIS (e- health)

A flagship project of Tencent is the ecosystem the company is building around healthcare with the help of AI. In 2014, Tencent launched WeChat Intelligent Healthcare. The platform allows users to book appointments and make payments at hospitals through WeChat accounts. This is complemented by WeSure, a medical insurance service. In 2017, Tencent launched the AI Medical Innovation System or AIMIS, an AI-powered diagnostic medical imaging service.

From the ATH perspective, while Tencent leads the development of the whole e-health ecosystem, the main solution, AIMIS, has been already adopted by more than a hundred of public hospitals around China in 2018. This collaboration has a vital role creating a critical mass for the service. At the same time, Guangzhou's Sun Yatsen University Cancer Research Institute is working closely with Tencent to develop the diagnostic component of the AI. Besides, as in the case of City Brain, each of them belongs to its respective open innovation platform, both backed from the Ministry of Science and Technology initiative for the new generation of artificial intelligence, a plan for the development of those industrial fields that are considered strategic.

Security-oriented projects (SenseTime, Yitu Technologies, ...)

A top priority of China government is the provision of public security. In this field, there are many relevant developments. As relevant examples, Dragonfly Eye is the face-based data base solution developed by Yitu Technology and adopted by about two hundreds police services and immigration authorities. SenseTime is

specialized on image recognition, in use both by large companies (China Mobile, JD.com) and public organizations (Guangzhou public security bureau, the Yunnan Provincial Public Security, and the National Satellite Meteorological Center, ...).

From the ATH perspective it is worth to mention that different levels of government are ready to bet on the solutions of startups and emergent companies, providing access to eligible companies to records and key data and allowing room for experimentation and improvement. Governments issue regularly success stories of their usage of such technologies, disclosing the company who was involved in the project. It is another instance of a win-win tacit agreement and alignment between governments and firms, where governments have access to the latest technology and companies gain reputation and can experiment with large enough datasets.

Cambricon - Microelectronics projects

China's semiconductor industry, which could support hardware-based AI processing, is still lagging behind. As this is a well-known issue by the government, there are in fact a number of key initiatives in China designed to achieve a higher level of independence in chip manufacturing. As a master plan, the Made in China 2025 has assigned the highest priority to develop an own microelectronic industry to achieve the goal of 70% of internal demand supplied by local manufacturers and reach technological independence.

From the ATH perspective, this has created a new scenario for startups to enter into the microelectronic industry arena -a market closed to new companies due to economies of scale for decades- and disrupt this industry. The most relevant example is the AI chip startup Cambricon Technologies. It was founded in 2016 by two brothers working at the Chinese Academy of Sciences (CAS), and become a unicorn in just two years. The company has experimented a huge growth fueled by a strategic business partnership with a large company such as Huawei and being funded not only by government backed venture capital but also by other large companies such as Alibaba and iFlytek. Of course, all the large tech companies in China have announced in 2018 that they are working in their own AI chips, see the cases of Alibaba (Ali-NPU), Baidu (Kunlun) and Huawei (Kirin 980).

Foreign large tech companies

The role of foreign large tech companies is very limited in the AI ecosystem. US companies such as Apple, Amazon Web Services, Google and Microsoft have set up research centres and joint ventures in China trying to tap into China's local talent and to position themselves in the future, but with no major direct participation in the development of the ecosystem. Microsoft Research Asia participates in the National Engineering Laboratory of Brain-like Technology and Application and also collaborates in "AI for Good" and social initiatives. In the case of Google, its mobile app store, search engine, location services, email and cloud services are banned in China but still the company has focused on exposing its products -AI or not- in China, with the basic rationale of attracting developers to its platform and even set up a research centre in China. AWS operates its cloud services through a partnership in China. Apple is mostly focused on commercial aspects and local suppliers.

From the ATH perspective, the difficulties of foreign companies to participate in the innovation ecosystems is a sign of its inward perspective, the relevance of the alignment between local companies and the government and the relevance of the supply of talent.