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Making Sense of Economic Ecosystems

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Executive summary

Like biological ecosystems, economic ecosystems are fundamentally about competition and cooperation. Companies engage in different ecosystems to achieve more than they could on their own. For the economy, these ecosystems are a valuable way to boost productivity growth.

To better understand how economic ecosystems could increase productivity, we zoom into the four types – **entrepreneurial, knowledge, innovation** and **business ecosystems** – to show the value of each.

Table 1 Summary of the four economic ecosystems

Economic ecosystem type	Goal	Type of output	Examples
Entrepreneurial	Fostering entrepreneurship in a certain region	New start-ups, scale-ups, conditions to support entrepreneurship	Silicon Valley; Greater Copenhagen region; Greater Amsterdam
Knowledge	Generating new knowledge with universities and other institutions as key partners	Patents, new discoveries	Fraunhofer Society in Germany; Food Valley; knowledge ecosystem of Amsterdam
Innovation	Creating new products and improving processes	New and better products and processes, making knowledge tangible	Silicon Valley tech and software innovation ecosystem; Brainport Eindhoven; innovation ecosystem in Amsterdam
Business	Creating, delivering and capturing value	Increased revenue, growth	Nvidia's CUDA GPU computing ecosystem; ASML's ecosystem; financial services ecosystem in Amsterdam

For example, entrepreneurial ecosystems provide the necessary conditions for entrepreneurship to thrive. We found that regions with more developed entrepreneurial ecosystems, such as Greater Amsterdam and Southeast North Brabant, also have higher labour productivity than other regions.

Knowledge ecosystems have universities, research institutes and innovators playing a central role in these ecosystems. These ecosystems are built to generate new knowledge.

Ecosystems that fit in between knowledge and value are innovation ecosystems: they integrate the exploration of new knowledge and its exploitation for value co-creation to develop new products and improve processes. The importance of such innovation ecosystems cannot be overstated: between 1996 and 2022, the Netherlands has experienced a strong increase in the absolute number of collaborative innovators amongst companies.

Finally, there are a multitude of business ecosystems that are centred around the creation, deliver and capture of value. Such business ecosystems can be organised in several ways around a:

- Company: think of the ecosystem around Philips or ASML;
- Platform: such as Apple or Amazon;
- Technology: for example, quantum computing in Delft or Nvidia's CUDA GPU computing ecosystem;
- Geographical area: like chemical clusters in Emmen, Delfzijl and Heerenveen;
- Industry: think of the financial services ecosystem in Amsterdam;
- Entrepreneur: such as 'PayPal Mafia' or 'Skype Mafia';
- Or a specific goal: for example, to tackle externalities like pollution or supply chain security, to distribute fixed costs such as security or exporting costs, or to build common energy storage to tackle grid congestion.

We separate the economic ecosystems based on their primary goals. However, in practice, the different types of economic ecosystems frequently overlap and interact. Moreover, some ecosystems may evolve through different types, functioning as stages in their development. For example, knowledge ecosystems become innovation ecosystems, which turn into business ecosystems, as entrepreneurship supports the path from knowledge to products and processes to value.

We give four lessons for policymakers to consider when it comes to economic ecosystems (see page 32 for the complete set of lessons):

1) **Foster cross-ecosystem collaboration.** Albeit each type of ecosystem has different goals and characteristics, they are not isolated from each other. In contrast, the different types of ecosystems are interdependent and flourish by collaborating, which drives productivity growth. To enable cross-ecosystem collaboration, competition authorities must strike a balance between cooperation and competition.
2) **Invest in regional ecosystem development.** Most ecosystems are as unique as their location. It is vital that ecosystem policies are tailored to the specific strengths and needs of regions, recognising that productivity is spatially dependent on competitive advantages and the availability of the right economic activities in proximity to each other. By investing in critical local infrastructure, talent development, and support networks, regions can create environments where businesses and entrepreneurs thrive, leading to more efficient, dynamic and innovative economic activity.
3) **Support ecosystem anchors and connectors.** Anchor organisations, such as universities, and large and innovative companies, and connectors, think of incubators, accelerators and public-private partnerships, coordinate efforts, reduce transaction costs and amplify the impact of individual participants within ecosystems, leading to economies of scale and scope. These types of organisations play a critical in ecosystem development and functioning. Policymakers should strengthen the role of anchor institutions and enablers that foster innovative collaboration by giving more opportunities for different parties to interact with each other, participate in common projects and share access to resources.

4) **Remake existing and develop new ecosystems to be future-proof.** To be future-proof, ecosystems must efficiently use scarce resources in production. Policymakers should thus incentivise companies to internalise the costs to society caused by externalities, such as pollution or high water use. Ecosystems and their participants, heavily reliant on scarce resources, should consider restructuring their business models.

When it comes to businesses, they should consider the following on economic ecosystems (see page 33 for the complete set of lessons):

1) **Define an economic ecosystem strategy and decide on your desirable level of involvement.** This provides a guiding framework for engagement in ecosystems and helps prioritise resources. It also calls for an agile operating model, with a culture of trust, collaboration and experimentation both internally and externally.
2) **Forge partnerships and consult policymakers.** Businesses should leverage ecosystems to build and enhance partnerships, moving beyond transactional relationships to strategic collaborations with suppliers, customers, research institutions, government agencies, and competitors. Policymakers can highlight priority areas and those with potential benefits from ecosystem development.
3) **In business ecosystems, companies should explore new business models and learn from others.** Analysing potential partners and engaging with various industries and ecosystems can uncover growth opportunities and broaden horizons. Additionally, when considering business model reinvention, ecosystems and their participants should restructure their operations to future-proof activities.

Introduction

Productivity growth is the main driver of prosperity in the longer term. Since the Second World War in developed economies, like the Netherlands, about 80% of growth in gross domestic product (GDP) per capita, a proxy measure for prosperity, has come from productivity growth.[1]

Historically, productivity growth has been a reliable way to increase prosperity, but two trends are challenging that: lagging productivity growth in recent decades, and national and international challenges to raising productivity growth. First, while in the past productivity has grown by about 1-2% per year, since 2005, it has only grown by an average of 0.3% in the Netherlands.[2] That is a dramatic slowdown, and there is not a full understanding of the root causes yet.[3] In addition, the recent escalation of the global trade war will likely harm productivity growth, as international trade is an important driver of labour productivity.[4] Moreover, we know that productivity is under pressure also because policy uncertainty is negatively impacting private Research & Development (R&D) as well as the broader business climate in the Netherlands.

Lagging labour productivity growth hampers structural economic capacity, already constrained by labour shortages, overburdened electrical grids and limited space. Yet, we need economic growth to tackle several challenges. These include rising healthcare costs from an ageing population, increased defence spending due to geopolitical challenges, and higher climate mitigation and adaptation costs. Solutions to these problems will require higher productivity growth.

There are three levels to look at productivity growth – the **micro**, **meso** and **macro**.[5] We have already touched upon the **micro** level, writing about how productivity growth can be achieved by **better management practices**, **reducing absenteeism** and **changing business models** in companies. We also looked at the **macro** level to see **what explains the differences in labour productivity growth** between the Netherlands, other European Union (EU) countries, the United Kingdom (UK) and the United States (US). In addition, we have also written at the **meso** level, looking at boosting productivity growth in the **transportation**, **construction** and **public sectors**, as well as comparing productivity at the **meso** level between **Dutch regions** and **industries**.

In this publication we focus on yet another part of the **meso** level, where companies are linked with other companies, knowledge institutions and governmental bodies in symbiotic relationships, forming economic ecosystems.

Economic ecosystems: from biology to economics

We start by showing how the ecosystem concept evolved from biology to economics, and that, like biological ecosystems, economic ecosystems are fundamentally about competition and cooperation.

Three sets of factors define biological and economic ecosystems

A biological ecosystem is an area, bounded by geography, that combines organisms, such as plants, animals and microbes, and non-living factors, such as temperature, humidity and terrain, in a connected system, where every part depends on every other part, either directly or indirectly. For example, an initial change in the temperature affects what plants can grow there, which subsequently impacts the animals that depend on plants for food and shelter. Hence, a biological ecosystem can be characterised by three sets of factors:

- **Boundary area** sets the geographical borders of the ecosystem,
- **Organisms** are the inhabitants of the ecosystem,
- **Conditions** characterise the functioning of the ecosystem and its elements.

Similarly, this ecosystem analogy can be used to describe the economic world. First, geographic area sets the boundaries of the economic ecosystem. Second, a firm is connected to government bodies, associations, knowledge institutions and other types of 'economic organisms'. Third, a set of conditions, such as those that define the business climate, regulate how an economic ecosystem and its elements function.[7]

Table 2 Three sets of factors that define biological and economic ecosystems

Factor	Biological ecosystem	Economic ecosystem
Boundary area	Lake, forest, desert	Cluster, region, platform
Organisms	Plants, animals, microbes	Knowledge institutions, firms, government bodies
Conditions	Temperature, humidity, terrain	Laws and regulations, culture, infrastructure

Source: PwC analysis, based on Clark et al. (2018).

Productivity as the life-sustaining mechanism in economic ecosystems

The goal of biological ecosystems is to create and maintain a healthy, functioning ecosystem that can continue to support life. This involves maintaining a balance between different species, ensuring sufficient resources and adapting to changing conditions.

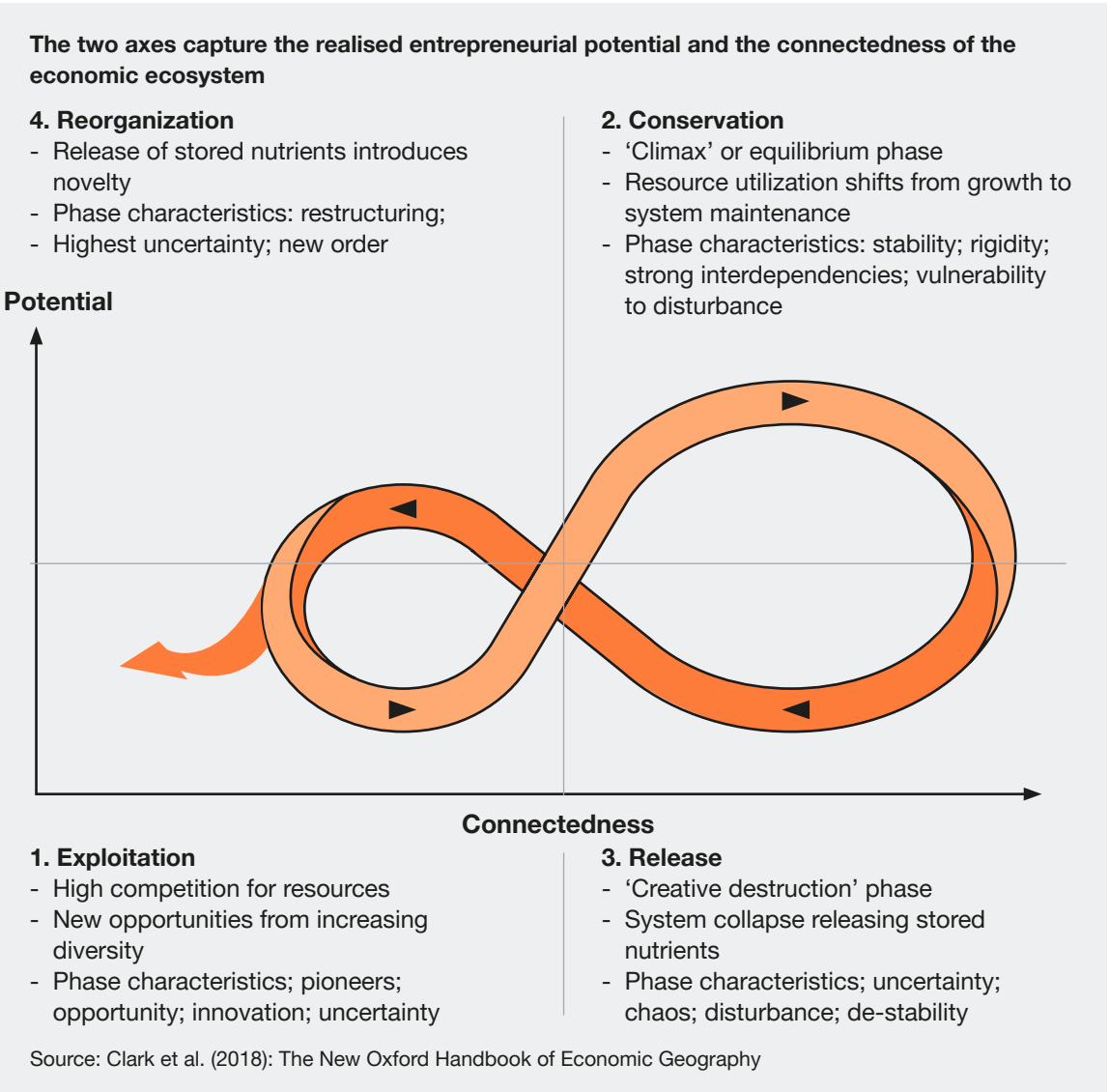
In economic ecosystems, productivity is what supports economic life. Productivity is about turning resources into various outcomes for organisations, people and places – the different organisms in ecosystems.[8] Productivity can be sustained by having the right participants in an ecosystem, conditions and resources that support productivity, as well as mechanisms to adapt to change in a positive way. A thriving and productive economic ecosystem which uses resources efficiently and effectively, leads to organisations being more successful at what they

do, people becoming more prosperous and having a higher well-being, and places becoming more attractive to live and work in. This in turn creates economic growth.[9]

Economic ecosystems evolve in four phases

Clark et al. (2018) found that biological ecosystems evolve through four phases – **exploitation, conservation, release** and **reorganisation** – that have direct parallels to economic ecosystems (Figure 1).

Figure 1 Four phases of economic ecosystem evolution



Source: Clark et al. (2018): The New Oxford Handbook of Economic Geography

First is the **exploitation phase**. In biology, organisms settle into a territory, compete for resources and form complex interdependencies. In the economic world, ecosystems start from an opportunity and entrepreneurial drive. This is the seed for economic growth. Either new organisations are formed, or existing ones enter the space, bringing fresh ideas and technologies that challenge incumbents and push productivity boundaries. With more entrants, a diverse set of participants and ideas cluster together, leading to knowledge spillovers, learning and innovation.[10]

Second is the **conservation phase**, where the system stabilises after a long period of growth and reorder. In economics, firms consolidate and establish system-level standards, boosting efficiency. Strong cross-level synergies such as spin-offs, mergers and acquisitions develop, creating economies of scale and scope that enhance productivity through better coordination and resource use. In addition, participants become more specialised, and develop skills and expertise that lead to higher productivity. Hence, the structure of the ecosystem becomes denser, more connected and self-reinforcing, reaching a plateau. Economic growth slows down. With that, the ecosystem also becomes more rigid and vulnerable to unanticipated external shocks.[11]

Third comes the **release phase**. Like a fire in a forest, a shock, for example, a regulatory change or a technological breakthrough, can break the existing structure, releasing abundant energy into the environment. The system goes from stability to chaos. This is when 'creative destruction' happens, enabling a new wave of productivity growth: inefficient participants are eliminated and those remaining are pushed to adapt. Resources are reallocated from declining areas to more productive and innovative ones.[12]

Fourth and finally, the **reorganisation phase** takes place. Entrepreneurs once again seek opportunities amidst the disturbances and start to establish a new order in the system. Learning from previous cycles, entrepreneurs experiment with novel means of operation and structures. Talent is again attracted to the new opportunities. After the reorganisation phase has taken place, the cycle of entrepreneurship, ecosystem formation, innovation and economic succession repeats.[13]

Four types of economic ecosystems – entrepreneurial, knowledge, innovation and business – with distinct goals

Before analysing economic ecosystems, it is important to define the different types. Valkokari (2015) notes that the economic ecosystem metaphor is often used without a clear definition to describe overlapping concepts, such as industrial, business, service, innovation and knowledge ecosystems.

Each ecosystem type has a distinct goal

Economic ecosystems form organically around goals. For the economy, they are a valuable way to boost productivity growth and drive economic development. Participants engage in different ecosystems to achieve more than they could on their own, whether it comes to creating more knowledge, innovation or value.

Hence, following Scaringella & Radziwon (2018), we distinguish between four types of economic ecosystems – entrepreneurial, knowledge, innovation and business – based on their **primary goals**:[14]

- For **entrepreneurial ecosystems**, the goal is **fostering entrepreneurship in a region**;
- For **knowledge ecosystems**, **generating new knowledge**;
- For **innovation ecosystems**, **making knowledge tangible** through product and process innovation;
- For **business ecosystems**, **to create, deliver and capture value**, enabling ecosystem participants to achieve more collectively than they could separately.

For other ways to look at economic ecosystems, see Appendix on page 35.

Summary of the four economic ecosystems

To understand ecosystems, their participants and their evolution, it is crucial to distinguish between different types. Each type of ecosystem has different goals and outputs. In Table 3, we summarise the four economic ecosystems.

Table 3 Summary of the four economic ecosystems

Economic ecosystem type	Goal	Type of output	Examples
Entrepreneurial	Fostering entrepreneurship in a certain region	New start-ups, scale-ups, conditions to support entrepreneurship	Silicon Valley; Greater Copenhagen region; Greater Amsterdam
Knowledge	Generating new knowledge with universities and other institutions as key partners	Patents, new discoveries	Fraunhofer Society in Germany; Food Valley; knowledge ecosystem of Amsterdam
Innovation	Creating new products and improving processes	New and better products and processes, making knowledge tangible	Silicon Valley tech and software innovation ecosystem; Brainport Eindhoven; innovation ecosystem in Amsterdam
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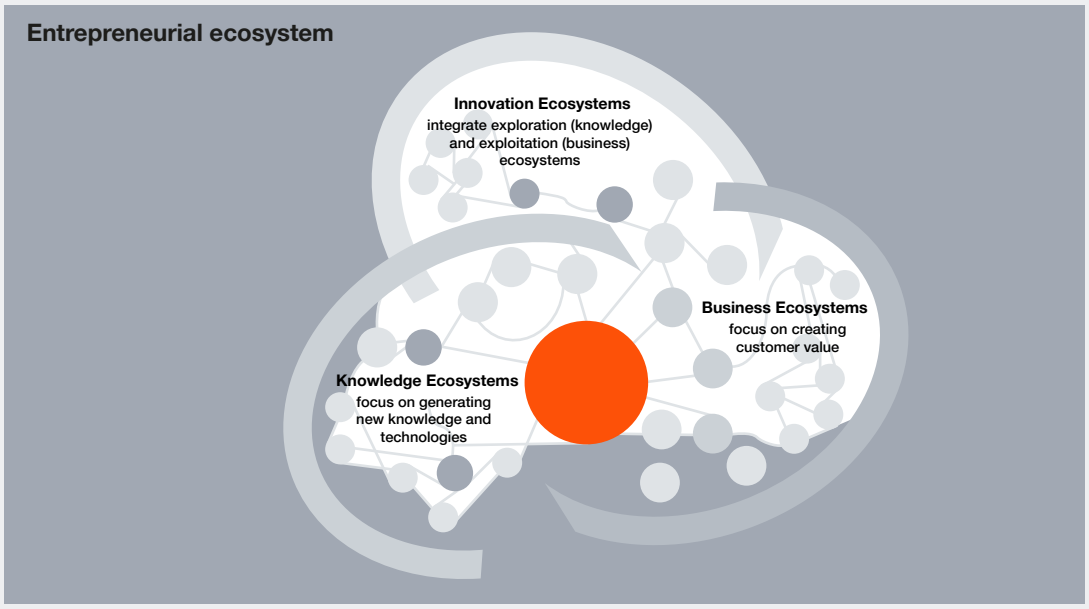
Source: PwC analysis, based on Scaringella & Radziwon (2018) and Valkokari (2015).

In Appendix on page 36, based on Scaringella & Radziwon (2018), we provide a more detailed overview of the different characteristics that define each type of ecosystem.

Although separate in theory, in practice ecosystem participants and ecosystems can overlap

In practice, separating economic ecosystems into different types can be challenging due to the complexity of defining precise objectives and the potential for these goals to overlap. Additionally, participants can play different roles in overlapping ecosystems (Figure 2).[15]

Figure 2 Relationships between the four types of overlapping ecosystems



Source: Valkokari (2015).

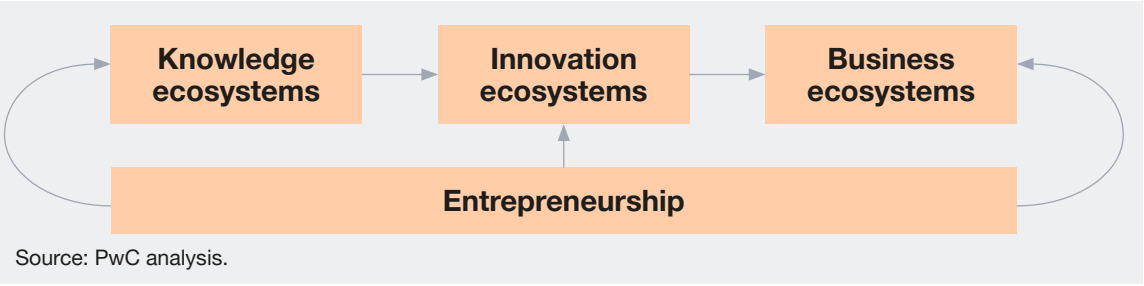
For example, ASML plays a role as a focal company in its supply chain, while it also fosters open innovation in the Brainport Eindhoven region.[16] In many cases, such companies that play important roles in different ecosystems drive the emergence, interaction and evolution of economic ecosystems.

Additionally, the ecosystems can overlap and have multiple goals. For example, the Brainport Eindhoven region in the Netherlands simultaneously embodies a knowledge ecosystem (there is a strong high tech knowledge ecosystem around Eindhoven University of Technology), a business ecosystem (supply chain around ASML and Philips) and an innovation ecosystem (open R&D collaboration at the High Tech Campus).

Entrepreneurship supports the path from knowledge to products and processes to value

Some ecosystems can also evolve from one type to another (Figure 3).

Figure 3 Entrepreneurship supports the path from knowledge to products to value



Source: PwC analysis.

For example, knowledge ecosystems initiate processes in less established technological and commercial fields. They are crucial for the latest technology and scientific advancements. Innovation turns knowledge into viable products or processes. Business ecosystems then create and capture value from these innovations. Entrepreneurship drives this transition from knowledge to products to value, supported by entrepreneurial ecosystems which integrate various knowledge, innovation and business ecosystems.

In the next sections, we take a deep dive into. We illustrate each type of ecosystem through the lens of Greater Amsterdam, as it is a region with the highest level of labour productivity and the most favourable conditions for labour productivity growth.[17] We also look at other Dutch and international examples.

Entrepreneurial ecosystems: to foster entrepreneurship in a region

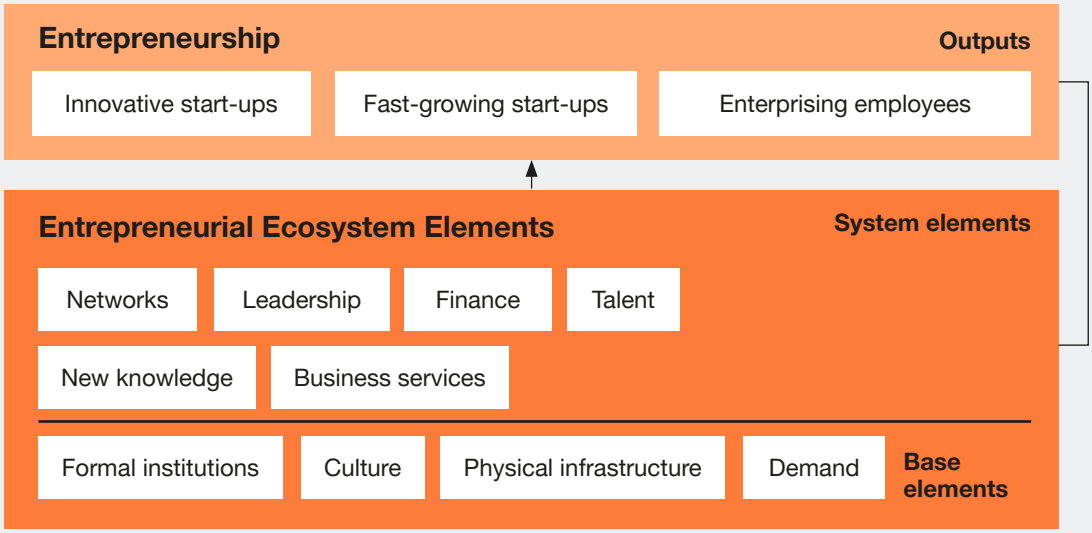
Definition

Entrepreneurial ecosystems comprise a set of interdependent participants and factors that are coordinated to enable productive entrepreneurship within a particular territory.[18]

Ten elements are necessary for successful entrepreneurial ecosystems

Successful entrepreneurial ecosystems consist of ten elements that can be split into two layers – base elements and system elements – which are all necessary to achieve the goal of productive entrepreneurship in the form of innovative and fast-growing start-ups, as well as enterprising employees (Figure 4).[19]

Figure 4 Overview of the ten necessary elements for an effective entrepreneurial ecosystem



Source: Birch (2024): Entrepreneurial Ecosystem Index 2024.

The first layer of base elements consists of:

- **Formal institutions:** these are 'the rules of the game in society' that define the quality and efficiency of formal institutions. They determine, for example, the level of perceived corruption and how entrepreneurship-friendly the legal and regulatory framework is.
- **Culture:** it reflects the degree to which entrepreneurship is valued in society, and it is important to incentivise entrepreneurial activity.
- **Physical infrastructure:** a highly developed physical infrastructure is a key element to enable connectivity and accessibility to enable economic interactions and entrepreneurship.
- **Demand:** market demand of informed consumers for the products and services offered by entrepreneurs is needed to sustain entrepreneurship in the long term.

The second layer is made up of these **system elements**:

- **Networks:** entrepreneur and business networks allow for an effective flow of information, knowledge, labour and capital.
- **Leadership:** provides guidance for and direction of collective action.
- **Finance:** the supply and accessibility of finance for new and small firms is an important condition for their growth and survival.
- **Talent:** the presence of a diverse and skilled group of workers is perhaps the most important element of an effective entrepreneurial ecosystem.
- **New knowledge:** investments in new knowledge are an important source of entrepreneurial opportunities, and if they lead to better solutions, they are also a source of prosperity.
- **Business services:** The supply and accessibility of intermediary services can substantially lower entry barriers for new projects and reduce the time to market of innovations.

These ten entrepreneurial ecosystem elements are interdependent and evolving. They explain the entrepreneurship levels in a region.[20] When aligned, the ecosystem generates economic and societal value.[21] A strong entrepreneurial ecosystem feeds itself, and productive entrepreneurship can also feed back into the individual elements. In other words, a well-functioning ecosystem ensures prosperity and fosters its own development.

Additionally, as entrepreneurial ecosystems support other economic ecosystems (Figure 3), these are the necessary elements that are also required to foster the development of knowledge, innovation and business ecosystems.

The role of large companies in entrepreneurial ecosystems

Entrepreneurial ecosystems often build upon existing industry clusters or location-specific assets. They frequently evolve around large companies that provide infrastructure, act as first customers or strategic partners, offer mentorship and corporate venture capital or spin-off start-ups via corporate entrepreneurship. This can especially be the case in regions with a strong corporate sector, like Munich in Germany.[22] Furthermore, the bankruptcy or shrinkage of large corporate incumbents has been the catalyst for developing entrepreneurial ecosystems in places like Israel, India, Colorado in the US and Denmark.[23]

There are also ecosystems, like grassroots or digitally native ecosystems, where start-ups emerge and thrive without the presence of large anchor firms. In those ecosystems, universities, coworking spaces and accelerators often play a more prominent role. Furthermore, peer networks, angel investors and local governments may fill the support gap.

Historical perspective and examples

The attempts to create entrepreneurial ecosystems in many places have become more prevalent with the success of Silicon Valley. However, the specific case of Silicon Valley, albeit being used as 'the shining example on the hill', is more tied to the outcomes of specific events, such as the founding of Stanford University with an explicitly industrial orientation, historical trends (the US government shifting defence research away from the East Coast in the 1930s and 1940s and the emergence of the venture capital industry in the 1950s and 1960s), and the existence of a long-lasting culture that encourages risk-taking, rebellion and innovation, instead of a replicable recipe to follow.[24]

Since the development of Silicon Valley, there are many other examples of successful entrepreneurial ecosystems worldwide. Notable ones are the entrepreneurial revitalisation of Waterloo, Ontario, in Canada; regional industrial cluster formation in Washington, D.C., and the innovation economy in Colardo, the US; and the role of entrepreneurial culture in Kyoto, Japan.[25]

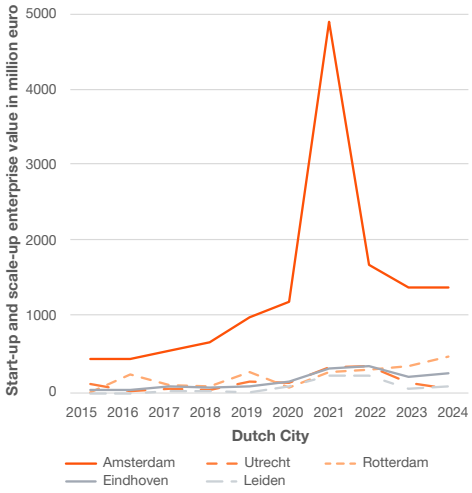
In the European context, the leading entrepreneurial ecosystems in 2022 were the capital region of Denmark, London, Helsinki and Stockholm.[26] In the Netherlands, according to the Entrepreneurial Ecosystem Index 2024, the most developed entrepreneurial ecosystems are Delft and Westland, the Greater Amsterdam and Southeast North Brabant regions.[27]

Entrepreneurial ecosystem of Amsterdam

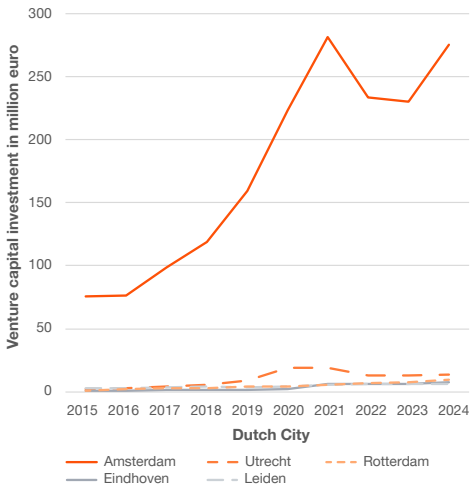
Greater Amsterdam is the leading entrepreneurial ecosystem in the Netherlands. Figure 5 shows the venture capital investment and Figure 6 shows the start- and scale-up enterprise value of major Dutch cities.[28]

Figures 5 and 6 Amsterdam's entrepreneurial ecosystem dominates in economic size and financial attractiveness

Start-up and scale-up enterprise value per Dutch city



Venture capital investment per Dutch city



Source: Dealroom.

Amsterdam is a vital start-up ecosystem also from a European perspective, hosting 7% of all EU-founded unicorns.[29]

Amsterdam thrives as an entrepreneurial ecosystem due to its specialised knowledge- and technology-intensive sectors. The region excels in ICT, creative industry, fintech, and life sciences, with Greater Amsterdam employing around 20% of the Netherlands' knowledge-intensive jobs. Strong knowledge institutions like Universiteit van Amsterdam (UvA, ranked 55th in the QS World University Rankings 2025), Vrije Universiteit Amsterdam (VU, ranked 221st in the QS World University Rankings 2025) and Hogeschool van Amsterdam (HvA) supply skilled talent and research, supported by a robust network of incubators like Think Amsterdam Science Park, Startup Village, and B. Amsterdam.

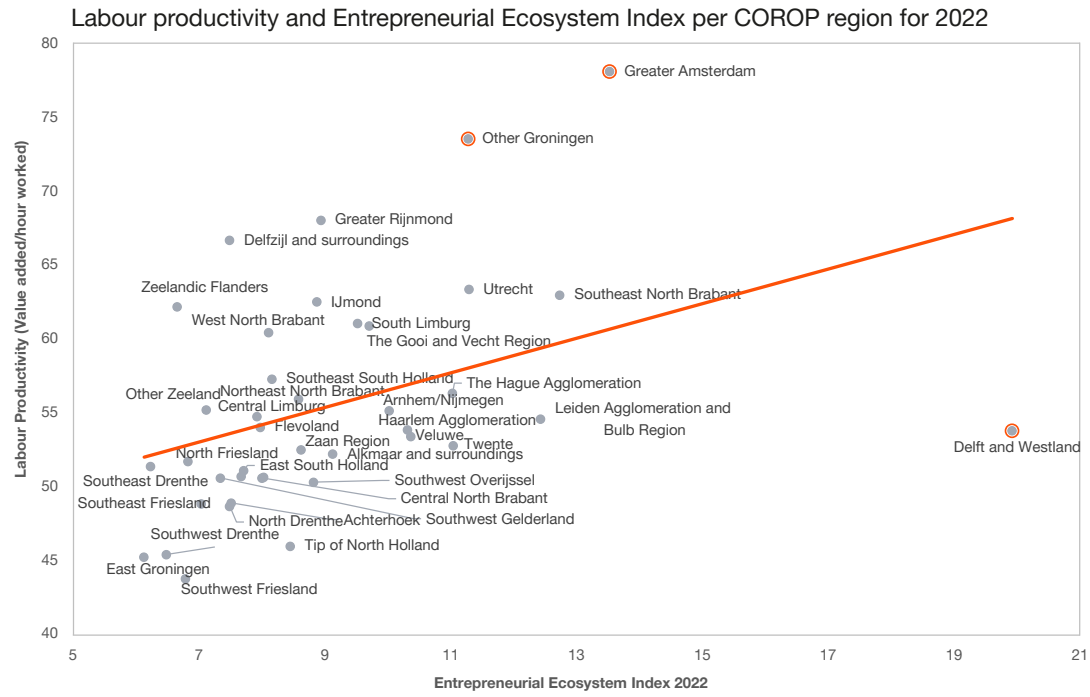
The companies in the Greater Amsterdam region excel in adopting and commercialising technology. This accelerates productivity growth and strengthens the region's earning power. This is achieved through a triple-helix model in which the local government, knowledge institutions and companies work together on innovation policy. As a global financial hub, Amsterdam supplies a growing amount of venture capital, business angels and funds.

The Amsterdam region has great appeal and attracts international talent, start-ups and investors, in part thanks to its international English-language education, an open culture and good infrastructure. Amsterdam's cultural diversity stimulates creative entrepreneurship and innovation. These factors lead to large agglomeration effects and enable the region to attract and absorb innovation that has been generated elsewhere, promoting its labour productivity.[30]

Dutch regions with more developed entrepreneurial ecosystems tend to have higher labour productivity

Recently, we looked at **Dutch Regional Productivity**. In Figure 7, we test how regional productivity aligns with the Entrepreneurial Ecosystem Index for the Netherlands.[31] We use the year 2022 to match both the latest available regional labour productivity data with the respective Entrepreneurial Ecosystem Index.

Figure 7 Dutch regions with more developed entrepreneurial ecosystems tend to have higher labour productivity



Source: Entrepreneurial Ecosystem Observatory Dashboard, PwC analysis.

It clearly shows that more developed entrepreneurial ecosystems tend to have higher labour productivity, see for example Southeast North Brabant and Greater Amsterdam.[32] The two main channels of how entrepreneurial ecosystem development boosts productivity are increased business formation rates and the development of more innovative entrepreneurship and new technologies, among other channels.[33]

Figure 7 includes a few outliers, such as Delft and Westland, Greater Amsterdam and Other Groningen regions. Each of these areas has underlying drivers that could explain their divergence from the rest.

In the Other Groningen region – now phased-out – capital-intensive gas industry strongly elevated its labour productivity. While there is an entrepreneurial ecosystem in the city of Groningen, it is less developed than its elevated labour productivity indicates.

Greater Amsterdam is the economic heart of the Netherlands, having the highest labour productivity score of all regions. In absolute size, Greater Amsterdam hosts the largest and strongest entrepreneurial ecosystem in the Netherlands.[34] Greater Amsterdam benefits from a strong inflow of innovation and human capital, thanks to its robust market demand and financing environment.

The disparity between Delft and Westland's Entrepreneurial Ecosystems Index and their labour productivity is evident in their economic composition. Delft, known for its future-oriented innovations, such as quantum computing and aerospace engineering, linked to Technical University Delft, contrasts with Westland's greenhouse horticulture-based economy. This imbalance may lead to a disproportionate allocation of resources to less productive sectors. The distinct ecosystems of Delft and Westland seldom reinforce each other, which may explain why their innovation excellence does not boost their entrepreneurial ecosystem.

The Delft and Westland region, which is part of the province South Holland located between The Hague and Rotterdam, has a higher score in the Entrepreneurial Ecosystem Index 2022.[35] Considering its economic size, Delft and Westland is a high-performing centre of innovation intensity and output. The Delft and Westland region scores exceptionally high in new knowledge creation, leadership and networks. However, it is less developed in finance, business services and market demand elements compared to more advanced economic areas such as Greater Amsterdam.[36]

This demonstrates that developing the elements in Figure 4 enhances the quality and success of entrepreneurial ecosystems. Regions should focus on future-proof sectors that use production resources efficiently to boost productivity and foster long-term economic growth through entrepreneurship.

Knowledge ecosystems: to generate knowledge

Definition

Knowledge ecosystems focus on the generation of new knowledge through joint research work, collaboration, or the development of a knowledge base.[37] Knowledge ecosystems can overlap with innovation ecosystems, only here the emphasis is more on (scientific) research and less on innovation in developing new products.

Properties

Universities, research institutes and innovators, such as technology entrepreneurs, play a central role in these ecosystems.[38] Large firms with established R&D departments, SMEs and start-ups can also be a part of knowledge ecosystems.

In the Netherlands, the Rathenau Institute distinguishes five different groups of public knowledge institutions in the knowledge infrastructure, based on their functions:[39]

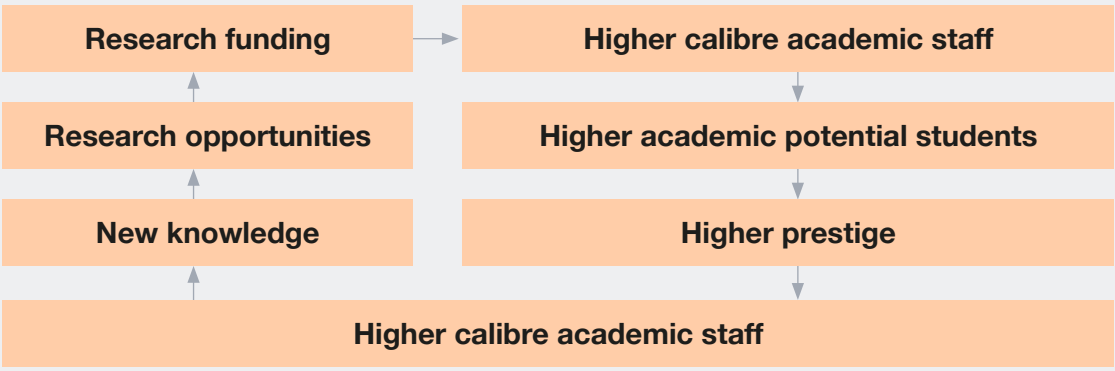
- **Policy-oriented organisations** focus chiefly on research in support of policymaking.
- **Government laboratories** support the national government by executing its knowledge-intensive responsibilities.
- **Applied research institutes** (**TO2 institutes**), support businesses, industry and government by conducting and/or facilitating research and innovation.
- **Sector-oriented foundations** combine research in support of policymaking with a focus on the knowledge requirements of professionals and their clients in the health care, sports, culture and security sectors.
- **Professional research and training organisations** combine research with training for aspiring and qualified professionals who work in the defence, law enforcement and diplomatic sectors.

Like innovation ecosystems, knowledge ecosystems do not have to be defined by geographical proximity, but, in many cases, they are because of agglomeration effects.[40] Agglomeration facilitates face-to-face interactions, which are essential for implicit knowledge exchange. Proximity allows for trust-building, informal communication and rapid feedback loops.

Universities as the focal point of knowledge ecosystems

The clustering of talent, knowledge and active collaboration are key properties of knowledge ecosystems.[41] This is one of the main reasons why many universities are at the centre of knowledge ecosystems. The self-reinforcing mechanism of how knowledge ecosystems originate around universities can be explained as follows (Figure 8).

Figure 8 Clustering feedback loop of knowledge, talent and collaboration around universities



Source: PwC analysis.

Universities obtain funding through research, scientific work and government grants aimed at developing expertise in specific fields. With increased funding and improved research opportunities, universities can attract highly qualified researchers. This enhances the universities' reputation and attracts talented students. Some of these students may become leading academics, gaining recognition that draws further research and funding opportunities. This cycle helps universities generate new knowledge and secure additional funding.

The clustering of the best students, advanced academic knowledge and scientific personnel attracts companies and others who want to link to the university's knowledge ecosystem. This is how a knowledge ecosystem grows and feeds itself.

Collaboration in knowledge ecosystems is essential for generating new knowledge. The system becomes self-reinforcing as new knowledge builds on existing information, leading to greater returns from collaboration. Network effects increase the value of the ecosystem as more participants join, attracting talent, funding and institutional support.

Historical perspective and examples

Most well-known knowledge ecosystems originate near universities. Good examples of this phenomenon are the Cambridge cluster, which is one of the world's most successful life sciences and technology clusters, centred around the University of Cambridge in the UK and the Greater Boston Area in the US that houses 44 knowledge institutions, including the Massachusetts Institute of Technology (MIT) and Harvard University.

There are also examples of knowledge ecosystems that are not as geographically concentrated. In the Netherlands, the Food Valley is a region where food companies, research institutes, and Wageningen University and Research Centre are active in food-related sciences and technological development. Because the cluster also involves vocational training institutions and companies, it ensures that the ideas from the knowledge institutions can be implemented. Similarly, the Fraunhofer Society in Germany is the biggest organisation for applied R&D in Europe. This is a publicly owned research organisation with 76 institutes spread throughout Germany and other countries, each focusing on different fields of applied science.

Knowledge ecosystems of Amsterdam

Amsterdam has eight knowledge quarters and campuses that combine elements of both knowledge and innovation ecosystems. Amsterdam is home to world-class universities, such as the UvA and VU. These universities, in addition to other knowledge institutions and universities of applied sciences, act as pillars of the knowledge ecosystems in Amsterdam, which are clustered in several parts of the city.

For example, Amsterdam Science Park is a cutting-edge scientific district driving research in artificial intelligence (AI), technology, sustainability and life sciences. Roeterseilandcampus places UvA's economics, business, social and behavioural sciences and law faculties. In Amsterdam's historic centre lies the University Quarter (Universiteitskwartier), home to the humanities faculty and the university library.

Furthermore, there are several important medical knowledge and research clusters. The Zuidas Innovation District (Kenniskwartier) is home to renowned life science and health organisations centred around Amsterdam UMC. In addition, the Life Sciences District is home to organisations focused on med-tech, e-health and gene therapy. The Health and Innovation District (Schinkelkwartier) is important for blood-related topics and life sciences institutions.[42]

Innovation ecosystems: to create products and improve processes

Definition

Innovation ecosystems integrate the exploration of new knowledge with its application for value co-creation. In contrast to business ecosystems that focus on value capture, innovation ecosystems emphasise value co-creation by linking various organisations. This way, innovation ecosystems combine different characteristics of business and knowledge ecosystems.

Properties

Intermediators, such as policymakers, innovation brokers and funders, play a crucial role in innovation ecosystems by connecting different economic entities.[43]
Innovation ecosystems consist of four main properties:

- **Interdependence:** innovation ecosystems focus on the exploration of new knowledge and its application for value co-creation and collaboration between different interdependent participants, such as companies and universities.
- **Heterogeneity:** participants in an innovation ecosystem are diverse entities that collaboratively develop various processes or products.[44]
- **Future-orientation:** as innovation ecosystems focus on value creation over value capture. They have a stronger future-orientation than business ecosystems.
- **Geographic proximity:** due to their collaborative nature, participants in innovation ecosystems are geographically clustered. However, the physical boundaries of ecosystems are increasingly difficult to define.[45]

Historical perspective and examples

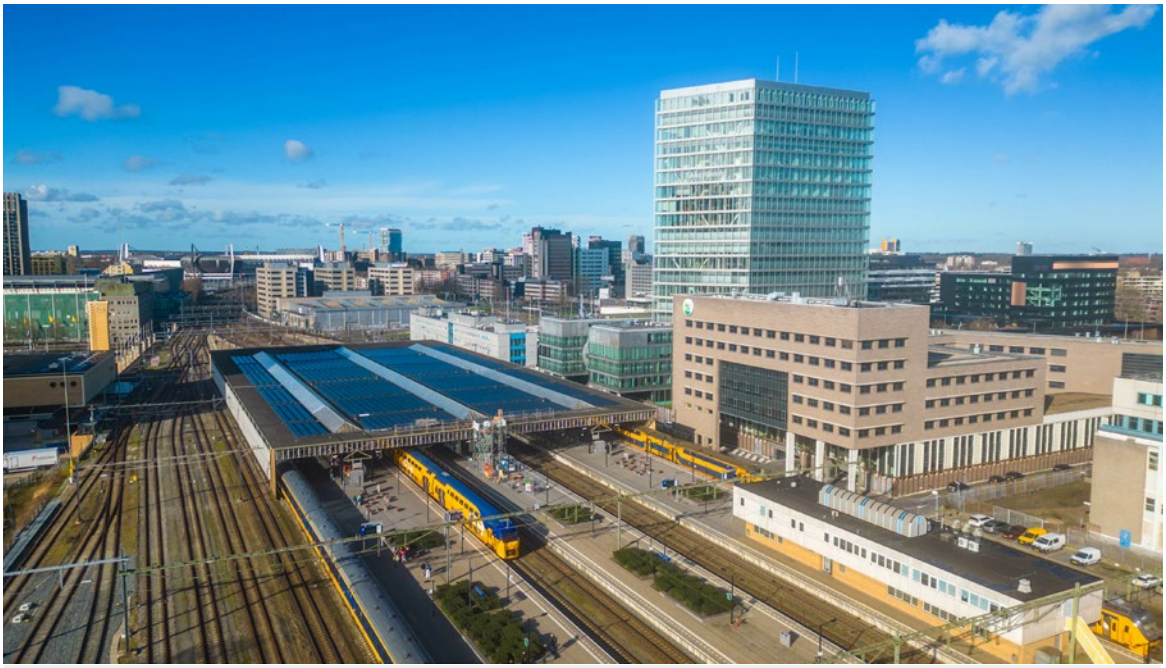
There are many examples of innovation ecosystems that have successfully created advanced products and processes globally. Prominent examples range from tech and software ecosystems in Silicon Valley, to consumer electronics in Seoul and to the semiconductor industry in the Netherlands.[46] The last is one of Europe's most successful examples of an innovation ecosystem located in Brainport Eindhoven.

Examples of innovation ecosystems

Clusters are geographical areas in which triple helix parties (government-knowledge institutions-education bodies) in certain sectors or technology domains collaborate intensively to foster innovation, exports, knowledge, start-up companies, and more. Examples of such in the Netherlands are Brainport Eindhoven and the creative sector in Amsterdam.

A **science or innovation park** is a defined area where researchers from institutions and companies collaborate on R&D and innovation, centred around a knowledge institution like a university or academic hospital. An example is the Utrecht Science Park.

An **innovation campus** is a business or former business campus where corporate anchor tenants perform R&D and where other companies also establish themselves and collaborate in research.



Innovation ecosystem of Brainport Eindhoven: a triple helix success story

Brainport Eindhoven's origins trace back 125 years when Philips and DAF laid the industrial foundation of the Eindhoven region. Historically a poor area, Southeast Brabant developed a culture of cooperation and mutual support. This spirit of collaboration became institutionalised in the 1990s when economic crises forced regional participants to unite, embracing the triple helix model of governments, companies and universities.

Companies like ASML thrived in this innovation ecosystem. The ecosystem combined Philips' R&D know-how, TU Eindhoven's academic expertise and a growing network of local suppliers. Government grants in the 1980s allowed ASML to endure high R&D costs, leading to the development of cutting-edge knowledge and skilled graduates from TU Eindhoven, which strengthened ASML's global competitiveness.[47]

The self-enforcing feedback loop of the innovation ecosystem created a 'win-win-win' situation for all triple-helix participants. Today, the success is exemplified by ASML's ongoing investment in TU Eindhoven and its commitment to creating local jobs. This continued willingness to invest in the future underscores the broader economic value of successful innovation-led companies.

A **facilities campus** is an innovation place where the magnet effect comes from specific research facilities or pilot plants and not from a 'knowledge carrier' such as a university or an academic medical centre. Companies can establish themselves near these facilities and use them independently or in collaboration with other companies. A Dutch example is the Pivot Park in Oss.

An **innovation district** is often an inner-city, easily accessible area with a mix of diverse businesses, knowledge institutions, work, residential, recreational and shopping facilities and amenities, which leads to an ecosystem of innovation that facilitates the generation of ideas and promotes their commercialisation. An example of this is the Strijp-S in Eindhoven.

Not all innovation ecosystems are tied to geography—examples include Sony and JVC's video recorders, mobile telecom standards like GSM, and the MIT Media Lab. One key driver in such ecosystems are industry standards, which, in contrast to regulations, are consensus-driven voluntary standardisation methods. Industry standards provide a shared foundation that enables diverse participants to collaborate effectively.[48] By ensuring interoperability and reducing uncertainty, industry standards accelerate the adoption of new technologies and attract investment.

Innovation ecosystems in Amsterdam: smart cities, clean tech, life sciences and health

Amsterdam was ranked as the most innovative small city in 2023 globally.[49] With a strong focus on ethical technology, Amsterdam is an important innovation ecosystem in smart city and clean tech, as well as life science and health fields. Amsterdam has eight knowledge quarters and campuses that combine elements of both knowledge and innovation ecosystems.

Amsterdam Science Park houses 176 companies, from start-ups to multinationals, that, in collaboration with educational and research institutions in the area, develop in the fields of digital innovation, AI, sustainability, life sciences, health and high-tech systems and materials.

The Marineterrein Living Lab is a community consisting of government bodies, businesses and knowledge institutions in Marineterrein. This environment facilitates interactions amongst entrepreneurs, scientists, creatives, makers, students and policymakers to develop solutions aimed at enhancing the city's liveability. Additionally, the Knowledge Mile is a district that focusses on developing innovations on urban-focused and sustainable development-related topics.

Amsterdam also has several innovation ecosystems focused on life sciences and healthcare (which also overlap with Amsterdam's knowledge ecosystems). The Zuidas Innovation District (**Kenniskwartier**) is home to renowned life science and health organisations centred around Amsterdam UMC. In addition, the Life Sciences District is home to organisations focused on med-tech, e-health and gene therapy. The Health and Innovation District (**Schinkelkwartier**) is important for blood-related topics and life sciences institutions.

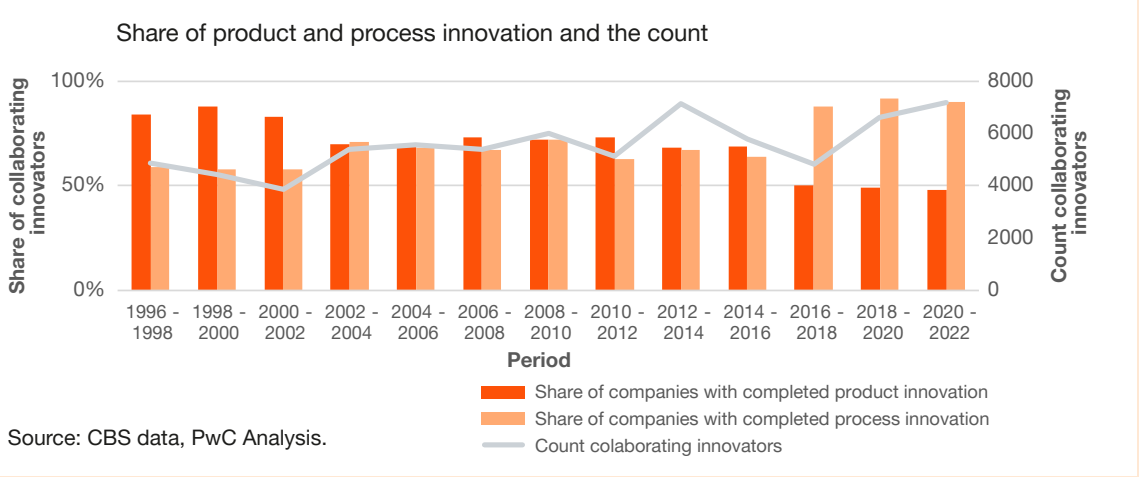
Dutch companies increasingly collaborate to innovate

As explained previously, innovation ecosystems foster collaboration between various heterogeneous entities. In the following, we illustrate how innovation collaboration is characterised and how it is developing in the Netherlands. Innovation collaborations are often opaque or undisclosed and therefore not easily quantified. To gain a more detailed understanding, we first define two types of innovation.

There are two main innovation types: **process** and **product innovation**.[50] **Product innovation** refers to the creation of new or significantly improved goods or services within the ecosystem. **Process innovation** is the adoption of new or significantly enhanced methods of production or delivery that contribute to the ecosystem's overall efficiency, adaptability and value creation. Both types of innovation thus aim to increase the productivity of a firm and are vital parts of innovation ecosystems. See Appendix on page 35 for the complete set of related innovation definitions.

Between 1996 and 2022, the Netherlands has experienced a strong increase in the number of collaborating innovators (see Figure 9).

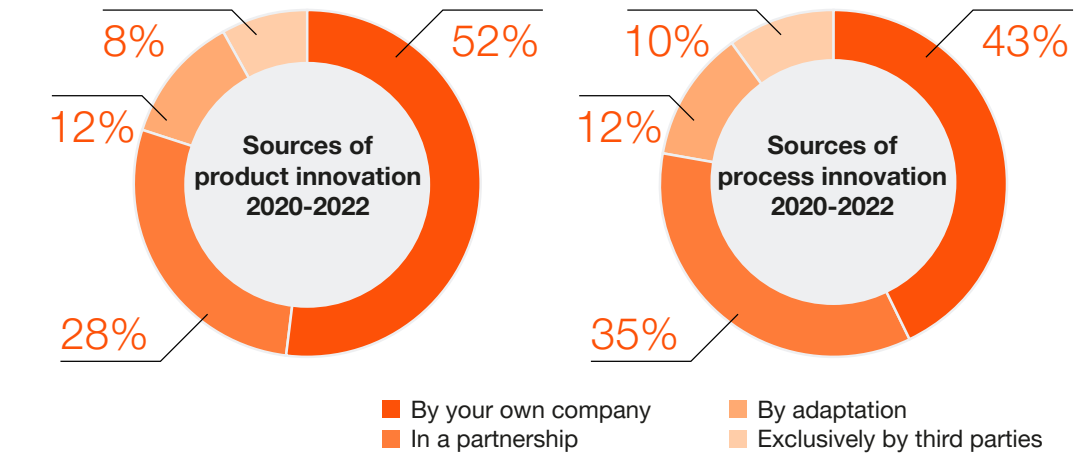
Figure 9 Companies are increasingly collaborating on process innovation, while collaboration on product innovation is declining



This indicates that companies increasingly collaborate to generate innovation, and innovation ecosystems become more important over time. However, the relative focus of innovation has shifted. While product innovation has decreased by about 35 percentage points, process innovation has increased by 31 percentage points. The decrease in product innovation is positively correlated with a falling share of hours worked in manufacturing and thus likely indicates a potential broader shift from a manufacturing- towards a service-based economy.[51]

Moreover, Figure 10 shows that 28% of product and 35% of process innovation is achieved in partnership with other companies. Therefore, a significant proportion of innovation materialises when a company collaborates with external organisation, signifying the importance of innovation ecosystems in the Netherlands.

Figure 10 A large share of product and process innovation takes place outside the own company

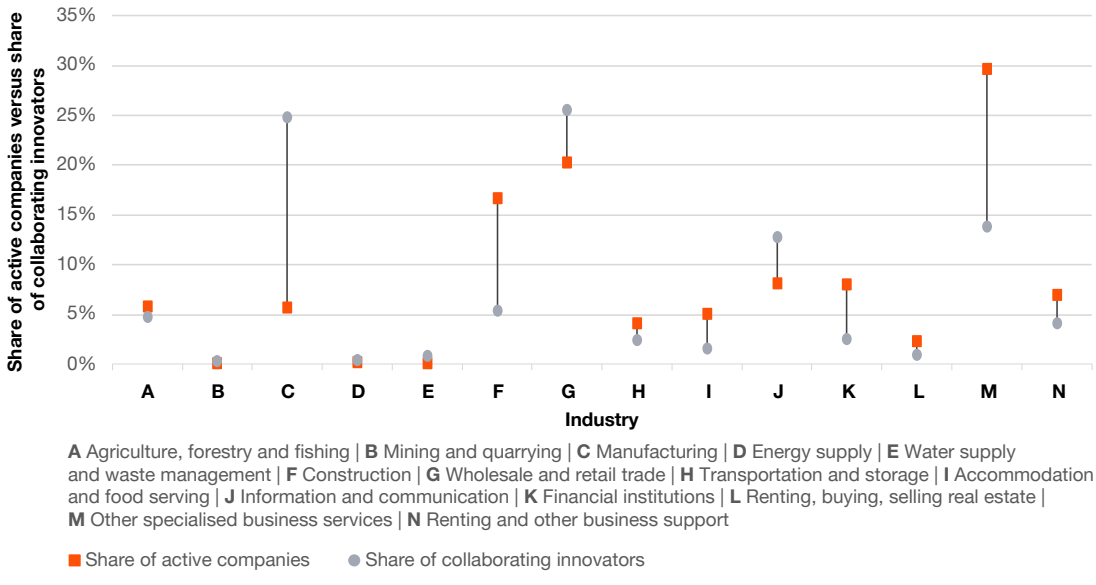


Source: CBS data, PwC analysis

Furthermore, the share of collaborating innovators is spread out amongst different industries. As can be seen in Figure 11, the manufacturing, wholesale and retail trade, and information and communication industries are having more innovation collaborations relative to their share of total active companies in the economy. This indicates that these industries are highly collaborative and form relatively more partnerships than the rest of the economy.

The data underlines the importance of collaboration for innovation in the Netherlands. Innovation ecosystems provide the platform for companies to learn from and with each other, resulting in important knowledge spillovers. In doing so, innovation ecosystems are key to ensuring sustained innovation, which ultimately boosts productivity growth.

Figure 11 Manufacturing, wholesale and retail trade, and ICT are the most collaborative industries in the Netherlands



Source: CBS data, PwC analysis

Business ecosystems: to create, deliver and capture value

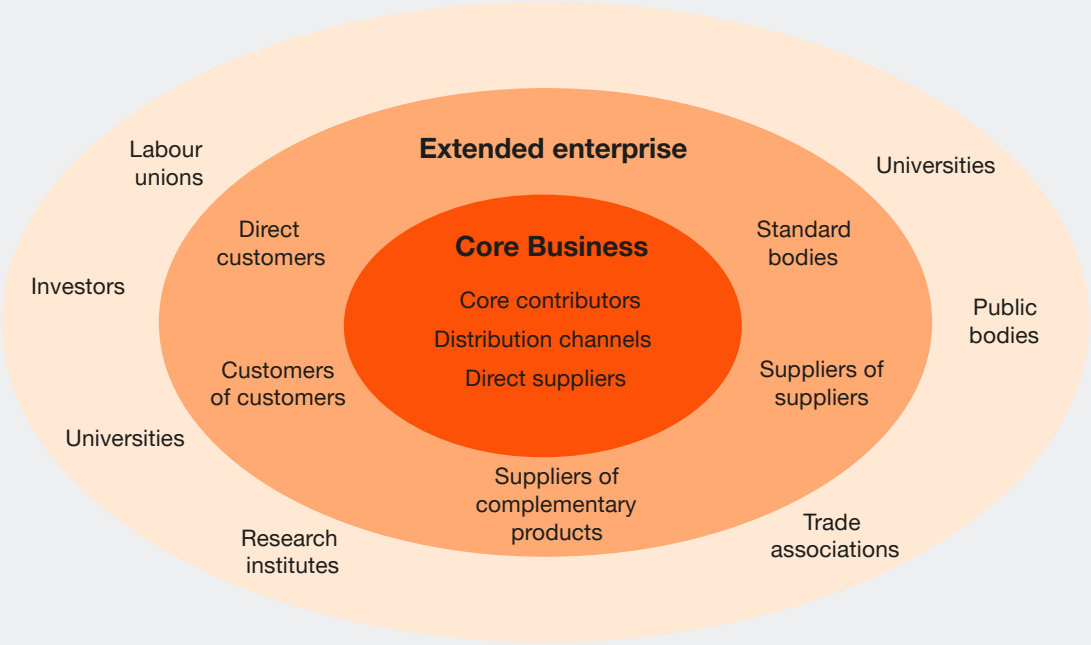
Definition

Business ecosystems are established for value creation, delivery and capture.[52] Value can mean driving growth, generating more sales, reinventing business models, or even in another non-monetary form , always with a focus on (end) consumer's value.. Business ecosystems bring together a largely independent, dynamic group of participants who complement each other to create offerings that generate more value when used in an integrated way.[53] If the perceived consumer value is not high enough, business ecosystems will not create a sufficient demand to be successful.

Properties

James F. Moore famously coined the term 'business ecosystem' and wrote that 'innovative companies cannot develop in a vacuum. They must attract resources of all kinds and involve capital, partners, suppliers and customers to create cooperative networks.'[54] A business ecosystem is composed of several layers of participants, which correspond to differing levels of commitment to the business (Figure 12).

Figure 12 Layers of the business ecosystem



Source: Moore (1993)

The ecosystem's core business layer consists of the parties forming the heart of the business: the business network participants such as suppliers, a focal firm (a company at the centre of the ecosystem), distributors and customers.[55] However, in practice, the boundaries of business ecosystems are blurry. Companies work cooperatively and competitively to support holistically integrated products, services. solutions and platforms, aiming to satisfy customer needs and ultimately integrate the next round of innovation in business ecosystems.[56]

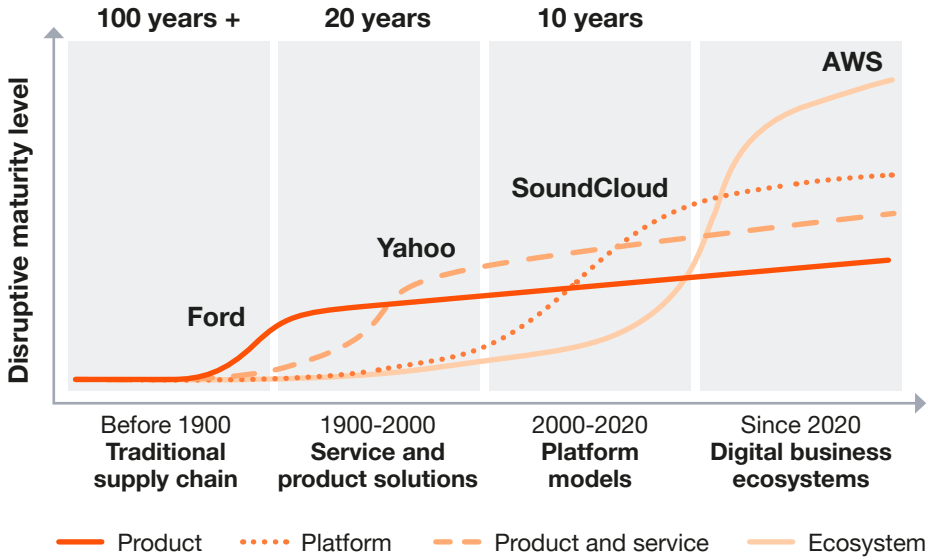
Following that we can say that a business ecosystem can be characterised by three central properties:[57]

- **Independence**: ecosystem players both cooperate and compete independently.
- **Complementarity**: participants within the ecosystem complement each other, creating value for the entire ecosystem by, for example, combining and sharing resources, assets and knowledge which reduces the required investment for innovation. At the same time, they must continuously adapt to be successful. By influencing each other, they further develop their relationships.
- **Synergies**: well-functioning ecosystems generate high added value through integrated experiences. The overall benefit of the ecosystem is greater than the sum of the individual services provided by the companies within it, following the principle of '1+1=3'.

Evolution of digital business ecosystems

Modern digital business ecosystems can be seen to have originated in four stages (Figure 13).

Figure 13 Digital business ecosystems can be seen as the next evolution step after product, service and product solutions and platform models



Source: PwC (2022): Business Ecosystems. How They are Revolutionising Industries and Markets.

Supply chains are usually the first stage towards a business ecosystem. Companies for more than 100 years have been linked in supply chain relationships to access (or provide) better, more competitive and more diverse sets of inputs (or outputs) from (or to) other companies.

Next follows the **integrated product solutions** stage. In this stage, product-related services are added to strategically expand the value chain, replacing the 'traditional' supply chain with integrated product solutions.[58]

The third stage is the **platform model** stage. Platforms are technological infrastructures which bring companies together, promote innovation, enable transactions and generate value through scalability and network effects.[59]

The final evolution of this concept is the **digital business ecosystem**, for which platforms are a prerequisite, as they represent a progression in the digital economy. While traditional platforms can create networks effects, digital business ecosystems generate additional lock-in effects that create strong bonds that keep customers and partners engaged within the ecosystem.[60]

Historical perspective and examples

There are several ways how business ecosystems can be organised, such as around a **company** or a **platform, technology, geographical area, industry, entrepreneur** or a specific **goal**.

Business ecosystems around a company or a platform

In many instances, business ecosystems revolve around a **company** or a **platform**. For example, mobile ecosystems are configured around dominant market players such as Apple and Samsung, and the competition between them is a well-known example of business ecosystems. Another example is Amazon, which has evolved from a platform as an online book retailer to a business ecosystem that integrates a wide range of products, services and other businesses.[61] This way, Amazon created a large number of touchpoints across the consumer's life, such as retail, entertainment, health, B2B services and logistics. This holistic approach creates value through user convenience, resulting in a strong lock-in effect A non-digital example is the ecosystem with high-tech companies first organised around large players such as Philips in the 20th century and later ASML, a spin-off from Philips.[62]

Business ecosystems around a focal technology

There are also examples of business ecosystems around a **technology**. Such an example is the Dutch quantum computing start-up ecosystem in Delft, organised around quantum technology. The Dutch government in 2024 attempted to develop a national strategy around ten technologies, including quantum.[63] However, it has so far been difficult to establish a thriving ecosystem for each of them without any large and relevant market players for these technologies.

A prominent recent example of a business ecosystem around technology is the success of Nvidia's CUDA GPU computing ecosystem. This is a special parallel computing platform and programming language with a rich set of tools enabling the development of many companies and technologies around it.[64] Nvidia's flagship hardware for AI applications, combined with the CUDA software, led to such a head start and lock-in effects that switching to an alternative has seemed unthinkable for many users.[65]

Business ecosystems around a geographical area

Similarly, there are also examples of business ecosystems, such as industrial parks, clusters or districts, that are organised around a specific **geographical area** in which related economic activities take place that benefit from each other's presence. In the Netherlands, examples of such an organisation are chemical clusters in Emmen, Delfzijl and Heerenveen.[66]

Business ecosystems around an industry

There are also **industrial ecosystems**, which encompass all players operating in a value chain, from the smallest start-ups to the largest companies. Examples of industrial ecosystems are initiatives such as Gaia-X, a pan-European organisation to develop data infrastructure, and Catena-X, a global data ecosystem specifically for the automotive industry.

Business ecosystem of Amsterdam: a hub for financial services

Amsterdam is an example of a business ecosystem around a specific industry in a geographical area when it comes to the prevalence of financial services in the city. Amsterdam has a rich history of financial innovation. It is where the world's first central bank, stock exchange (AEX) and limited company were all established.

Today, Amsterdam is the centre of the Dutch banking and fintech sectors. In addition to the headquarters of the Dutch Central Bank (DNB), and major globally active Dutch banks, such as ABN AMRO and ING, Amsterdam is home to the offices of more than 50 international banks, the European Investment Bank (EIB), as well as several major accounting firms, law firms, trust services, insurance providers, pension funds and other international financial companies. Additionally, the city's fintech sector includes Dutch unicorns such as Adyen, Mollie and Bunq. The city also acts as a hub for globally successful trading companies. Moreover, the development of the creative industry in Amsterdam is one of the reasons why many international companies find it important to be established in Amsterdam to attract talent.

This network of traditional banks, fintech companies, pension funds, insurers and supporting financial services (like accounting, trust and law firms) forms a dynamic business ecosystem focused on financial services.[67]

Business ecosystems around an entrepreneur

In the start-up world there are prominent examples of successful founders creating ecosystems of new companies either around their personal or funding networks. These are cases of an ecosystem forming around an **entrepreneur**, especially in the venture capital industry. Known examples are the 'PayPal Mafia'[68] in the US and the 'Skype Mafia' in Europe.[69]

Business ecosystems around a specific goal

Companies can also group around a **specific goal**. For example, companies in the Amsterdam region already collaborate to better market the region under the 'Iamsterdam' framework. Similarly, also companies from less visited regions can cooperate to more cost-effectively and efficiently market their region.

Companies can cooperate to tackle externalities, such as reducing pollution, ensuring supply chain resilience and continuity in times of crisis, and distributing fixed costs like security and exporting costs.

The Netherlands has recently experienced severe electricity grid congestion. A potentially likely scenario is that companies will have to cooperate either amongst themselves or with public entities in public-private partnerships to invest in and build energy storage and battery systems.

Lessons for policymakers and businesses

We covered four different types of economic ecosystems: entrepreneurial, knowledge, innovation and business ecosystems. Ecosystems are fundamentally about competition and cooperation. Participants engage in different ecosystems to achieve more than they could on their own, whether it comes to creating more value, knowledge or innovation. For the economy, they are a valuable way to boost productivity growth and drive economic development.

Lessons for policymakers

Foster cross-ecosystem collaboration

Policymakers should therefore encourage and facilitate cross-ecosystem collaboration. Such interactions allow for faster knowledge transfers, more efficient innovation cycles and better resource allocation, fostering long-term productivity and economic growth. Albeit each type of ecosystem has different goals and characteristics, they are not isolated from each other. In contrast, the different types of ecosystems are interdependent and flourish by collaborating. Productivity growth is increasingly driven by complementarities across policy areas, including innovation, education and business dynamics.[70]

To enable cross-ecosystem collaboration, competition authorities must strike a balance that allows sufficient room for cooperation but does not inhibit competition within and beyond ecosystems. This way, ecosystems can simultaneously compete and cooperate to ultimately increase their productivity.

Invest in regional ecosystem development

Most ecosystems are as unique as the regions they are located in.[71] It is vital that ecosystem policies are tailored to the specific strengths and needs of regions, recognising that productivity is spatially dependent on competitive advantages and the availability of the right economic activities in proximity to each other. The spatial reallocation of scarce resources to more productive sectors and regions with comparative advantages is a key driver of productivity growth.[72]

Southeast North Brabant and Greater Amsterdam show that regions with well-developed entrepreneurial ecosystems tend to have higher labour productivity. By investing in critical local infrastructure, talent development, and support networks, regions can create environments where businesses and entrepreneurs thrive, leading to more efficient, dynamic and innovative economic activity.

Remake existing and develop new ecosystems to be future-proof
To maintain high levels of economic wellbeing in the long run, economic ecosystems must be built on endowments that are future-proof. Therefore, it is crucial that ecosystems effectively use scarce resources such as labour, capital, environmental and physical space. Policymakers should thus incentivise companies to internalise the costs to society caused by externalities, such as pollution or high water use. Economic ecosystems heavily reliant on scarce resources – particularly when less productive – should consider restructuring their models by enhancing input efficiency through automation or AI, or by reducing their scarce resource dependency or by investing in product and process innovation.[73]

Support ecosystem anchors and connectors
Policymakers should strengthen the role of anchor institutions like universities and large innovative companies and enablers such as incubators, accelerators and public-private partnerships that foster innovative collaboration. Anchor institutions and enablers coordinate efforts, lower costs, and enhance participant impact, leading to economies of scale and scope.[74] For instance, innovation ecosystems benefit from connectors that help start-ups access research, funding, and markets—accelerating the time it takes to turn ideas into valuable products and services.

Lessons for businesses

Define an economic ecosystem strategy and decide on your desirable level of involvement
It is essential to determine whether to only be a participant or whether to take a more active role in the ecosystem. A clear strategy, principles and expected outcomes should be developed for all ecosystem activities. This would allow to have a guiding framework for existing and future involvement in ecosystems and to enable prioritisation, ensuring optimal use of resources.

In addition, the ecosystem perspective requires an operating model that is built on agility, a culture of trust, collaboration and experimentation within an organisation and externally. The dynamic nature of economic ecosystems demands flexibility. Companies must be able to adapt their capabilities and roles in response to new technologies, market demands, competition, and collaboration opportunities. Finally, consistent measurement frameworks are essential to evaluate whether participation in ecosystems aligns with current business goals.

Create new and strengthen existing partnerships and look to policymakers for guidance
Ecosystems are about competition and collaboration. Businesses should form strategic partnerships with various entities, including suppliers, customers, research institutions, government agencies, and even competitors.

Additionally, policymakers, not only at the regional and national levels, but also at the supranational level like the EU, frequently share strategic vision documents. These documents, such as the reports by Draghi,[75] Letta[76] and Niinistö[77], not only point out the issues that are on the policy agenda, but also the areas that need transformation and that could provide future opportunities for productive ecosystem development and participation.

In business ecosystems, explore new business models beyond the core business and learn from others

To expand the product portfolio and develop integrated solutions, it is important to explore new business models beyond the core business. Continuous business model reinvention is becoming more important, as 42% of CEOs doubt the long-term sustainability of their business models in ten years' time.[78]

When considering business model reinvention, all economic agents, especially ecosystems and their participants that are heavily reliant on scarce production factors, should consider restructuring their operations to future-proof activities. Conducting analysis of potential partners, frequently engaging with different participants across various industries, can help identify such opportunities for new growth areas. To be able to identify these opportunities, an organisation should focus on an active trend management and prioritisation process as well as an effective innovation funnel, which is not solely product- and service-focused, but looks at different business models – always combining value creation, delivery and capture. This requires strong senior leadership support and involvement. Moreover, active participation in different ecosystems can be helpful to broaden this horizon.

Appendix

Other ways to separate ecosystems

We distinguish different economic ecosystems by their primary goal or 'type of flow' in more academic terms. According to Valkokari (2015), there are other ways to separate and analyse different economic ecosystems:[79]

- **Geographically** (local, regional, national, global)
- **Chronologically** (from past to present to future)
- **Maturity** (growing, developed, declining)
- **Dynamically** (snapshot, dynamic)
- **Permeable** (open, closed)
- By **types of flows** (knowledge, value, physical)

Innovation definitions[80]

Collaborating innovators: companies that actively and jointly work with other companies and institutions (partners) on the development of technologically new or improved products, services or processes, whether in a formal partnership or not. Usually, the costs and possible revenues of this type of partnership are shared. Outsourced work is therefore not included.

Innovators with completed innovations: product innovators and process innovators who have successfully implemented and completed technological innovation projects in the period under review.

Process innovators: companies that have carried out innovation projects in the period under review that have led to new or greatly improved production processes, distribution methods or support activities for goods and/or services.

Product innovators: companies that have carried out innovation projects in the period under review that have led to technologically new or greatly improved products or services.

Technological innovators: Total of product innovators and/or process innovators.

Extended list of characteristics of different economic ecosystems

This table elaborates on the discussion about differences and similarities between the four economic ecosystems on page 10. It compares characteristics within four categories – **economic, territory, stakeholders** and **social** – that can be used to define and compare different economic ecosystems.

Table 4 Characteristics of four types of economic ecosystems

Category	Characteristic	Business ecosystem	Entrepreneurial ecosystem	Innovation ecosystem	Knowledge ecosystem
Economic	Goal	Value creation; performance enhancement	GDP growth	New and better products and processes	New knowledge
	Knowledge dynamics	Knowledge mobility	New knowledge production through interaction	Coordinated knowledge flows: purposive knowledge inflows and outflows	Make use of knowledge available in the region: proximity to knowledge generators
Territory	Anchoring	Platform as an anchor point to the ecosystem			Presence of an anchor tenant
	Territorial size	Close proximity; inherently local	The country or region	Spatial proximity (in case of innovative business ecosystems) or/and virtual spaces	Close proximity
	Industry		Disruption of existing industries and creation of new ones	Wide range of industries	Technological clusters
	Development	Adaptation and evolution	Co-creation and evolution, which are fostered by policymakers and drives innovation	Co-creation	
Stake-holders	Firms	Inter-organizational/ interfirm networks	Entrepreneurial firms embedded in networks, Interconnected companies	Firms embedded in networks	Large firms with established R&D departments, SMEs, and start-ups
	Networking among firms	Learning, connectivity, and mutually influencing interactions	Interaction between entrepreneur and ecosystem	Interdependence	Collective learning. Networking between residents
	Other stakeholders	Complementors; a large volume of innovating entities	Individuals and entrepreneurial teams; social, institutional, industrial, organisational, temporal and spatial networks	Complementors, government organizations, funders, resource providers, standard setters, and complementary innovators	The universities, public research organisations
	Value chain	Customers, suppliers, distributors, outsourcing firms, makers of related products or services, technology providers	Open-minded customers, specialized suppliers, service providers, training institutions, and support organizations	Customers, suppliers, intermediaries	Diversity of organizational forms
	Governance	Orchestrator	'Anchor events' as governance platform	Leading firm/ ecosystem orchestrator/network orchestrator	University or public research organization
Social	Collaboration versus competition	Collaboration and competition resulting in coopetition relationships; symbiosis	Private enterprises coexisting in symbiotic relationships	Simultaneous cooperation and competition	Knowledge-based R&D collaboration
	Workforce	Job creation function	Mobility of innovative entrepreneurs; job creation		Mobility of personnel

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