KU LEUVEN
RESEARCH & DEVELOPMENT

Regional economic development and the role of clusters in regional innovation ecosystems

Reflections on drivers and performance of cluster dynamics

Koenraad Debackere, March 26th, 2025

Science, the endless frontier
Scaling, the twin peaks

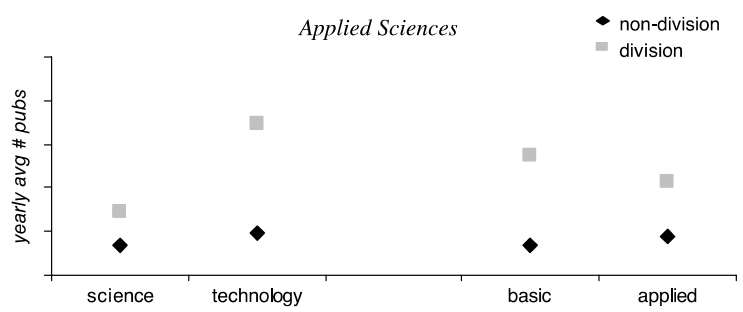
Science, pushing the endless frontier, driven by the curiosity of inquiry and falsification

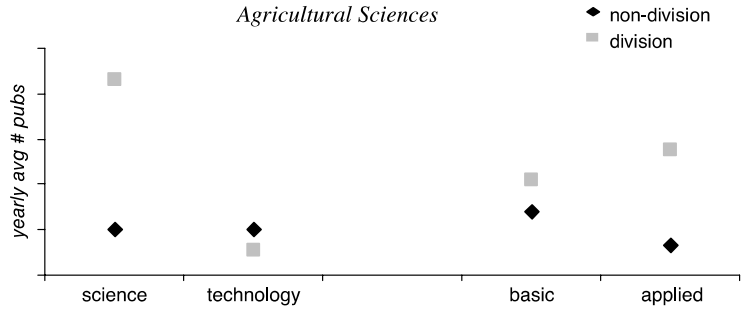
"The mistake that people sometimes make, and often teach, is that science is a bank of knowledge. After all, the word "science" comes from the Latin scire – to know. But science isn't just about knowing, it's about not knowing and having a way to find out." (Adam Rutherford & Hannah Fry, 2021)

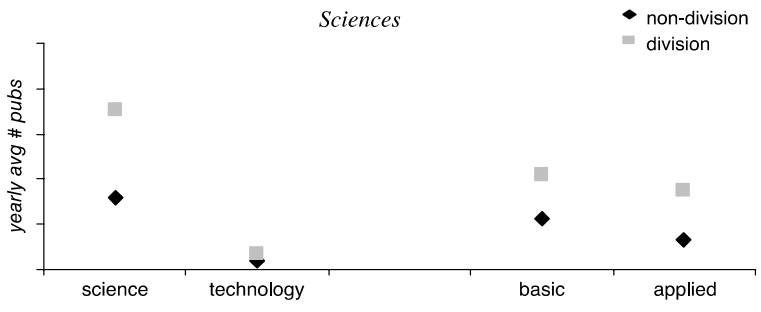
"The iron rule of explanation: (1) strive to settle all arguments by empirical testing, and (2) to conduct an empirical test to decide between a pair of hypotheses, perform an experiment or measurement, one of whose possible outcomes can be explained by one hypothesis (and accompanying cohort) but not the other." (Michael Strevens's Knowledge Machine, 2020, building on Thomas Kuhn and Karl Popper).

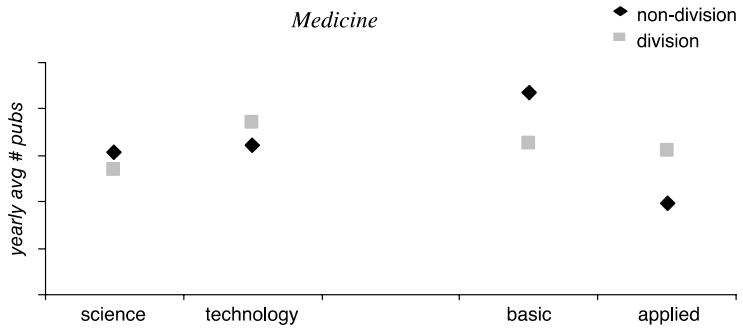
"The knowledge machine is a social institution governed by the iron law." Robert Merton and the sociology of science, 1973.

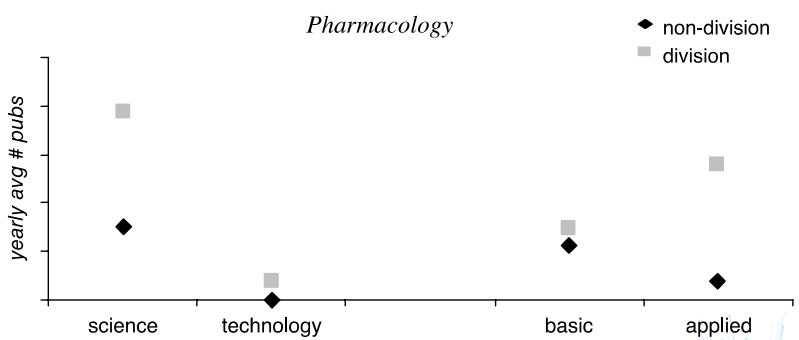
Cognitive spillovers push scientific discovery and valorisation (Research Policy, 2004)

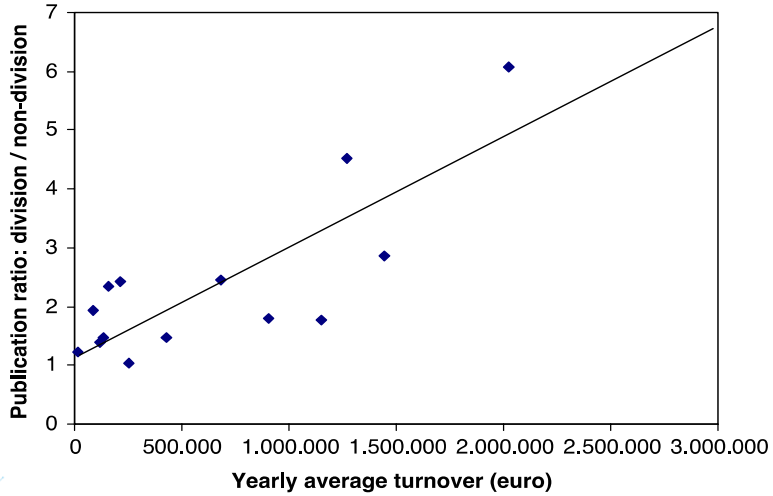












RESEARCH IMPACT

The dual frontier: Patented inventions and prior scientific advance

Mohammad Ahmadpoor[1,2] and Benjamin F. Jones[1,2,3*]

The extent to which scientific advances support marketplace inventions is largely unknown. We study 4.8 million U.S. patents and 32 million research articles to determine the minimum citation distance between patented inventions and prior scientific advances. We find that most cited research articles (80%) link forward to a future patent. Similarly, most patents (61%) link backward to a prior research article. Linked papers and patents typically stand 2 to 4 degrees distant from the other domain. Yet, advances directly along the patent-paper boundary are notably more impactful within their own domains. The distance metric further provides a typology of the fields, institutions, and individuals involved in science-to-technology linkages. Overall, the findings are consistent with theories that emphasize substantial and fruitful connections between patenting and prior scientific inquiry.

TECHNICAL CHANGE AND THE AGGREGATE PRODUCTION FUNCTION*

Robert M. Solow

IN this day of rationally designed econometric studies and super-input-output tables, it takes something more than the usual "willing suspension of disbelief" to talk seriously of the aggregate production function. But the aggregate production function is only a little less legitimate a concept than, say, the aggregate consumption function, and for some kinds of long-run macro-models it is almost as indispensable as the latter is for the short-run. As long as we insist on practicing macro-economics we shall need aggregate relationships.

Even so, there would hardly be any justification for returning to this old-fashioned topic if I had no novelty to suggest. The new wrinkle I want to describe is an elementary way of segregating variations in output per head due to technical change from those due to changes in the availability of capital per head. Naturally, every additional bit of information has its price. In this case the price consists of one new required time series, the share of labor or property in total income, and one new assumption, that factors are paid their marginal products. Since the former is probably more respectable than the other data I shall use, and since the latter is an assumption often made, the price may not be unreasonably high.

Before going on, let me be explicit that I would not try to justify what follows by calling on fancy theorems on aggregation and index numbers.[1] Either this kind of aggregate economics appeals or it doesn't. Personally I belong to both schools. If it does, I think one can draw some crude but useful conclusions from the results.

* I owe a debt of gratitude to Dr. Louis Lefeber for statistical and other assistance, and to Professors Fellner, Leontief, and Schultz for stimulating suggestions.

[1] Mrs. Robinson in particular has explored many of the profound difficulties that stand in the way of giving any precise meaning to the quantity of capital ("The Production Function and the Theory of Capital," *Review of Economic Studies*, Vol. 21, No. 2), and I have thrown up still further obstacles (ibid., Vol. 23, No. 2). Were the data available, it would be better to apply the analysis to some precisely defined production function with many precisely defined inputs. One can at least hope that the aggregate analysis gives some notion of the way a detailed analysis would lead.

Theoretical Basis

I will first explain what I have in mind mathematically and then give a diagrammatic exposition. In this case the mathematics seems simpler. If Q represents output and K and L represent capital and labor inputs in "physical" units, then the aggregate production function can be written as:

$$Q = F(K,L;t). \qquad (1)$$

The variable t for time appears in F to allow for technical change. It will be seen that I am using the phrase "technical change" as a shorthand expression for *any kind of shift* in the production function. Thus slowdowns, speedups, improvements in the education of the labor force, and all sorts of things will appear as "technical change."

It is convenient to begin with the special case of *neutral* technical change. Shifts in the production function are defined as neutral if they leave marginal rates of substitution untouched but simply increase or decrease the output attainable from given inputs. In that case the production function takes the special form

$$Q = A(t)f(K,L) \qquad (1a)$$

and the multiplicative factor $A(t)$ measures the cumulated effect of shifts over time. Differentiate (1a) totally with respect to time and divide by Q and one obtains

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + A\frac{\partial f}{\partial K}\frac{\dot{K}}{Q} + A\frac{\partial f}{\partial L}\frac{\dot{L}}{Q}$$

where dots indicate time derivatives. Now define $w_K = \frac{\partial Q}{\partial K}\frac{K}{Q}$ and $w_L = \frac{\partial Q}{\partial L}\frac{L}{Q}$ the relative shares of capital and labor, and substitute in the above equation (note that $\partial Q/\partial K = A\,\partial f/\partial K$, etc.) and there results:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + w_K\frac{\dot{K}}{K} + w_L\frac{\dot{L}}{L}. \qquad (2)$$

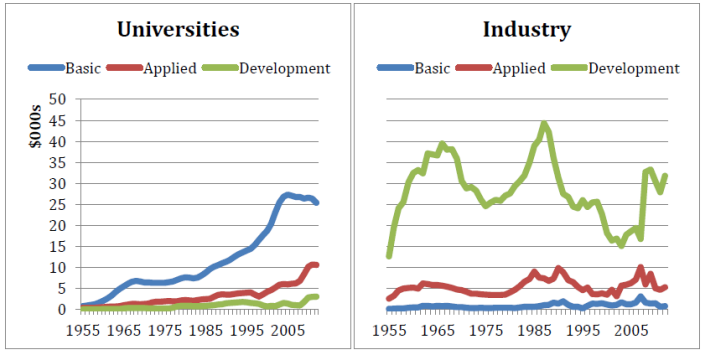
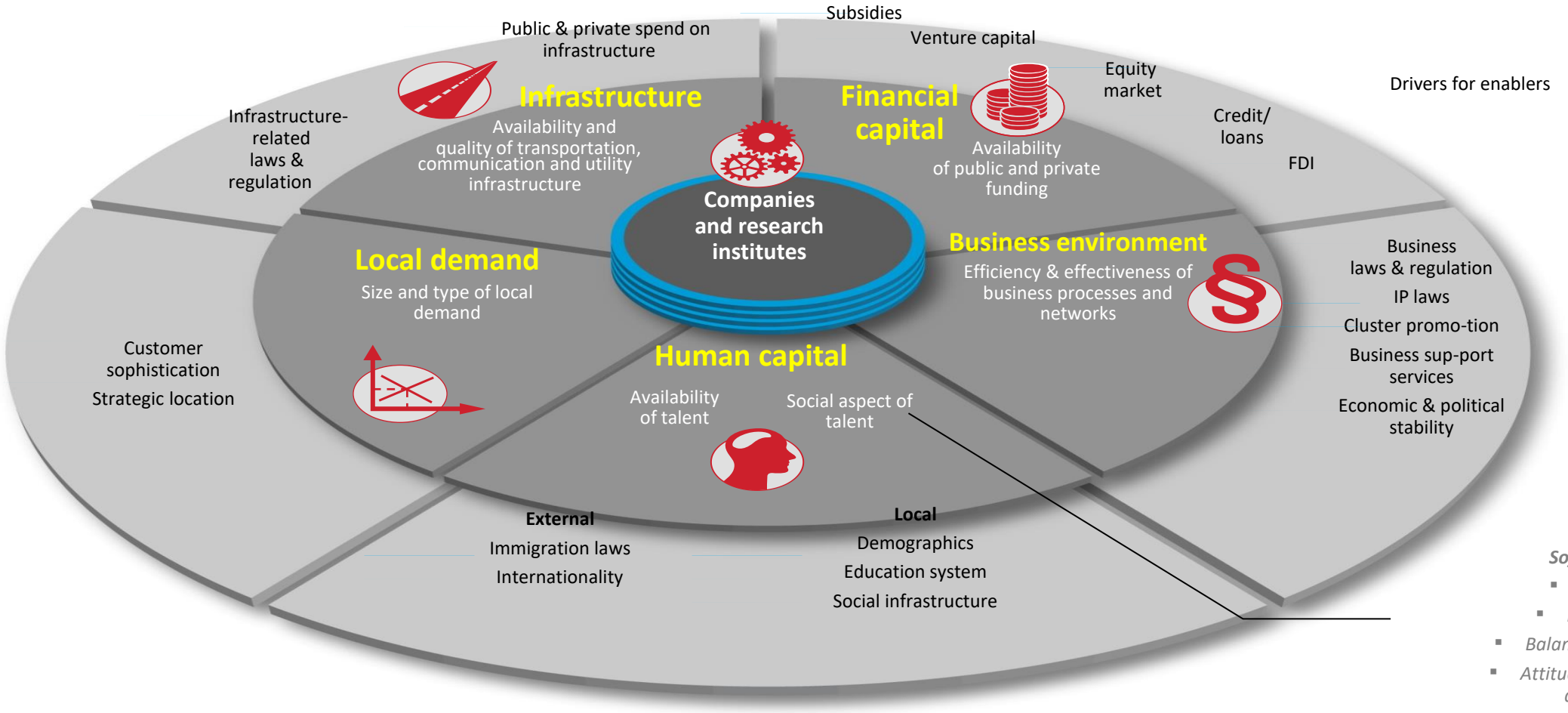


Figure 2. Character of federal research spending. All amounts in $M, expressed in 2015 dollars. (Data from the American Association for the Advancement of Science.)

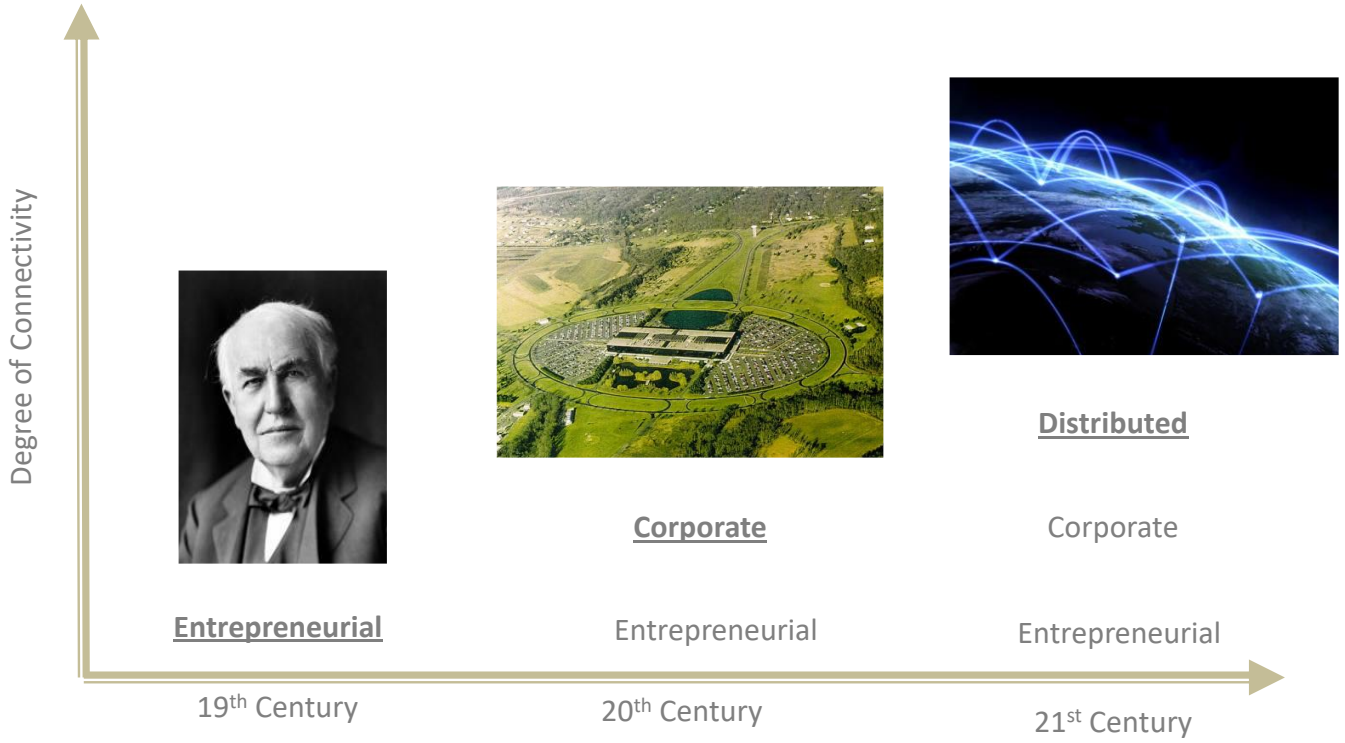
Science, technology, and market

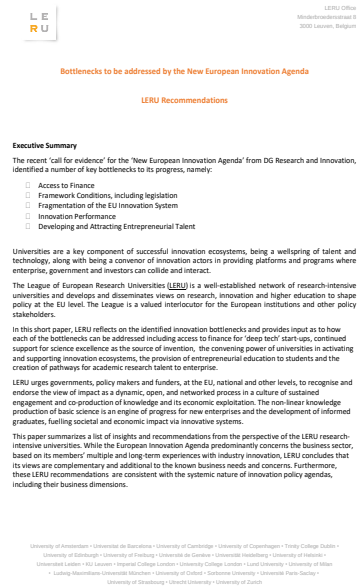
Understanding ecosystems, redrawing the boundaries of competition and innovation

Ecosystem ingredients



Connected, entrepreneurial science, cornerstone of TTO-driven valorisation strategies





Bottlenecks to be addressed by the New European Innovation Agenda

LERU Recommendations

Executive Summary

The recent 'call for evidence' for the 'New European Innovation Agenda' from DG Research and Innovation, identified a number of key bottlenecks to its progress, namely:

- Access to Finance
- Framework Conditions, including legislation
- Fragmentation of the EU Innovation System
- Innovation Performance
- Developing and Attracting Entrepreneurial Talent

Universities are a key component of successful innovation ecosystems, being a wellspring of talent and technology, along with being a convenor of innovation actors in providing platforms and programs where enterprise, government and investors can collide and interact.

The League of European Research Universities (LERU) is a well-established network of research-intensive universities and develops and disseminates views on research, innovation and higher education to shape policy at the EU level. The League is a valued interlocutor for the European institutions and other policy stakeholders.

In this short paper, LERU reflects on the identified innovation bottlenecks and provides input as to how each of the bottlenecks can be addressed including access to finance for 'deep tech' start-ups, continued support for science excellence as the source of invention, the convening power of universities in activating and supporting innovation ecosystems, the provision of entrepreneurial education to students and the creation of pathways for academic research talent to enterprise.

LERU urges governments, policy makers and funders, at the EU, national and other levels, to recognise and endorse the view of impact as a dynamic, open, and networked process in a culture of sustained engagement and co-production of knowledge and its economic exploitation. The non-linear knowledge production of basic science is an engine of progress for new enterprises and the development of informed graduates, fuelling societal and economic impact via innovative systems.

This paper summarizes a list of insights and recommendations from the perspective of the LERU research-intensive universities. While the European Innovation Agenda predominantly concerns the business sector, based on its members' multiple and long-term experiences with industry innovation, LERU concludes that its views are complementary and additional to the known business needs and concerns. Furthermore, these LERU recommendations are consistent with the systemic nature of innovation policy agendas, including their business dimensions.

EU Strategy For Data

As Open As Possible, As Closed As Needed: Challenges Of The EU Strategy For Data

1. The 2020 Package on Shaping Europe's Digital Future

On February 19th, 2020, a few days before the outbreak of COVID-19, the European Commission published a package of four documents on the digital transformation in the EU: a general communication on shaping Europe's digital future,[1] a European strategy for data,[2] a white paper on artificial intelligence (AI)[3] and a report on the safety of products and liability in the era of AI, Internet of Things and robotics.[4]

This package was the first set of measures adopted by the new Commission in order to pursue one of the six priorities of the political program of President von der Leyen for 2019-2024, *i.e.*, ensure that the EU is fit for the digital age. Therefore, the general approach and the specific contents of the digital package deserve careful consideration from a public policy perspective, although many initiatives were merely outlined in broad terms.

The legislative proposal for a regulation on European data governance (Data Governance Act), published by the European Commission on November 25th, 2020, is the first deliverable under the European strategy for data.[5] It will be followed, in 2021, by sectoral proposals on common European data spaces and a legislative initiative on a data act aimed at fostering data sharing among businesses and between business and government.

This article provides a reasoned overview of the Commission's agenda, as far as data are concerned, for the forthcoming months.[6] We describe the main features of the approach outlined by the 2020 EU strategy for data and comment on the main challenges that have to be met to ensure that the strategy achieves its ambitious objectives, with a focus on the rules concerning access to data.

1. COM(2020) 67 final.
2. COM(2020) 66 final.
3. COM(2020) 65 final.
4. COM(2020) 64 final.
5. COM(2020) 767 final.
6. A public consultation on the strategy ran from 19 February to 31 May 2020; a summary report on the contributions submitted by more than 800 stakeholders is available on the Commission's website.

When designing data access rules and policies, concerns regarding potential social loss due to an inefficient single digital market and incentives for innovators allowing them to reap a fair share of the benefits of their innovation investments should be understood and balanced. Openness and exclusivity are two sides of a coin that must be managed carefully when shaping Europe's digital future.

For instance, the second Payment Services Directive (PSD2)[7] is linked to a trend in financial regulation (open banking) aimed at security, innovation and market competition. By requiring banks to provide other qualified payment-service providers (PSPs) connectivity to access customer account data and to initiate payments, commoditization in the European banking sector is stimulated. However, at the same time, innovation should not be hampered. This implies that, similar to what we will see in later paragraphs for the Public Sector Information Directive (EU) 2019/1024, there is a need for data access to be as open as possible, but as closed as needed to allow innovation dynamics in the financial sector to unfold.

Another data-related example is to be found in the current rush to identify safe and effective vaccines and therapeutics to counter the COVID-19 pandemic.[8] Massive, rapid production will require firms to share data not just about what to make but how to make it. To achieve this, an appropriate equilibrium has to be found between recognizing the rights of the originator and nudging the knowledge transfer necessary for the adequate scale-up and production of the vaccines. Public procurement policies and guaranteed order place-

7. Directive (EU) 2015/2366.
8. *Science Magazine*, August 21st 2020: 312-314.

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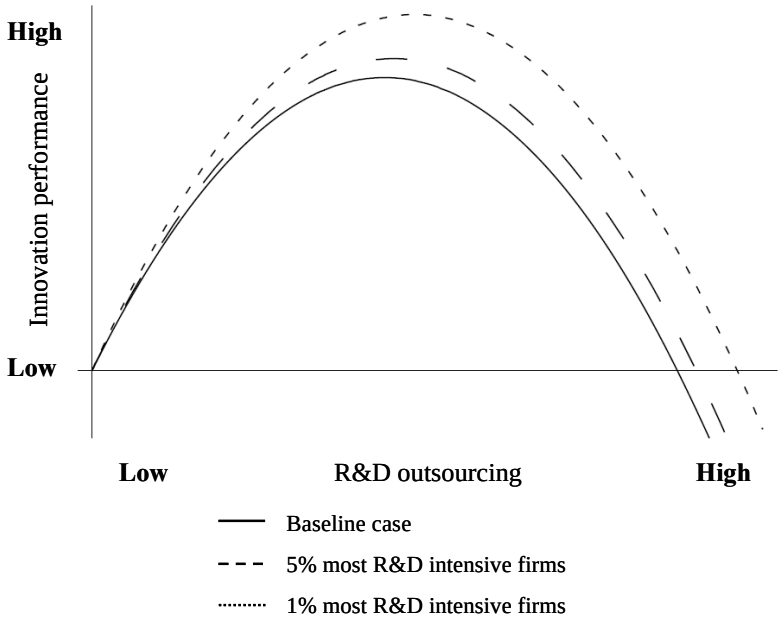
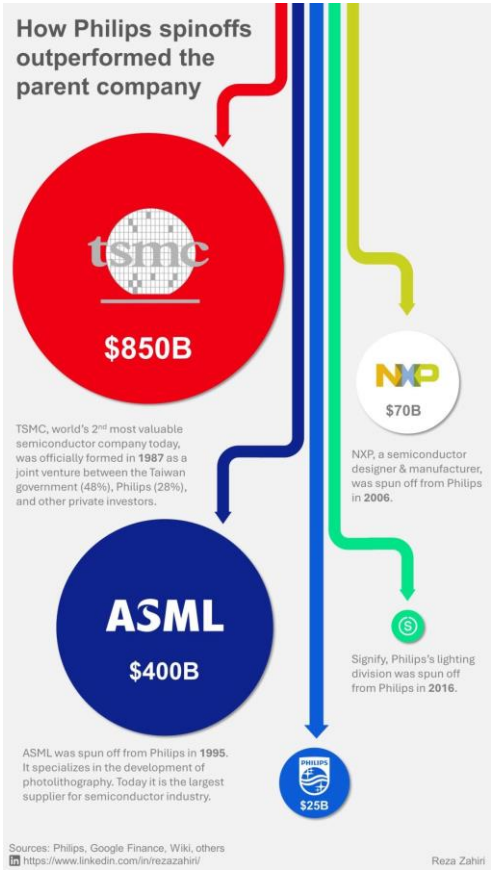
Source: Dahlander & Gann, Research Policy 2010

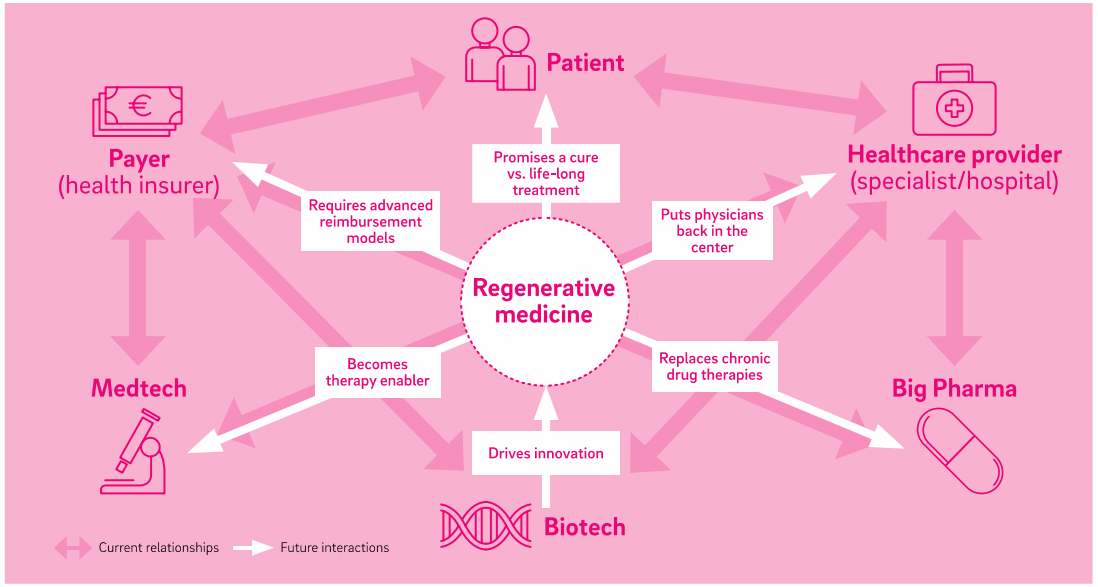
Leveraging Ecosystems

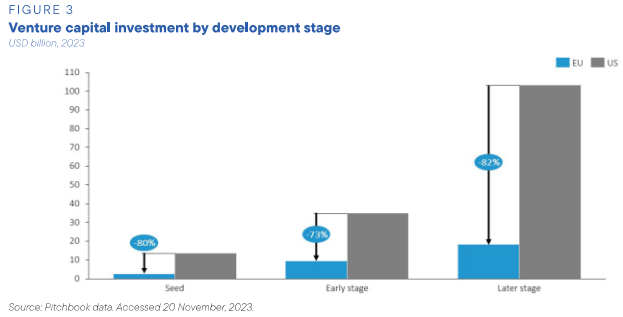
Figure 1: The effect of internal R&D on the relationship between R&D outsourcing and innovation performance



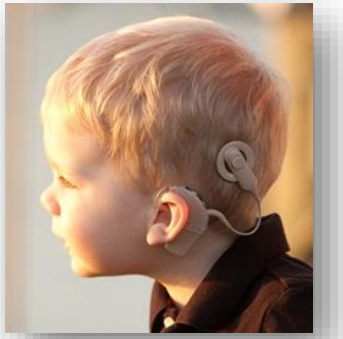
Source: Grimpe et al., JMS, 2010







Organizing for ecosystem innovation



effex

PUSH – PULL
PULL - PUSH

European Capital of Innovation

EUROPEAN CAPITAL OF INNOVATION AWARDS 2020

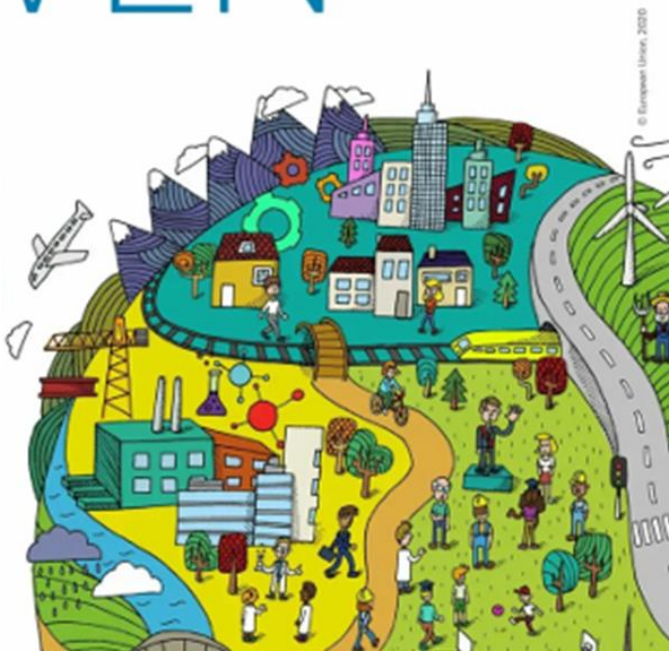
ec.europa.eu/icapital

#iCapitalAwards

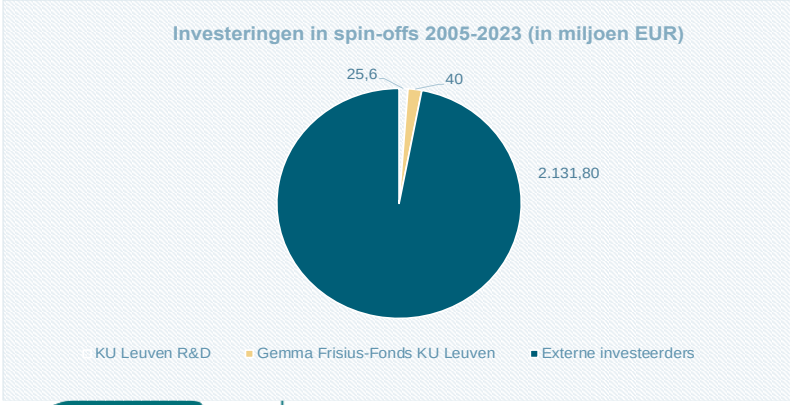
European Commission

WINNER

LEUVEN



Incubation & seed financing



Gemma Frisius Fund KU Leuven (GFF)

- Seed capital for spin-off companies
- GFF founded in 1997 & GFF II in 2002
  - At the end of 2009 GFF and GFF II merged into one single fund
- Partners:
  - KU Leuven (20% of capital)
  - KBC Bank (40%) and BNP Paribas Fortis Private Equity (40%)
- Combination of:
  - Knowledge and technology transfer expertise (university)
  - Financial expertise (financial partners)
- Not restricted to one technology domain

GEMMA FRISIUS FUND

27 years active

+1000 jobs

76 high-tech spin-off companies

3 partners

€ 50.5 M invested

+15 exits

Building a hightech ecosystem

- Partners

- ELAt:
  - Eindhoven/Brainport - Leuven - Aachen triangle
    - Cross-border and interregional network
    - Stimulation of knowledge economy

Building a hightech ecosystem

- Horizontal networks

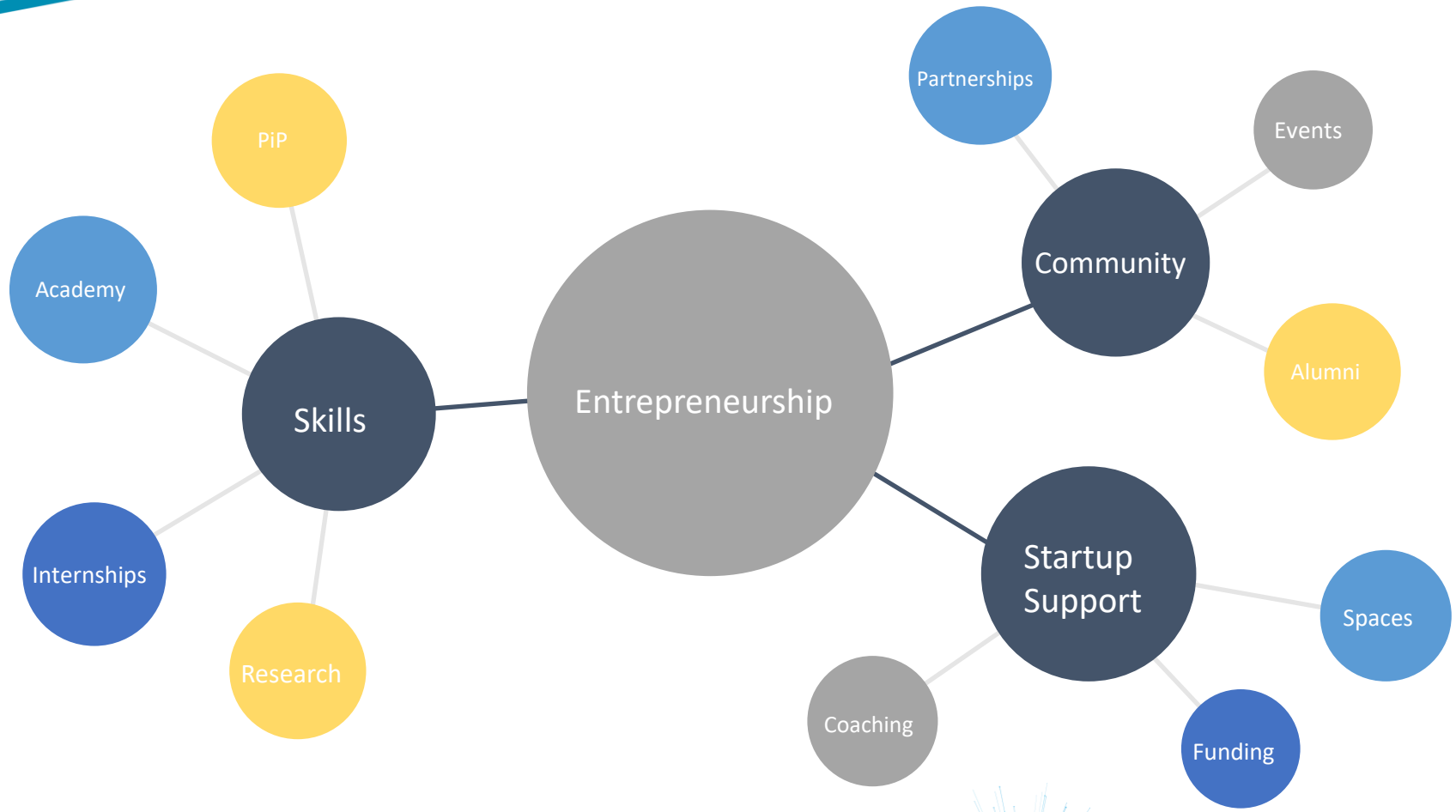
- Vertical networks: technology clusters

Ecosystem infrastructure

- Arenberg Science Park
- Haasrode Science Park
- Leuven Noord Science Park
- Leuven Bio-Incubator
- KU Leuven Innovation & Incubation Centre (I&I)

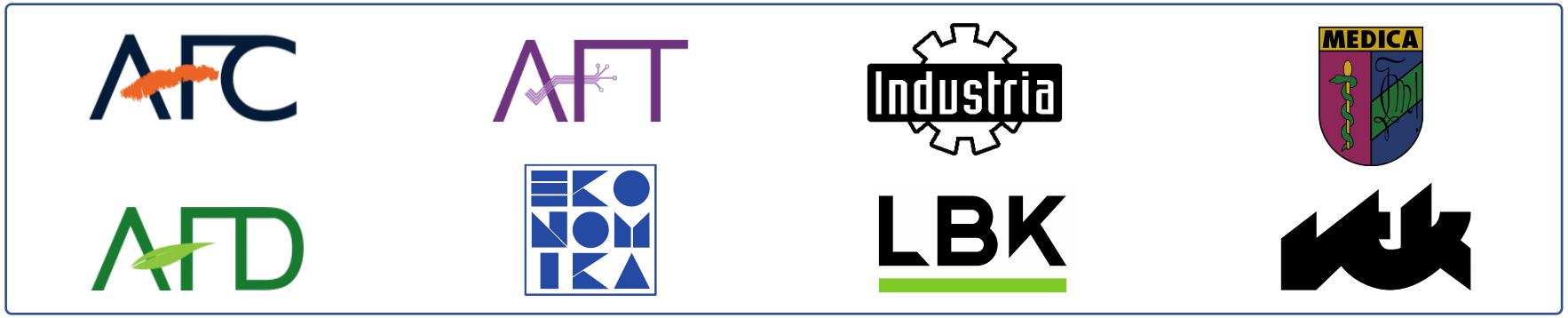
Talent, talent, talent
Students, students, students

Community for Innovation driven Entrepreneurship: student engagement



KICK

Community building



To conclude

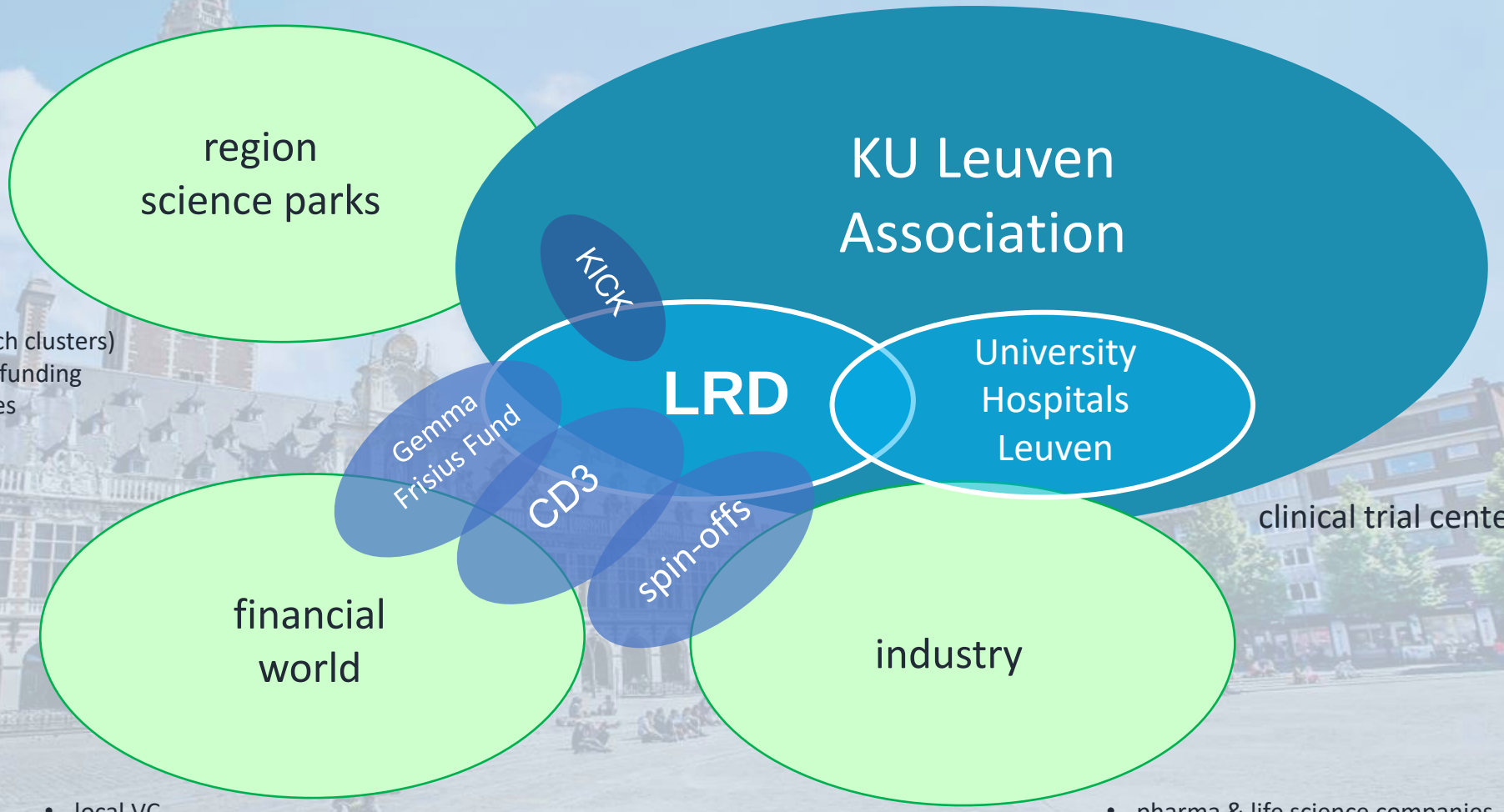
Mission

"Promoting and supporting knowledge and technology transfer between ecosystem actors, active ecosystem builders"

- Research collaboration
- Spin-offs and regional development
- IP protection and licenses

Growing a networked ecosystem incubator

- horizontal networks
- vertical networks (tech clusters)
- regional non dilutive funding
- cross border initiatives

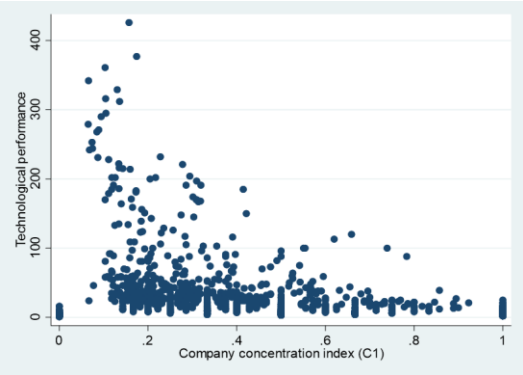


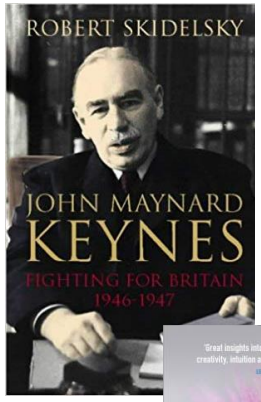
- local VC
- public private funds
- international VC
- corporate venture funds

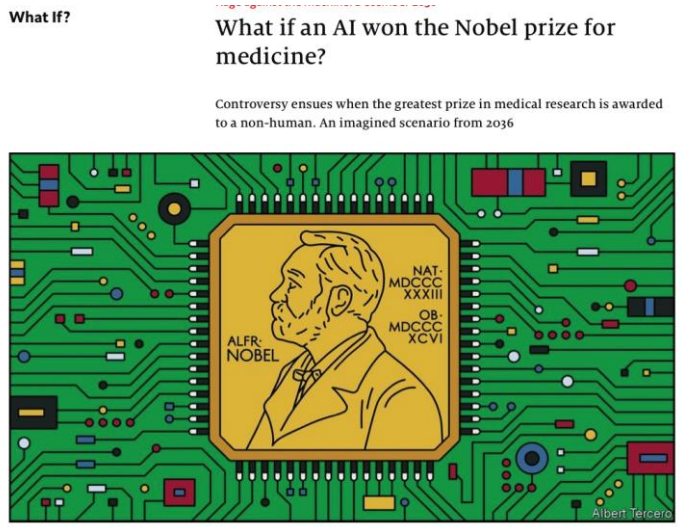
- pharma & life science companies
- software & digital companies
- design & engineering
- CRO, CMO, …

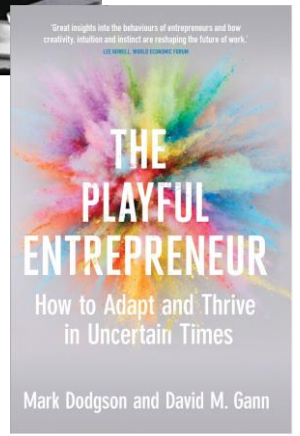
And, remember, *le temps n'accepte pas ce qui se fait sans lui* – patience, persistence, performance - 3 P's of technology transfer

1945 Max Delbrück, Cold Spring Harbor	1953 James Watson, Francis Crick, Rosalind Franklin	1973 Paul Berg, Herbert Boyer, Stanley Cohen	2012 Jennifer Doudna, Emmanuelle Charpentier	2019 David Liu (et al., Nature)
The quest for physical laws unique to biology, "complementarity"	The discovery of the double helix structure of DNA	Invention of and patent on recombinant DNA technology	CRISPR CAS invention(s)	Prime editing invention









THANK YOU

KU LEUVEN RESEARCH & DEVELOPMENT

50 years of creating impact

GEMMA FRISIUS FUND

25 years of supporting high-tech entrepreneurship