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Financing the Deep Tech Revolution:
How investors assess risks in Key Enabling Technologies (KETs)

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Financing the Deep Tech Revolution: How investors assess risks in Key Enabling Technologies (KETs)

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Abstract

Deep technologies stand at the forefront of the next generation of innovations. They are critical for fostering disruptive innovations, competitiveness and sustainable economic growth in Europe. These key enabling technologies (KETs) from the micro-electronics, nanotechnology, photonics, industrial biotechnology, advanced materials and advanced manufacturing sectors form the basis of high-tech solutions and applications that are transforming our daily lives.

At the same time, there is a substantial market failure in the financing of deep-tech solutions associated with KETs companies. Deep technology innovations are inherently risky, capital intensive and require patient, long-term financing. Due to the rapid cycles of innovations and the increasing complexity of deep technologies, there is a sizeable 'knowledge gap' between innovators and investors. These information asymmetries hinder investors from adequately assessing the technical and financial viability of deep-tech solutions. Investors often lack the adequate knowledge and tools to recognise truly disruptive technologies that are likely to lead to the next wave of innovations. Thus, information asymmetries represent a major bottleneck in terms of accessing funding for the majority of Europe's 10 000 KETs companies and have led to significant underinvestment in the sector in Europe.

The present study examines how to address these knowledge and funding challenges and how to improve the financing conditions for deep-tech innovations associated with KETs companies in Europe. It contains three main sections. First, it analyses the current due diligence processes of commercial banks and investors, identifying the underlying reasons for the existing bottlenecks in terms of financing deep-tech solutions. Second, it identifies a concrete set of potential solutions based on the analysis of existing investment models from several countries that have been successful in promoting investments in the deep-tech sector, including Korea, Singapore, Israel and the United States. Third, it provides a set of key recommendations for boosting investments in the deep-tech sector across Europe (i) to reduce information asymmetries about KETs companies by developing a "European Information Sharing Platform" that aggregates public support for KETs companies across Europe, helps to link up European-wide financing chains and over time provides the basis to develop a standardised technology assessment to support decision-making processes for private and public investors; (ii) to refine existing financial instruments to better fit the specific characteristics of deep-tech investments and KETs companies, with a particular focus on higher risk-taking types of hybrid capital, asymmetric public support to boost Europe's venture debt and equity scene, and supply chain finance as a way to link up established companies with young KETs innovators; and (iii) to strengthen the enabling environment for KETs companies by fostering "joined-up" innovation ecosystems and regional clusters across Europe.

Foreword

'Science to finance' and 'finance to science'

Such was the imperative with which a March 2016 study by the EC and the EIB concluded on how to improve funding conditions for Key Enabling Technologies, and how to strengthen the skills of investors to comprehend these technologies and related market risks.

Key Enabling Technologies from the micro-electronics, nanotechnology, photonics, industrial biotechnology, advanced materials and advanced manufacturing sectors hold deeply transformative power over our daily lives. They stand at the forefront of the next wave of innovation and are instrumental in bridging the digital-physical divide. They are strategic for fostering sustained competitiveness and growth in Europe. We must therefore get it right in providing adequate support and funding for this set of essential technologies.

For bankers and investors, KETs projects display characteristics that appear challenging. They require high upfront capital investment, often require long piloting phases and operate in unchartered markets. Hence, KETs projects, perhaps more than other segments, demand 'patient' capital – and we need to find innovative ways to finance them and to become better in how we assess their risks.

Here at the EIB, we attach great importance to enhancing the effectiveness of our financing solutions and to ensuring that innovative KETs companies have access to the right kind of funds and professional advice. Observing investment models and best practices from global 'hot spots' of excellence, be that Korea, Israel, Singapore or the US, we have brought our insights back to Europe in order to inspire the present recommendations. In recent years, the EIB has scaled up its quasi-equity facility to the largest of its kind in Europe to support innovative, high-growth companies, including in the KETs domain. We are also deploying a wide range of risk-sharing facilities with the European Commission in dedicated sectors such as the InnovFin Energy Demonstration Projects (EDP), many of which are based on key enabling technologies.

Therefore, I believe we are already on the right path – but we can and should do more.

Going forward, more and closer coordination of initiatives and information sharing about KETs projects by the public sector, as well as more data-driven, systematic ways to assess publicly funded technology will be required. We also already know that blended instruments combining early-stage grants with growth capital will increasingly become necessary to respond to the finance gaps that KETs companies face.

With a refined set of instruments and a host of new initiatives on the way, I believe that Europe is generally well positioned to take advantage of the unprecedented opportunities provided through rapid technological change. This report demonstrates that enhancing investments in the early and growth stages of KETs companies and simultaneously reducing the knowledge and finance gaps in this area are critical to helping unlock the potential of Europe's scientific knowledge and research.

Ambroise Fayolle

Vice-President, European Investment Bank

Preface

We are all experiencing the profound impact of technological progress on our daily lives. Mastering advanced technologies is not just about producing better products or services – it also affects how we work, how we lead our lives and how we can shape our future. Key Enabling Technologies (KETs) are by definition at the heart of the matter. They are at the same time 'deep tech', research-intensive, interdisciplinary, long-term oriented and disruptive.

We should be proud about Europe's scientific excellence, technology leadership and the innovativeness of our start-ups and SMEs. These companies will be well positioned to improve EU competitiveness and worldwide industrial leadership - but only if they are able to scale up their innovations and turn them into viable businesses. They need help to create the markets of the future and secure and maintain technological and market leadership. To do this Europe has to close a major innovation gap so that these enabling technologies can be rapidly deployed in the marketplace – by the companies that have developed them.

Action is needed at EU level because of the complexity of the value-chains concerned, the multidisciplinary nature of these technologies, their high development costs, and the cross-sectoral nature of the problems to be addressed.

This study on the due diligence and risk assessment for KETs provides a strategic insight into the bottlenecks for access to finance for highly innovative technology ventures. And it lays out a comprehensive set of concrete ideas for improving access-to-finance and mobilising private capital to foster the potential of KETs in Europe.

It addresses the question of how to get investors on board at an early stage of promising developments, explores possibilities for using technology rating, and shows how this would allow the channelling of investments into projects of strategic importance. The recommendations underline the importance of mobilising European networks and skills to boost the EU's competitiveness and ensure that all industrial players, and society at large, can benefit from accelerating the deployment of KETs by SMEs in Europe.

In order to implement already one of the important recommendations of this study, the European Commission has launched this year a call to help improve the technological rating for KETs projects tackling informational asymmetries at their core source.

We warmly welcome this study and will carefully consider the other recommendations.

Peter Dröll — *Director Industrial Technologies*

Jean-David Malo — *Director Open Innovation and Open Science*

European Commission – DG Research and Innovation

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EXECUTIVE SUMMARY

In 2009, the European Union (EU) identified Key Enabling Technologies (KETs) as instrumental in strengthening the pace of innovation and addressing major societal challenges. The term encompasses a group of six technologies: micro-/nano-electronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing systems. KETs are viewed as a key plank of future competitiveness and innovation in Europe, and thereby key contributors to future economic growth and employment. As a result, KETs are a core area of focus within the Industrial Leadership pillar of the EU's Horizon 2020 programme, with €6bn in research and innovation funding earmarked for these technologies for 2014-2020.

One of the major challenges of Europe with regard to advanced technologies – and KETs in particular – lies in the difficulty of translating its knowledge base into marketable goods and services. This innovation gap has been identified as the European 'Valley of Death'. Too many innovations fail to achieve material scale and commercial viability. The inability to attract suitable financing is one of the reasons. Approximately 10 000 SMEs in Europe base their business on the development and commercialisation of KETs and adequate access to finance is widely considered to be an essential precondition to ensure further growth and development of these KETs companies.

In March 2016, InnovFin Advisory conducted a study on "Access to finance conditions for KETs companies"[1]. The study highlights that despite the exceptionally good market conditions in the financial markets, not all companies benefit from such conditions the same way. While there is relatively good support for seed and first series of funding, many research-driven companies find it hard to raise much needed growth capital to scale up their businesses after initial commercial success. The study also shows that it is not enough to have risk-sharing financial products to resolve KETs companies' financing needs. KETs companies are still too little aware of these and can benefit from expert financial advice to become "investor-ready". Similarly, bankers and financial investors need to find ways to overcome a limited understanding of frontier technologies and the underlying market potential that may lead them to shy away from worthwhile investments.

The first study showed that the financing needs of KETs companies with revenue below €50m are generally not met, and this challenge is even more acute for KETs companies with revenues below €10m (even at the highest levels of the Technology Readiness Level scale). The 2016 study also highlighted that some of the KETs' specificities contribute in particular to lenders' and investors' risk, especially the complexity of the technology and inherent risk and uncertainty (value of intellectual property – IP), long life cycles (between investments and cash flow) and capital intensity. Broadly speaking, this market failure arises from two major differences between KETs companies and other innovative and/or small companies: (a) KETs projects/companies are capital-intensive and have long life cycles, and therefore require particularly large investments and long-term loans compared to the size of the company (e.g. revenues, assets) and (b) the complexity of the "deep technology"[2] and products they offer makes it particularly difficult for lenders and investors to understand and assess the market

[1] InnovFin Advisory, European Investment Bank, European Commission (2016), "Access-to-finance conditions for KETs companies"

[2] Unique, differentiating, hard to reproduce, technological or scientific advances that require a thorough understanding of the technology and market to understand their potential. Typically KETs qualify as such deep technologies.

potential. These two factors impair the economics of traditional financial tools, leading to a financing shortfall.

In this context, InnovFin Advisory and Oliver Wyman conducted a follow-up study to identify the bottlenecks in the due diligence process and technological assessment that KETs companies with revenue below €50m (herein referred to as "KETs companies") encounter when seeking finance, to explore potential solutions and design some guiding implementation criteria for the identified solutions.

Approach

We conducted this study in a three-step approach. First, we mapped the due diligence process and requirements for all forms of financing relevant to KETs companies in order to identify key challenges in the risk assessment of relevant projects. We interviewed 34 financial intermediaries such as commercial banks, specialist lenders, asset managers, and venture capital and private equity firms spanning 12 EU Member States[3]. We also identified a number of potential solutions supported by eight case studies of national and regional authorities, from and outside Europe, that have attempted to address these bottlenecks including Israel, Korea, Saxony, Singapore, Sweden and the US[4]. These solutions included both new ideas for the EU as well as potential solutions that build on initiatives already underway. Finally, we detailed three main groups of recommendations and outlined how they fit with existing initiatives as well as high-level guidelines for implementation.

Bottlenecks in KETs financing and evidence of best practice solutions from case studies

Our study identified three key access-to-finance bottlenecks for KETs companies attributable to the key differences between KETs and other innovative and/or small companies:

(1) Structurally high credit risk

(2) Severe information asymmetries

(3) Lack of access to the right funding

First, KETs companies typically present a high credit risk for lenders (cost of credit risk amounts to 70-80% of total cost of loan for KETs companies compared to 20-30% for an average SME)[5] . This structural difference is primarily due to a lack of tangible collateral and the high inherent risk of KETs companies. High inherent risk refers to a high probability of default as a result of higher market, technology and product risk. Tangible collateral refers to assets a company can put up to secure credit the commercial value of which can be assessed on the basis of existing income streams, and which are easy to liquidate in the event of default, e.g. cash, commodities, real estate, and accounts receivable. Typically, material collateral is harder to create out of patents, brands, or intellectual property of which the value is uncertain and hard to establish, the legal seizure complicated and the markets thinner than for tangible assets or patents/IP with a proven revenue stream.

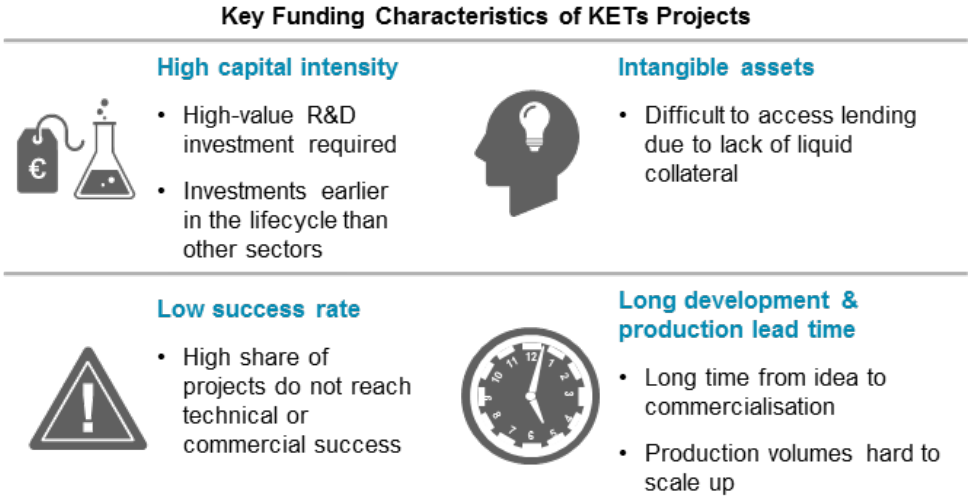
Second, KETs companies tend to suffer from severe information asymmetries related to the underlying technology and its market potential or time-to-market, that make lenders and

[3] See paragraph 'Interviews with financial intermediaries', and Appendix A. 'Interviews'
[4] See section 'Evidence of best practice solutions from case studies', Chapter 3
[5] See Chapter 2, 'Bottlenecks in KETs financing'

investors require higher risk premia[6]. Due to the rapidly increasing complexity of deep technology there is a large 'knowledge gap' between innovators and investors. Frequently, financial intermediaries do not have sufficient information and/or technical expertise to evaluate the technical and economic viability of deep technology projects and innovative fast-growing KETs companies.

Third, KETs companies lack access to the full suite of adequate financing instruments that suit the specificity of their sector at crucial stages in their development. Bottlenecks in lending are not purely a European phenomenon; however, funding in the EU is more focused on traditional debt funding (i.e. bank loans) whereas the share of equity and hybrid instruments (venture debt most notably)[7] is significantly higher in countries such as the US and Israel, making access to funding, in particular growth financing during the scale-up of operations, more easily available to KETs companies.

The illustration below summarises the key characteristics of KETs companies related to lending.



High credit risk of KETs companies (1)

KETs companies typically present a high credit risk for lenders, i.e. there is a higher risk for lenders to lose money on the loans they provide to KETs companies. Lenders such as banks assess the creditworthiness of SMEs, including KETs companies, with standardised and automated credit scorecards primarily focused on past financial and business data. This approach by definition is limited in taking a forward-looking stance to assess the opportunities and potential of disruptive technologies. These scorecards furthermore cannot be easily transferred to assess young KETs scale-ups or pilots that cannot demonstrate at least a few reporting periods of financial history and still have low or negative profitability and cash flows.

In addition, the KETs scale-ups within the scope of this study, with only first revenue generation and negative operative profitability, tend to have little collateral to offer banks in the event of a default[8]. Most KETs companies' assets are intangible (e.g. patented or not patented intellectual

[6] Refers to the difference between the expected return on a loan and the certain return on a risk-free investment
[7] Hybrid instruments combine characteristics of equity and debt instruments
[8] Note: Collateral is usually at equal levels for ICTs and KETs; however, the amount of funding is higher for the latter as the development and scale-up of operations is more CAPEX-intensive

property) and are difficult to value (especially pre-revenue) and difficult to sell (i.e. illiquid markets). Given this practical challenge of monetising IP-linked collateral of early stage KETs companies, loan officers and risk managers in commercial banks presume de-facto little or no collateral in the event of default. There are many public programmes to facilitate the use of IP as collateral with the goal to enhance deep technology companies' access to finance, such as Singapore's IPFS programme[9], however with limited success in encouraging banks to attribute meaningful value to IP as collateral.

Moreover, KETs companies are inherently risky compared to other companies at similar stages of commercial deployment. KETs companies have a high probability of default due to uncertainties around the commercial potential of their technology *(market risk)*, the science itself *(technology risk*) and the company's ability to turn it into viable products and services *(product and implementation risk)*. A typical bank SME loan portfolio will experience 1.0-1.5% in expected loss per annum (i.e. 2-3 clients in a portfolio of 100 would default in a year, with a ~50% recovery on the loan due to the lack of tangible assets/collateral). By contrast, a diversified portfolio of KETs companies will experience 15-20% in expected loss per annum[10] [11]. The uncertainty of KETs companies increases with the innovativeness and young age of the company and technology. Even with the best available information about the underlying technology, the market potential and the management, the level of risk remains fundamentally higher than what low-tech scale-ups will face.

Due to the aforementioned factors, it is estimated that banks would need to charge interest rates in the range of 20-30% p.a. compared to 4-5% for an average SME[12] to achieve their target return on capital on a traditional lending product with no equity (and thus higher risk) component. This is not an attractive proposition for most borrowers. Incremental efficiencies in the credit process and or improvements in information available on KETs companies are unlikely to fundamentally transform these underlying economics. Traditional bank lending is therefore scarcely viable as an appropriate financing mechanism for KETs scale-ups. This is not just a European phenomenon: we observe limited bank lending to KETs companies in all our case study markets including the US and Asia. In contrast, equity and hybrid investment vehicles, which can sustain a higher fundamental level of risk, offer a more attractive return to financiers and a more flexible repayment structure to companies.

Information asymmetries (2)

Our interviews indicated that investors – both on the equity and debt sides – suffer from a poor understanding of the technical and economic viability of the specific ("deep tech") innovations associated with KETs companies. Information asymmetries prevent investors from adequately evaluating different technology solutions and recognising truly disruptive technologies that are likely to lead to important transformations in the design and development of consumer products and services. This knowledge gap between the deep tech community and investors has also been found critical to address in a recent InnovFin Advisory study on 'Access to finance

[9] See case study on 'Intellectual Property Office of Singapore – Intellectual Property Financing Scheme'
[10] Approximately 15-20 clients in a portfolio would default in a year, with limited recovery of the loan given intangible collaterals
[11] Based on expert judgement from interviews with financial intermediaries such as commercial banks, specialist lenders, asset managers, and venture capital and private equity firms
[12] Based on ECB statistics and interviews with experts

for Research and Technology Organisations (RTOs) and their academic and industrial partners', launched in March 2017.

The time horizon required for the development and incubation of these innovations is long, and the uncertainty in terms of technical viability and market potential high. Therefore, KETs companies find it harder to access finance than the average young, high-growth company. As the international case analysis shows, in South Korea the public sector intervenes to reduce information asymmetries between innovators and investors and to provide better incentives for private investors to finance KETs companies: KOTEC, a Korean development agency, has created a "technology credit scoring tool" combining financial and business elements (in line with banks' approach) and technology assessment (in line with innovation agencies) within a single scorecard guiding its decision to allocate guarantees. This approach, financed by the banking sector, over many years of implementation has achieved greater transparency for private sector investors with regard to KETs projects. What is more, it provides the government with a data-driven, systematic decision-making tool to determine which projects will benefit from a state guarantee, and a clear rationale for the allocation of public resources (e.g. conditional grants)[13]. We also observe relatively few commercial banking players in Europe that have in-house lending teams which, albeit bankers by training, have developed a certain technology focus and over time acquire specialised knowledge that can help them more adequately assess the underlying credit risk. However, this is not a wide enough phenomenon to speak of a trend, if at all, given the cost-cutting pressures on larger European banks.

An important consequence of the negative impact of information asymmetries on the ease of access to finance is the necessity to consider more dedicated financing instruments for 'deep tech' companies, and to bring in knowledgeable partners from KETs companies' ecosystems such as RTOs.

Fragmentation of financing options for KETs companies (3)

Beyond bank lending, other forms of financing are more adapted to the risk-return profile of KETs, however they are currently limited in scale and breadth in the EU.

Relative to the examined case studies, we observe insufficient financing in three key areas:

A. ***Equity and seed capital***: Despite a broad range of grant schemes, credit guarantees and research support that exist in the EU, these are often fragmented and show little coordination across different bodies. Our analysis of case studies (Israel, Korea, Sweden, US) highlights the merits of a joined-up approach between public support, research institutions and private-sector venture investors in creating early stage and scale-up capital for KETs companies; as an illustration, investments by venture capital funds represent ~0.02%[14] of GDP in the EU compared to a range of ~0.1-0.4% in the case study markets. This represents a noticeable, material size difference in venture capital accessible for young, innovative KETs companies. In the EU, Saxony and Sweden stand out as having successful joined-up KETs "cluster" strategies that have catalysed significant private sector capital in collaboration with public sector support. Other markets show evidence of successful public/private collaboration, supported by targeted products such as contingent grants provided by innovation agencies (e.g. Israel, and France with BPIFrance) and state participation in venture capital funds with asymmetric returns (i.e. funds that are

[13] See paragraph 'Korea Technology Finance Corporation – Technology Assessment' Chapter 3
[14] NVCA 2016 Yearbook, 2007–2015 statistics

structured to allow the participation of investors with different risk-return objectives, as observed in the US and Israel). Another way to increase the impact of grants, especially at the early stage of deep tech projects, is to 'blend' them explicitly with private forms of finance, especially equity, which could top up the grant provided certain milestones are met by the company[15]. Such public/private integration has the effect of deepening and widening the available venture capital, which again is a critical decision-making factor for entrepreneurs in embarking on a high-risk venture.

B. ***Hybrid instruments*****:** Venture debt and subordinated debt combine characteristics of debt, i.e. interest charged and principal to be repaid, with those of equity, i.e. participation in the upside of the business development through options or equity kickers. Thereby, hybrid instruments enable rebalancing of the risk-return profile for investors. Our analysis of case studies (SPRING's Venture Debt Programme in Singapore[16] and the British Business Bank's Help to Grow programme in the UK) highlights the value of this product for KETs companies, especially at the scale-up stage. However, venture debt is in its early stages in Europe excluding the UK, and has not yet reached a critical mass: as an illustration, only ~5% of European VC (venture capital)-backed companies obtain venture debt compared to ~8-10% in the UK and ~15-20% in the US[17]. This study interviewed selected venture debt investors to identify how to improve the present situation.

C. ***Supply chain finance***: Given the critical contribution of KETs companies to the supply chains of mid-sized and larger corporations, as well as the long development cycles of KETs' projects, evidence from case studies points to the value of supply chain finance products and platforms for KETs companies. Working capital finance refers to funding of the everyday operations of a company, i.e. money to cover accounts payable, wages etc. (as opposed to investments in e.g. tangible assets). Such supply chain facilities leverage the better creditworthiness of large companies to increase the supply of working capital and lending to KETs, while mitigating supply risks for the larger company as their supplier is guaranteed to tap into sufficient financing for product design, development and delivery. This form of financing is particularly valuable when KETs companies develop first client relationships, before they become able to afford traditional loans. We observe significant take-up of supply chain finance markets in countries or regions that successfully promote KETs projects (e.g. Korea, Saxony and Mexico).

In general and reflecting the need for specialised know-how amongst investors, we note that the private sector has started to mobilise dedicated funds over the past few years. Some KETs- or deep tech-focused venture funds are being launched. Commercial banks have started to explore innovative approaches to serve tech companies, albeit generally still focusing on ICT and FinTech. Clydesdale Bank, Barclays and Santander are exploring venture debt and similar growth finance products. Intesa Sanpaolo has established innovation centres and funds dedicated to innovative, young companies[18]. ING-DiBa and a number of other banks offer seed funding for start-ups (albeit not KETs-specific). These initiatives have adjusted their approach to the special needs of tech companies with increased technology knowledge (e.g. Intesa Sanpaolo's innovation centre) and adapted products. However, at the same time most initiatives are early-stage with limited amounts invested and an unknown track record. It is

[15] Alternatively the grant can be contingent upon receiving private forms of financing
[16] See paragraph 'SPRING – Venture Debt Programme', Chapter 3
[17] AFME, "The Shortage of Risk Capital for Europe's High Growth Businesses", March 2017
[18] See case study on Intesa Sanpaolo, Chapter 3

unlikely such ad-hoc efforts are sufficient to fill the financing gap for young, innovative KETs projects which was assessed in the first study.

Therefore, the conclusions from the present case studies point to a market failure, which results in a lack of breadth and depth of financing options for KETs companies, especially those at the scale-up as well as pilot and demonstration stages. The recommendations aim to ensure that the supply of private sector capital can gain depth and breadth more quickly, supported by more focused and effective public sector participation.

Recommendations

Addressing the market failure in the financing of KETs companies requires a strategic and comprehensive response. Across various EU and national level schemes, the available financial support to KETs companies is material, e.g. the Horizon 2020 programme earmarked €6bn for these technologies for 2014-2020. However, there is a clear case for significantly improving the *effectiveness* of the available support by joining up EU and national bodies, and by refining existing public sector financial schemes to better leverage private investment into KETs companies. We examined a long-list of potential initiatives and converged on three core recommendations anchored in best practices. We believe each of the three recommendations is mutually reinforcing, and it is important that a coordinated, synchronised approach across these recommendations is adopted throughout the implementation phase.

1. Reduce information asymmetries about KETs companies by developing a European Information Sharing Platform and, in the medium term, a technology credit assessment tool to support public decision-making processes

At present, data on the KETs sector and KETs companies are scattered across institutions at European, national and sometimes regional level. Promotional banks, innovation agencies and the EC hold significant data (e.g. on more than 31 000 companies that applied for the SME instrument). We therefore recommend the development of an information-sharing platform that provides easy access to information about funding programmes that support the KETs sector and individual companies. Minimum information to be collected in a first stage can be the amount and type of support received, the institution providing this support, the date received, the size of the grant/investment/loan, and a point of contact to the funding programme. Most if not all of this information is already made publicly available by individual institutions, albeit in a scattered manner that makes a comprehensive overview hard to get. The advantage of such an information platform would be for the public sector at large to get an understanding of the KETs funding landscape in Europe. Such information platforms inspired by best practices (notably in South Korea, US, Israel and Sweden) have been demonstrated to improve transparency and knowledge of the KETs sector across all levels and to support decision-making about the allocation of public funds.

We suggest a phased approach to implement this recommendation. First, the EC or another European-level institution would gradually develop the “information-sharing platform”, based on existing data about KETs companies and the sector that it already holds. Subsequently, agreements with national innovation agencies and promotional banks could be developed to facilitate the information sharing among agencies across the national and European levels.

For the development of such an information platform it will be critical to establish a set of common data standards and information protocols to facilitate the efficient exchange of data. Based on the definition of common standards, data from independently-owned and de-centrally operated databases can be automatised and aggregated into one joint IT interface. Each institution (at EU or national level) will continue to manage its own databases and data, while at the same time enabling the exchange of data between relevant parties.

Finally, based on the experiences from the first two phases, the EC would gradually enhance the breadth of the information and data available. Based on the accumulation of comparable data over a period of time, the EC and national innovation agencies could develop a systematic "technology credit assessment" to support a more data-driven approach towards the public allocation of funding. South Korea's establishment of KOTEC demonstrates that once a long series of data points exists, the collected information and data will make it possible to create a "technology credit assessment platform" based on standardised data sets on technology and financial performance. In Europe, Research & Technology Organisations could provide critical input into such technology assessment as they possess the necessary know-how and/or access to relevant experts.

There are a number of implementation options to be considered, e.g. choice of underlying data platform and analytics, confidentiality considerations, data collection process, standardisation of expert input (especially with regard to technology assessment), etc.

2. Fine-tune existing financial instruments and programmes to better fit the KETs/ deep tech risk-return profile, including dedicated instruments

In order to attract significant private capital for KETs projects, the EC, EIB, promotional banks and innovation agencies are encouraged to fine-tune available financial instruments and programmes with the aim of better integrating them into a more accessible, user-centric product offering (e.g. InnovFin, EFSI/European Growth Finance Facility, InnovFin SME Guarantee, and COSME). The objective must be to improve the suitability of these programmes to also account for the risk-return profile of KETs investments with high capital intensity and long development stages. Specifically:

- *Further develop contingent grants or "forgivable debt" facilities*: Innovation agencies and promotional banks (EC, national and regional agencies, universities, etc.) could transform part of the existing grant programmes into contingent grants that are repaid like a loan if a KETs company is successful, and not repaid if the KETs company is unsuccessful, thus increasing the capacity of the schemes as repaid grants are made available for new grants. Such a model has been successfully implemented by Israel's Innovation Authority. A similar result could also be achieved through "forgivable debt" products which may be easier to accommodate within given accounting frameworks[19]. National promotional banks/investors, e.g. BPIFrance, already employ such products with a special focus on deep technology scale-ups. Blended products, i.e. grants in combination with automatic or conditional equity financing, are also a suitable tool to boost the funding available at the seed and Series A stages, and can act as a strong signal to private VC investors.

[19] Loan which can be written down or significantly restructured in the event of commercial failure or lack of scaling.

- The EIB Group and promotional banks can harness their existing programmes to deliver greater capacity along the KETs company life cycle subsequent to the raising of seed capital.

  – *Equity financing*: Co-investments by the public sector into fund-of-fund structures with asymmetric return profiles[20] – as a follow-on to contingent grants – will ensure that the efforts put into Recommendations 1 and 3 crowd in additional equity capital. Similar to the US Small Business Investment Corporations, the public sector serves to leverage private venture funds by topping up the invested equity with publicly-funded debt that is serviced at a fixed, typically low return, allowing the equity investors to reap the upside of positive portfolio development and expanding the total amount of available venture capital. Alternative asymmetric structures include *pari passu* types of co-investment or equity guarantees on targeted deep tech funds. We expect corporate venture capital funds to be attracted to such structures as a method of adjusting the risk-return profile to their risk appetite and improving their awareness of KETs.

  – *Hybrid instruments*: While the EIB Group has recently introduced new hybrid instruments with the extension of InnovFin to include venture debt funds and the launch of the "European Growth Finance Facility", a quasi-equity type of debt under the EFSI umbrella[21], the use of hybrid instruments could be further enhanced through co-investments by the EIB Group and national promotional banks into venture debt funds. These facilities could be fine-tuned to crowd in investors through co-investment models and/or the provision of guarantees. Venture debt is particularly lacking in Europe, yet of high interest to KETs companies that have demonstrated first revenues and the need to scale up.

  – *Supply chain financing*: We recommend collaboration with commercial banks and supply chain finance specialists to further develop facilities that support large companies' use of supply chain financing for KETs companies. Such initiative should leverage the EC's collaboration with industry partners and other forms of public-private partnerships.

3. Enhance the enabling environment for KETs companies by fostering "joined-up" innovation ecosystems and regional clusters

Case studies from across Europe highlight the value of fully joined-up "innovation ecosystems" and regional clusters, connected through systematic information exchanges and gatherings, for the development of and commercialisation of deep technology products and services.

Local or regional innovation ecosystems enable R&D-intensive companies to benefit from positive externalities resulting from the geographic proximity of public institutions (i.e. local promotional banks), Research and Technology Organisation (RTOs), as well as large corporate and private sector investors in a given region. Linkages between KETs companies and traditional industries are more easily enhanced within such a local ecosystem, as demonstrated already in the automotive or energy sectors in certain regions, e.g. Germany in Baden-

[20] "Asymmetric return profiles" refers to investors having different return profiles (e.g. one with a higher risk but a Higher return than another) while, typically, investors in a VC fund share the same risks and potential returns
[21] Quasi-equity provides non-dilutive equity risk capital that is remunerated based on the company's performance.

Wuerttemberg or Saxony. Furthermore, it is important to strengthen inter-regional cooperation between different eco-systems to support a process of 'open innovation' which facilitates the linking-up of KETs companies with industry, research, and investors from other regions. Therefore, one core attraction of joined-up ecosystems is their function to help promote a ''smart" specialisation of regions towards certain KETs sub-sectors.

Local innovation ecosystems can additionally provide operational and financial support to KETs companies as they evolve. A key aspect that existing cluster/innovation ecosystems fail to fully incorporate is the provision of advisory services to innovative companies related to (i) general business advice (e.g. strategy, business planning) and (ii) access to finance more specifically. The main vehicles for the provision of such advice can be the EIB (through the InnovFin Advisory Services team and the European Investment Advisory Hub) at the EU level as well as promotional banks, innovation agencies and government (e.g. Ministries of Commerce) at national and regional level.

Another important opportunity for innovation ecosystems is to facilitate the development of more strategic and large-scale regional programmes. This is particularly relevant for KETs whose pilot deployment often requires high infrastructure costs; hence the need to cross-develop smart specialisation strategies of EU regions that help promote the emergence of inter-regional business models and help coordinate the use of financing instruments at different levels. The study highlights the case of Silicon Saxony in Germany, where strong coordination at the local level has effectively fostered synergies between regional, national and EU-level funding programmes.

Various such initiatives already exist at the EU, national and regional level (e.g. Fast Track to Innovation, Vanguard) and can be developed into more closely integrated, inter-regional clusters.

Finally, this report highlights the role that Europe's Research & Technology Organisations can play in the build-up of robust ecosystems. RTOs can provide expert input on the investment readiness and market potential of a new technology.

In summary, this report recommends that access to finance be strengthened for deep tech/KETs scale-ups in three main ways: by expanding and introducing more financing instruments with an adequate risk-return profile for such projects (notably more and more easily available equity, venture debt and supply chain finance), respectively supporting private actors that provide such financing; much more proactive coordination and information sharing about public support to KETs projects at the EU, national and regional levels; and closer integration of local/regional clusters to promote inter-regional linkages, as well as further advisory services at local and regional level to help KETs companies access finance and investment. This report outlines these elements in further detail and aims to provide a positive stimulus to policy-makers, public bankers and market practitioners.

1. Context, objective and approach

In 2009, the European Union identified Key Enabling Technologies (KETs) as instrumental in strengthening the pace of innovation and addressing major societal challenges. The Key Enabling Technologies (KETs) are a group of six advanced technologies (micro-/nano-electronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing systems) instrumental to the growth and innovativeness of the European Union economy. One of the core challenges faced by KETs companies is commercialising the developed research and knowledge – a gap known as the European "Valley of Death".

As outlined in the March 2016 InnovFin Advisory study on "Access-to-finance conditions for KETs companies", financial intermediaries such as commercial banks fail to cater to the financing needs of many KETs companies. This problem is particularly exacerbated for smaller companies with revenues below €50m and even more so for companies prior to first revenue generation, coming out of the piloting phase of their technological innovation. As a result, the objectives of this study are to identify the bottlenecks and information asymmetries in the lending process to KETs companies, explore potential solutions by leveraging success stories from other regions and design a high-level operating model and implementation plan for the shortlisted solutions.

The study is based on a three-step approach consisting of the identification of due diligence bottlenecks through interviews with private-sector financial intermediaries, the identification of potential solutions using the examples provided by country case studies and, finally, the development of a set of recommendations and an action plan.

The framework of analysis for this approach is based on reviewing financial intermediaries' strategy, risk appetite and organisation with respect to KETs companies. These characteristics are guided by the financial factors driving the market and therefore the inherent profitability and size of the market. The inherent attractiveness of the market is in turn driven by an array of external factors such as the availability of information, the macroeconomic conditions and the cost of funding, among others. The analysis has been conducted against the backdrop of these factors and the levers at the disposal of public authorities to impact them.

Finally, the inputs into the study consist of primary interviews conducted with a host of financial intermediaries as well as case studies based on interviews with public authorities across the globe. These are complemented by desk research and analysis as well as existing internal expertise and resources.

Context and recap of findings from previous studies

1.1.1. Central role of KETs companies in the EU's economy

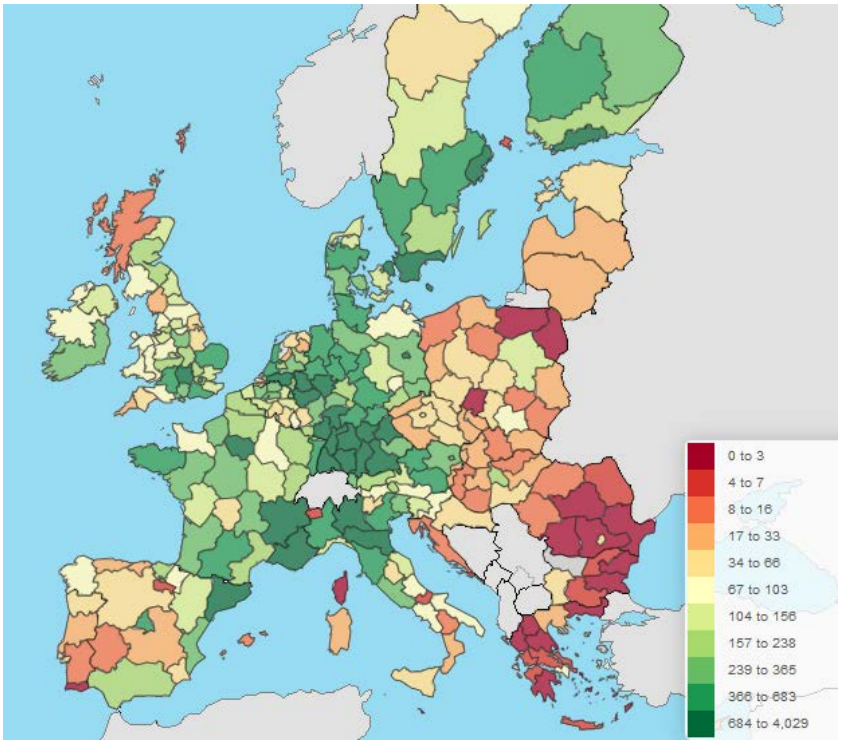
Key Enabling Technologies (KETs) are a core area of focus within the 'Industrial Leadership' pillar of the Horizon 2020 programme of the European Union. The term designates a group of six technologies: micro- and nano-electronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies.

Key Enabling Technologies provide the basis for innovation in a range of products across all industrial sectors. They are instrumental in modernising Europe's industrial base, underpinning

the shift to a greener economy, and driving the development of entirely new industries. While KETs are characterised by the substantial positive externalities and knock-on effects they can generate, their direct economic impact is already considerable, with a global market volume estimated at €646bn around 2006-2008 and over €1tn in 2015[22] (approximately 1.87% of global manufacturing value added)[23].

According to the 2016 InnovFin Advisory study on access-to-finance for KETs, "approximately 10 000 smaller to medium-sized companies in Europe base their businesses on the development and commercialisation of KETs"[24]. Figure 1 shows the regional distribution of KETs patents across regions in the EU.

Figure 1: Number of KETs patents across EU regions (NUTS-2), 2011[25]



One of Europe's major weaknesses with regard to KETs lies in the difficulty of translating their knowledge base into marketable goods and services. This innovation gap has been identified as the European "Valley of Death", which manifests itself in decreasing KETs-related manufacturing in the EU and patents that are increasingly being exploited outside the EU.

This lack of KETs-related manufacturing is detrimental to the EU for two reasons. First, in the short term, opportunities for growth and job creation would be missed as KETs companies would not have sufficient capital to scale up. Second, and more importantly, in the long term,

[22] European Commission, (2012), "A European strategy for Key Enabling Technologies – A bridge to growth and jobs", *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*
[23] The World Bank, (2015), Manufacturing value added worldwide
[24] InnovFin Advisory, European Investment Bank, European Commission (2016), "Access-to-finance conditions for KETs companies"
[25] European Commission, KETs Observatory

there may be a loss of knowledge generation because research and development (R&D) is intrinsically linked to manufacturing.

KETs and their impact on European economic competitiveness are therefore one of the most urgent priorities among the political priorities established by the Juncker Commission. The European Strategy for KETs aims to increase the exploitation of KETs and to reverse the decline in manufacturing as this will stimulate growth and jobs.

However, despite the measures put in place under the Horizon 2020 research programme, such as €6.7bn of grant funding, rebalancing of funding from basic research to applied research, an agreement between the EC and the EIB to sustain investments by KETs companies, the launch of InnovFin financial products by the EIB, etc., preliminary findings suggest that access to finance for KETs projects has been hampered by the lack of adequate funding available for high-risk/high-return projects.

With a view to addressing these challenges, the European Commission is developing an integrated approach of establishing policy actions and related roadmaps in the field of research, development and innovation. The access to finance for innovative companies in the KETs sectors will play a key role in this policy effort.

1.1.2. The EU's efforts to support KETs companies

The European Commission has produced several pieces of work identifying the challenges that KETs companies face. For instance, in the European Commission's 2009 communication *"Preparing for our future: Developing a common strategy for key enabling technologies in the EU",* the following barriers are identified:

- EU-funded research is not capitalised effectively, and commercialised outside the EU instead;
- Fragmented markets in Member States and the lack of a coherent technology policy limit the realisation of economies of scale;
- A lack of public understanding of Key Enabling Technologies.

Further research is documented in the EC's 2012 communication *"A European strategy for Key Enabling Technologies – A bridge to growth and jobs"*. Challenges pointed out in this communication include: (1) No common definition of KETs until the 2009 communication above; (2) Lack of coordination and effective use of public resources; (3) Capital-intensive nature of KETs – making it high risk – combined with insufficient access to risk capital in the EU; (4) Fragmentation of the EU internal market, coordination failures and other obstacles to effective competition in KETs markets; (5) Information asymmetries, as discussed above; (6) Regulatory differences across Member States; (7) Shortage of sufficient, skilled labour and entrepreneurs.

1.1.3. Challenges faced by KETs companies in accessing finance

In the period May 2015 to March 2016, InnovFin Advisory conducted a first study to evaluate the general access-to-finance conditions faced by companies investing in KETs, as well as to identify potential improvements.[26]

[26] InnovFin Advisory, EIB, EC (2016), "Access-to-finance conditions for KETs companies"

This study was conducted on a sample of 249 financially stable KETs selected from 10 000 companies in Europe. The sample was chosen to focus on businesses needing financing to fund research and development as well as growth-related activities. The emphasis in selection was put on SMEs and midcap companies with revenues in the range of €3-300m. As the main part of the study, interviews were conducted with 43 CEOs and CFOs of KETs and 16 representatives of commercial/public banks and funds. In addition, 150 tech-financing instruments in high-potential KETs economies were reviewed (including Canada, Israel and the US).

Despite a favourable overall lending climate, many KETs companies struggle or fail to obtain adequate debt financing. The study focused on investigating the root causes of the status quo and the potential short and mid-term solutions.[27] The study resulted in six key findings:

1. Due to general banking sector risk aversion, the lending needs of many KETs companies are not catered for, with 30% of those in the study failing to obtain adequate debt financing;
2. Dynamic innovators are not favoured by the conservative financing environment in Europe;
3. The funding process could be catalysed by leveraging EIB capabilities in technical and financial advisory;
4. Public financing agencies should play a stronger role in leveraging private funds;
5. Smaller KETs companies require support beyond pure finance;
6. Boosting the EU KETs sector requires smart, well-targeted investment for all types of companies: 'post start-ups', 'quantum leap companies' and 'well-established innovators'.

The 2016 study found that KETs companies with revenue below €50m (and especially below €10m) find it particularly difficult to access the level of financing they need. The study also identified some of the main drivers of the challenges that KETs companies face regarding access to finance (Figure 3).

[27] The scope of the study comprised four areas within the remit of the Directorate-General for Research & Innovation: nanotechnology, advanced manufacturing and processing, biotechnology, and advanced materials

Figure 2: Perceived difficulty for KETs companies to access debt financing[28]

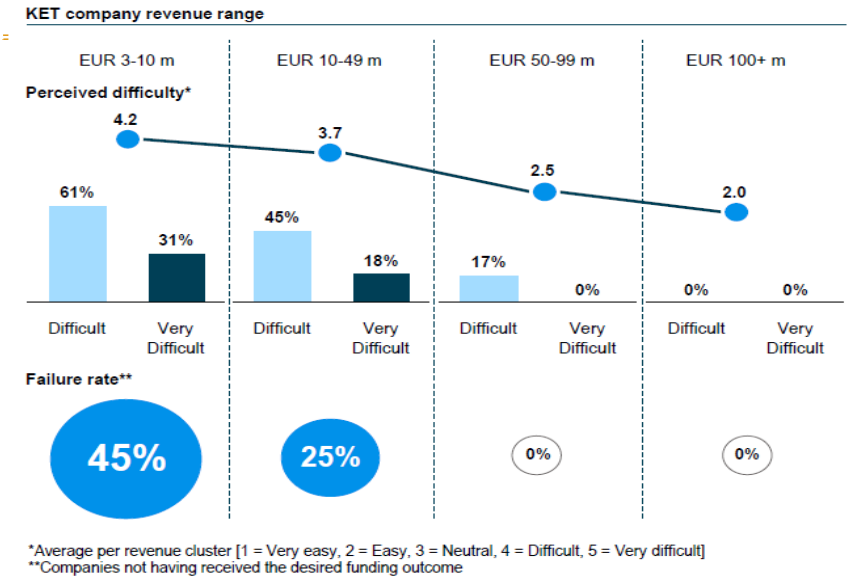


Figure 3: Identified drivers of challenges in access-to-finance for KETs companies[29]

Drivers	2016 InnovFin Advisory Study	KET boards' perspective	Financial institutions' perspective
KETs pose a **riskier** investment than other small companies with **higher capital expenditure** • High up-front investment • Early-stage, untested technologies without proven commercial application • Longer timelines to revenue generation than "standard" SMEs	"*KETs projects/companies require particularly **high capital expenditure** due to high R&D and component costs*" "*KETs projects/companies constitute **high-risk investments**, as KETs are early-stage technologies not yet associated with marketable and tested products.*" "*[The financial sector has…] **difficulties in understanding the potential of KETs innovations**. […] Such **a 'knowledge asymmetry' between borrowers and lenders** is thus likely to make their financial transactions more complex and the associated risks harder to assess…*"	• Banks put a low priority on understanding R&D efforts • Mismatch in perceptions of the investment horizon • Necessity to involve intermediaries with industry knowledge	• Absence of know-how to assess the risks • Long period until repayment • Absence of collateral that KETs could offer against the loan
Further development is needed to improve the structural environment for KET companies • Inadequate financing options • Policy and financing framework must improve structural conditions	"*The funding institutions and lenders **lack adequate financing instruments** for such high-risk investments or **require a very high interest rate***" "*The p**olicy and financing framework in Europe** requires further development to improve structural conditions for KETs projects/companies*"		

[28] InnovFin Advisory, EIB, EC (2016), "Access-to-finance conditions for KETs companies".
[29] Idem.

Objectives of the study

This study's objective is to build on the 2016 InnovFin Advisory study to:

- Identify key bottlenecks in access to finance for KETs companies.
- Identify potential solutions, leveraging examples of countries that have successfully tackled those challenges.
- Design a high-level implementation plan and roadmap for the identified solutions.

The 2016 study identified five drivers of the challenges faced by KETs that can be summarised as follows:

1. High capital expenditure due to high R&D and component costs.
2. KETs projects are high-risk investments as they are focused on nascent technologies.
3. Funding institutions lack adequate financing instruments for such high-risk investments.
4. In-house expertise to assess technology and its risk profile are limited.
5. The policy and financing framework in Europe requires further development to improve structural conditions for KETs projects/companies.

The 2016 InnovFin Advisory study makes the assumption that a core solution to improve access to risk finance for KETs companies is to target the information asymmetries identified as a major challenge at source by providing a credible evaluation of the technical and business viability of such companies to commercial banks during their due diligence processes. This conjecture could only be partly verified by this study.

In line with the findings from the previous report, our study focused on KETs companies with revenue below €50m and especially below €10m, as they are the ones that face the most challenges to access the desired level of funding.

Approach

The study is based on a three-step approach. First, we identified the bottlenecks based on responses from the 34 interviews conducted with private-sector financial intermediaries, Oliver Wyman's experience and expertise in the sector and primary and secondary research on existing analyses (e.g. reports). In addition, a sensitivity analysis was conducted on the profitability of loans to KETs companies. This resulted in the identification of a set of key information asymmetries relating to technology commercial risk assessment.

We then identified and selected potential solutions to the bottlenecks above by interviewing national innovation associations and other institutions that have successfully tackled and remediated some of these problems. The responses are further enhanced by leveraging the combined expertise of the EIB, the EC and Oliver Wyman.

Finally, we detailed a set of recommendations from the potential solutions identified in the previous step, supported by a high-level action plan for the implementation of these recommendations.

Framework of analysis

The framework of analysis for this approach is based on reviewing banks' strategy, risk appetite and organisation with respect to KETs companies. These characteristics are guided by the financial factors driving the market; the inherent attractiveness of the market is in turn driven by an array of external factors such as the macroeconomic conditions and the availability of information, as well as the levers at the disposal of public authorities to impact them. This framework is described schematically in Figure 4.

The first step is to assess the current challenges that banks face with lending to KETs in terms of strategy, risk appetite and organisation, based primarily on interviews with commercial banks and other lenders and investors (e.g. challenger banks, national promotional banks, asset managers, venture debt fund managers).

The subsequent step is to understand the economic incentives of bank lending to KETs based on financial factors such as profitability and market size. It is apparent through the review that banks would lend to KETs – and therefore adjust their strategy, risk appetite and organisation – only if such loan can generate sufficient profit. An assessment is made on the total profits from KETs lending as a function of average profitability of loans and aggregate market size. In other words, whether individual loans would be profitable (based on the RAROC[30] calculation), and if so, whether the total market size is large enough to generate sufficient profits to adjust the banks' approach and organisation.

Finally, government actions (e.g. regulation, financial incentives, and centralised information tools) that can affect the economic incentives for banks are assessed. Indeed, when market failures are identified, government intervention can improve the economic equation (e.g. financial guarantees to reduce losses in the event of default, credit bureau to reduce information asymmetries).

1.1.4. Bank's strategy, risk appetite and organisation

The first step of the analysis is to assess whether banks in Europe generally have a strategy, risk appetite and organisation that enable them to serve KETs companies adequately.

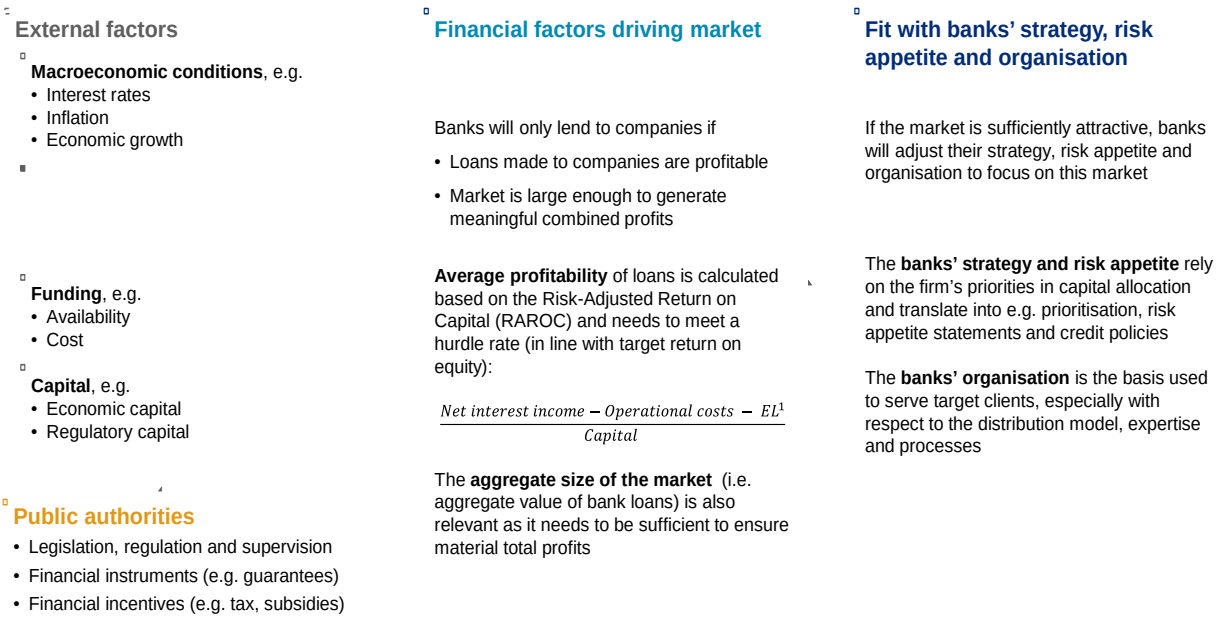
The bank's strategy and risk appetite rely on a number of key priorities for the bank, especially in terms of capital allocation; these include the prioritisation of resources, articulation of risk and strategy through risk appetite statements and the more granular risk and credit policies.

The banks' organisation has a significant impact on its ability to serve a wide range of clients. In particular, the distribution model's features, e.g. branch vs online-based, will impact the ability of a bank to appropriately service certain markets. In addition, current expertise (e.g. generalist relationship manager vs. centralised expert team) and credit processes (e.g. automated approval, delegation, etc.) will also play a significant role in a bank's ability to enter, or continue operating in, certain markets.

These factors are levers that the bank has to react to the market's inherent factors. However, the optimal way to address them is to tackle the underlying challenges in terms of inherent attractiveness and let banks adjust internally to tap into the opportunity.

[30] Risk-adjusted return on capital: a measure of profit taking into account risk (i.e. potential losses)

Figure 4: Framework of analysis



1.1.5. Inherent attractiveness of the market

The second step of the analysis is to review the economic incentives for banks to adjust their strategy, risk appetite and organisation to serve a certain market. For that, banks need to consider the market attractive.

A market will be deemed attractive for a bank if the average loan extended is profitable and if the market is sufficiently large to ensure that the bank's total profits are material. Providing credit will therefore be a direct function of the profitability of loans and the scale of the market. Note that these elements are inherent factors that cannot be controlled by the bank, although the public sector has at its disposal a number of levers to potentially adjust these factors.

Average profitability of loans

First, the loans that banks make to KETs companies need to generate profits that, on average, meet the bank's target return on equity (e.g. 10-20% depending on the bank[31]). The profitability of loans is typically assessed on a risk-adjusted basis with the Risk-Adjusted Return on Capital (RAROC)[32] below:

$$RAROC = \frac{NII - Operational\ costs\ -\ EL}{Capital}$$

The components are as follows:

[31] Oliver Wyman
[32] The formula presented is an approximation as one needs to account for the income from capital.

- *Net interest income* (NII) is the interest income (i.e. income from interest paid on loans) net of interest expense (i.e. cost of funding).
- *Operational costs* are the cost of providing the loan, and typically include direct costs (e.g. direct work to underwrite the loan) and indirect costs (e.g. IT).
- *Expected Loss* (EL) is a function of the probability of default[33] (PD), the loss given default[34] (LGD) and the exposure at default[35] (EAD). Our analysis focused on PD and LGD as they are the key drivers of credit risk. PD is driven by both the default rates of a sector and the ability of lenders to discriminate between borrowers, which usually depend on the availability of information. Indeed, Akerlof[36] shows that information asymmetries can cause substantial market inefficiencies, while Stiglitz[37] described how screening can be used to overcome information problems. LGD is primarily driven by the expected value of the collateral at the time of default/recovery.
- *Capital* refers to the funds that need to be held by banks in order to cover unexpected losses (UL). While regulations may require a minimum level of capital (regulatory capital), our analysis focused on economic capital, which is the amount of capital that banks set aside to cover unexpected losses. It is generally calculated based on internal models taking into account PD, LGD and their variance. It is a key component as it is the equity that shareholders need to set aside to make the loan and on which they try to generate a return (i.e. return on equity).

It is important to note that the individual components of the above equation are correlated and optimisation should therefore *not* be conducted on a single factor basis only. For instance, raising the interest rate charged on a loan will lead to increased interest income, but this may come at the cost of a rise in expected losses due to increased risk-taking and adverse selection (Stiglitz).[38]

Aggregate size of the market

In addition, conditional on lending being profitable, the aggregate size of the market needs to be sufficiently large in order to be attractive for the bank. Even if the average loan is profitable, the size of the market may not allow for material total profits that would justify any investment in market entry and the development of sectoral expertise or technology understanding.

The total market size can be assessed based on a range of factors such as the number of clients, the balance of loans, the potential for cross-selling, etc.

[33] The probability of default is defined as the likelihood that a given obligor will default within a predefined (typically 12-month) time frame.
[34] The loss given default is the percentage loss that is expected to be incurred on the loan balance at time of default.
[35] The exposure at default refers to the total value that a bank is exposed to at the time of default. For term loans, this is simply the outstanding balance. Given that the majority of loans granted are term loans, the EAD is not the most impactful component of the EL.
[36] Akerlof, George A. (1970). "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism". *Quarterly Journal of Economics*. The MIT Press. 84 (3)
[37] Stiglitz, Joseph and Weiss, Andrew (1981),"Credit Rationing in Markets with Imperfect Information", *The American Economic Review*, 71(3)
[38] Stiglitz, Joseph and Weiss, Andrew (1981),"Credit Rationing in Markets with Imperfect Information", The American Economic Review, 71(3)

1.1.6. Levers available to public authorities

The external factors affecting the inherent attractiveness of the market consist of the availability of information (e.g. ability to predict market potential with reasonable accuracy, uncertainty around technology/market/product), the asymmetry of available information (e.g. difference in the level of information available between lenders, investors and entrepreneurs), the overall macroeconomic conditions, the availability and cost of funding and the capital needs and requirements, among others. Public authorities have a number of levers at their disposal that can be used to adjust these external factors. First, regulation and legislation can have profound effects on capital requirements, reporting requirements and cost of funding. In addition, financial tools such as guarantees can shape the underlying attractiveness of lending to KETs companies. Financial incentives such as taxes and subsidies can also be used to affect cost of funding and capital. Finally, public authorities can design publications and programmes aimed at providing and structuring additional information to the market.

Inputs

The assessment of the banks' strategy, risk appetite and organisation as well as their incentives is primarily based on the 34 interviews with financial intermediaries and experts. The identification of solutions is in part based on country case studies focused on tools or policy measures that some countries have taken to address the bottlenecks identified. Finally, each of these steps is complemented with expert input (in particular the European Commission, EIB/EIF and Oliver Wyman) and desk-based research (e.g. academic research).

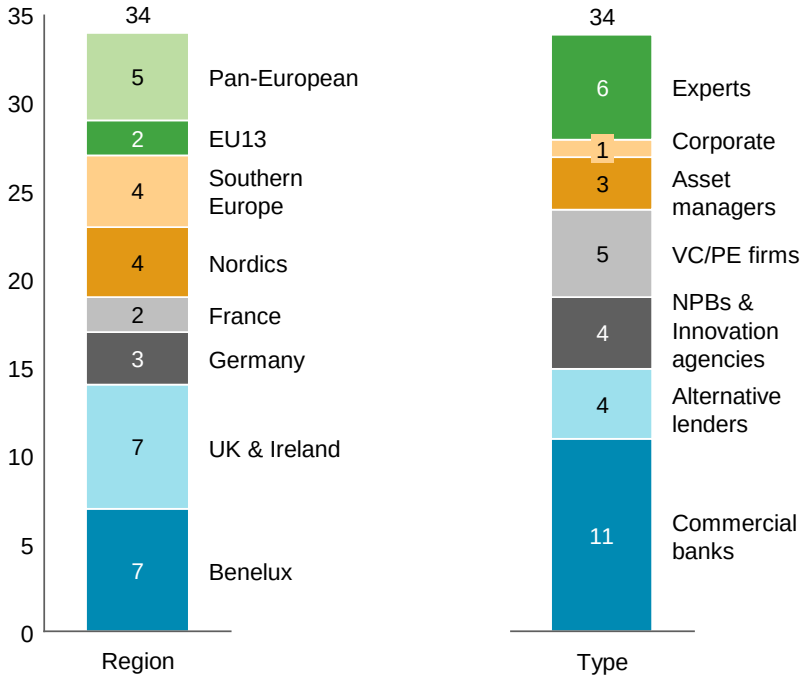
1.1.7. Interviews with financial intermediaries

In order to understand the key bottlenecks that KETs face in terms of access to financing, 34 interviews were conducted with a broad range of institutions.

Figure 5 shows the proportion of institutions interviewed by region (e.g. Southern Europe, Germany, and Nordics) and type (e.g. commercial banks, venture capital and private equity firms).

A significant proportion of the interviews conducted are with commercial banks given the high share of financing they account for in the bank-based European capital markets. 11 interviews were carried out with commercial banks accounting for ca. 20% of European bank assets. The banks that were interviewed cover a diverse peer set, including large universal banks, smaller regional banks, savings banks and cooperatives. A selection of alternative lenders (e.g. FinTech platforms), national promotional institutions and innovation agencies given their role in financing innovative companies, and venture capital and private equity firms were also interviewed in order to understand their approaches to investing in KETs companies as well as identify the challenges that their portfolio companies face in terms of access to finance.

Figure 5: Total number of interviews by region and type of institutions



The interviews conducted provide a wide coverage of the EU28 with additional insight from non-EU case studies. The proportion of interviews with institutions operating primarily in Western Europe[39] is significant due to the higher prevalence of KETs companies in these regions. Nonetheless, there is adequate representation of EU13 institutions to ensure that the results of the study are representative across all EU members. The interview questionnaire and the findings are detailed in Appendix A.

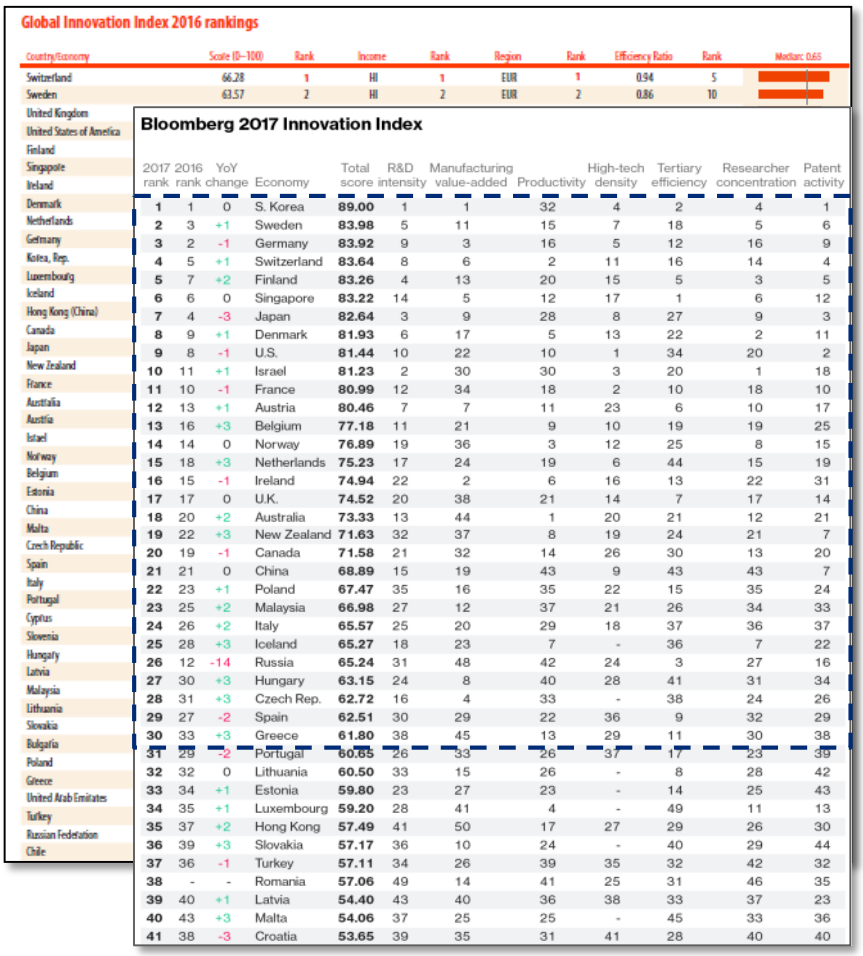
1.1.8. Innovation case studies

The country case studies are developed through interviews with relevant public sector institutions. The selection of suitable case studies is based on the following desirable characteristics. First, the country is at the forefront of the global innovation economy. Second, the group of case studies covers a wide variety of regions and approaches. Third, there is enough comparability with the EU to ensure that the lessons learned are as transferable as possible. Finally, the country in question has a high density of deep tech companies, and if possible a vibrant KETs sector.

In practice, this was implemented by selecting the top-ranked countries according to the Bloomberg Innovation Index[40] and the Global Innovation Index[41], shown in Figure 6. The top two performing countries are taken across the geographical regions. Additional consideration is given to the countries' comparability to the EU and the density of deep tech companies.

[39] Western Europe is considered as all non-CEE European countries. The category "Western Europe" in the chart refers to the UK, Ireland, the Netherlands and institutions operating fully across the continent.
[40] The BII takes into account seven broad indicators of innovation: R&D intensity, manufacturing value added, productivity, high-tech density, tertiary efficiency, researcher concentration and patent activity. The performance of the country on all of these components is aggregated in one score between 0 and 100.
[41] The GII innovation score computes an Innovation Input Index, showing the amount of investment in innovation and R&D, with an Innovation Output Index measuring the output of innovation. The final index is a score between 0 and

Figure 6: Bloomberg Innovation Index 2017 and Global Innovation Index 2016



Global Innovation Index 2016 rankings

Country/Economy	Score (0–100)	Rank	Income	Rank	Region	Rank	Efficiency Ratio	Rank	Median: 0.65
Switzerland	66.28	1	HI	1	EUR	1	0.94	5	
Sweden	63.57	2	HI	2	EUR	2	0.86	10	
United Kingdom									
United States of America									
Finland									
Singapore									
Ireland									
Denmark									
Netherlands									
Germany									
Korea, Rep.									
Luxembourg									
Iceland									
Hong Kong (China)									
Canada									
Japan									
New Zealand									
France									
Australia									
Austria									
Israel									
Norway									
Belgium									
Estonia									
China									
Malta									
Czech Republic									
Spain									
Italy									
Portugal									
Cyprus									
Slovenia									
Hungary									
Latvia									
Malaysia									
Lithuania									
Slovakia									
Bulgaria									
Poland									
Greece									
United Arab Emirates									
Turkey									
Russian Federation									
Chile									

Bloomberg 2017 Innovation Index

2017 rank	2016 rank	YoY change	Economy	Total score	R&D intensity	Manufacturing value-added	Productivity	High-tech density	Tertiary efficiency	Researcher concentration	Patent activity
1	1	0	S. Korea	89.00	1	1	32	4	2	4	1
2	3	+1	Sweden	83.98	5	11	15	7	18	5	6
3	2	-1	Germany	83.92	9	3	16	5	12	16	9
4	5	+1	Switzerland	83.64	8	6	2	11	16	14	4
5	7	+2	Finland	83.26	4	13	20	15	5	3	5
6	6	0	Singapore	83.22	14	5	12	17	1	6	12
7	4	-3	Japan	82.64	3	9	28	8	27	9	3
8	9	+1	Denmark	81.93	6	17	5	13	22	2	11
9	8	-1	U.S.	81.44	10	22	10	1	34	20	2
10	11	+1	Israel	81.23	2	30	30	3	20	1	18
11	10	-1	France	80.99	12	34	18	2	10	18	10
12	13	+1	Austria	80.46	7	7	11	23	6	10	17
13	16	+3	Belgium	77.18	11	21	9	10	19	19	25
14	14	0	Norway	76.89	19	36	3	12	25	8	15
15	18	+3	Netherlands	75.23	17	24	19	6	44	15	19
16	15	-1	Ireland	74.94	22	2	6	16	13	22	31
17	17	0	U.K.	74.52	20	38	21	14	7	17	14
18	20	+2	Australia	73.33	13	44	1	20	21	12	21
19	22	+3	New Zealand	71.63	32	37	8	19	24	21	7
20	19	-1	Canada	71.58	21	32	14	26	30	13	20
21	21	0	China	68.89	15	19	43	9	43	43	7
22	23	+1	Poland	67.47	35	16	35	22	15	35	24
23	25	+2	Malaysia	66.98	27	12	37	21	26	34	33
24	26	+2	Italy	65.57	25	20	29	18	37	36	37
25	28	+3	Iceland	65.27	18	23	7	-	36	7	22
26	12	-14	Russia	65.24	31	48	42	24	3	27	16
27	30	+3	Hungary	63.15	24	8	40	28	41	31	34
28	31	+3	Czech Rep.	62.72	16	4	33	-	38	24	26
29	27	-2	Spain	62.51	30	29	22	36	9	32	29
30	33	+3	Greece	61.80	38	45	13	29	11	30	38
31	29	-2	Portugal	60.65	26	33	26	37	17	23	39
32	32	0	Lithuania	60.50	33	15	26	-	8	28	42
33	34	+1	Estonia	59.80	23	27	23	-	14	25	43
34	35	+1	Luxembourg	59.20	28	41	4	-	49	11	13
35	37	+2	Hong Kong	57.49	41	50	17	27	29	26	30
36	39	+3	Slovakia	57.17	36	10	24	-	40	29	44
37	36	-1	Turkey	57.11	34	26	39	35	32	42	32
38	-	-	Romania	57.06	49	14	41	25	31	46	35
39	40	+1	Latvia	54.40	43	40	36	38	33	37	23
40	43	+3	Malta	54.06	37	25	25	-	45	33	36
41	38	-3	Croatia	53.65	39	35	31	41	28	40	40

100.

As shown in Table 1, the country case studies focus on specific measures taken in various countries to address the bottlenecks identified in Section 2.

Table 1: Overview of case studies

Region	Country	Theme	Description	Pg.
Asia	South Korea	Tech and market credit assessment	KOTEC's technology rating system (KTRS) assesses credit risk for technology companies based on a number of factors, including technology	64
	Singapore	Tech and market credit assessment	Singapore's Intellectual Property Financing Scheme (IPFS) supports using IP as collateral for lending by subsidising valuation and partially underwriting the loan	74
		Growth finance	SPRING's Venture Debt Programme (VDP) supports the development of venture debt products in Singapore through guarantees	88
Middle East	Israel	Growth finance	The Israel Innovation Authority provides conditional grants that need to be repaid only if the venture is successful and revenues are generated	92
North America	US	Growth finance	The SBA's SBIC programme has been successful in increasing venture capital through the provision of capital to funds and the creation of asymmetric returns for the government	78
Europe	Italy	Innovative bank business models	Intesa Sanpaolo, a private Italian bank, has three initiatives that can spur KETs companies: innovation centres, venture funds, and direct support of start-ups through its StartUp Initiative	97
	Sweden	Coordinated advice/ clusters	Sweden's public authorities (especially universities, Vinnova and ALMI) have focused on ensuring that innovative companies access a complete suite of financial products across public and private sector entities and throughout their life cycle	99
	Germany	Coordinated advice/ clusters	The Free State of Saxony has implemented a coordinated approach to develop a cluster focused on nurturing the micro- and nano-electronics industry through coherent coordination at the regional, national and European levels	108

In addition, the experience and expertise of the European Commission, the European Investment Bank and Oliver Wyman are included as key inputs into this study. A range of academic articles and expert studies were used to supplement this expertise.

Anonymity of interviews was guaranteed to provide an unbiased, free exchange of information.

2. Bottlenecks in KETs financing

Summary

Bottlenecks in traditional lending to deep tech, high-growth SMEs, including those active in the KETs sector, reside in credit risk, mainly high default rates and lack of collateral. While a non-KETs SME bank portfolio would have 1.0-1.5% expected loss per annum, for KETs companies this is estimated to be 15-20%[42]. For such companies, credit risk accounts for around 70-80% of the total cost of lending and is driven by the high probability of default and low recovery rates of young, high-growth companies.

Higher default rates are inevitable for younger, high-growth companies developing new technologies due to the inherent uncertainties around the underlying commercial potential. In addition, with such corporate characteristics, banks face information asymmetries and larger challenges than for conventional SMEs to discriminate between good and bad borrowers due to the particular complexity of the technologies and the uncertainty of their market potential – traditional credit assessment tools (especially scorecards) are based on historical financial data which the young, highly innovative companies in focus of this study lack. Improving risk differentiation would be costly (e.g. requiring involvement of technology specialists), which is an effort that commercial banks may be hesitant to undertake for a target market that is perceived as relatively small and low in returns. Low recovery rates finally are due to the relative lack of collateral in most young KETs companies, that typically lack sufficient tangible collateral (e.g. real estate); at the same time those companies find themselves restricted from using their most valuable assets, i.e. intellectual property, due to the difficulties for banks in first accurately valuing patent portfolios of highly innovative deep technologies and secondly reselling such portfolios on the market; thus the likely value realisable if the company has failed is in practice perceived as very limited by lenders.

Figure 7 compares the total cost of lending to an average SME with deep tech, high-growth SMEs, depending on their level of guarantees. It also details the estimated components of the costs: cost of funding (i.e. financing of the loan), operational costs (i.e. of the bank's operations to provide the loan), cost of risk (i.e. risk of losing the principal on a default), cost of the guarantee (if there is a guarantee), tax (i.e. income tax on profit) and cost of capital (i.e. remaining profit for the bank, based on a 10% target return on equity).

[42] Based on expert judgement from present interviews with financial intermediaries such as commercial banks, specialist lenders, asset managers, venture capital and private equity firms

Figure 7: Required interest rate to reach a 10% return on equity

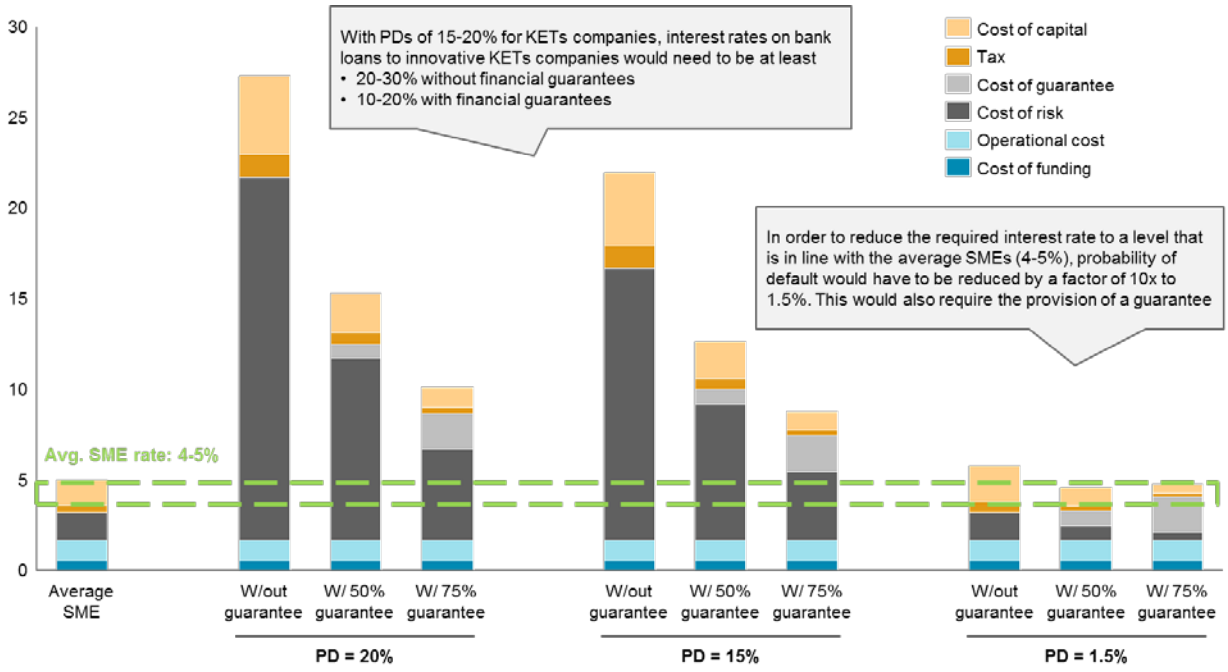


Figure 7 highlights that ultimately, traditional lending instruments, in the form of senior or junior loans, are not best suited to finance KETs companies. Those instruments cannot provide a return of investment that is attractive enough for lenders given the underlying higher level of risk, even when information asymmetries between KETs companies and investors are being reduced and there is financial and informational support. This is due to the fact that even with better information sharing and collateralisation, for instance, through the use of technology assessments and the valorisation of IP, respectively, returns for banks would be below cost of capital at standard pricing. Furthermore, the required interest rate to make lending to KETs profitable is prohibitively high. Figure 7 shows that given KETs companies' level of risk, interest rates would have to be at least twice as high as for SMEs even with guarantees. Such a level of interest would be unaffordable for innovative SMEs and may not be charged by banks due to the increased adverse selection and moral hazard that it would entail[43]. In light of this inherent lack of profitability and the currently limited and fragmented size of the KETs lending market, banks have lacked the right incentives to create a strategy and organisations enabling them to serve KETs companies.

A few banks have acknowledged these challenges and are exploring alternative approaches to finance innovative companies through, for instance, venture debt, incubators, and a team of dedicated in-house innovation and deep technology experts. Intesa, for instance is running several innovation centres across Italy, one of which is dedicated to supporting high-tech start-ups as part of an expert network including state institutions, universities, incubators and commercial banks. Clydesdale Bank has also extended more than GBP 105m in loans to 33 companies, through its

[43] Note: Higher interest rates deter "safe" borrowers and encourage risk-taking according to Stiglitz, Joseph and Weiss, Andrew (1981), "Credit Rationing in Markets with Imperfect Information", The American Economic Review, 71(3)

Growth Finance division.[44] Nevertheless, mostly these initiatives are limited in scale compared to overall lending to innovative SMEs, and are focused on the ICT and FinTech sectors, rather than deep technologies of KETs with high capital intensity and long pilot and commercialisation lines before revenue uptake. A few similar initiatives have been further reduced or stopped in an effort by commercial banks to cut operating costs and generate profits.

More broadly, the fragmentation of financing options for KETs companies across the companies' life cycle and geographies remains a major challenge. While traditional debt products do not have an adequate risk profile to finance such companies, alternative debt instruments that may rebalance the risk-return equation (e.g. mezzanine debt with equity characteristics) are in insufficient supply in Europe (an estimated €60-300m of actual venture debt vs. potential demand of approximately €1bn)[45]. In addition, in spite of its adequate risk-return profile, the availability of equity in Europe is insufficient across the life cycle for companies to grow smoothly. A recent AFME study shows that the equity gap in some EU Member States like France, Germany, Netherlands, Poland and Romania is three to five times larger than that of the US.[46]

[44] See paragraph 'Intesa Sanpaolo', Chapter 3
[45] See paragraph 'Current situation in Europe'
[46] Association for Financial Markets in Europe (2017), "The Shortage of Risk Capital for Europe's High Growth Businesses"

High credit risk of KETs companies

In order to assess what determines the cost of bank lending (i.e. loans) to innovative deep tech companies in the KETs sector at the early stage of their life cycle (revenues below €10m), credit risk is the predominant driver of the cost of bank lending to KETs companies in the scope of this study. Therefore the focus of the investigation is placed on the two main components of credit risk: the high probability of default of KETs companies (driven primarily by the high level of uncertainty around the ability to develop and commercialise new technology), and their high loss given default (as they typically lack sufficient tangible assets and find it hard to monetise their IP in the event of failure).

2.1.0. Components of credit risk

As described in Section 0, when banks review the profitability of extending a loan to an innovative SME, they review both the income that will be generated by the loan and the cost of providing credit. The primary driver behind the cost of providing a loan to KETs companies lies in their inherently higher level of credit risk. In the RAROC framework outlined in the previous section, the cost of credit risk is captured by the expected loss term; it is the weighted average loss that is expected to arise from lending to a client, based on a certain probability that the borrower will default and the amount that is expected to be lost if they do default.

Figure 8 compares the cost of bank lending for loans provided to average SMEs and KETs companies. The assumptions made throughout this analysis are outlined in the description of each cost component.

The **cost of funding** represents the cost of the funds deployed and is calculated through fund transfer pricing mechanisms that quantify the cost of borrowing for the bank, taking into account the maturity of the loan. In the current low rate environment, this cost is relatively small.

The **operational cost** is composed of the direct cost in underwriting the loan and running the credit processes, as well as indirect costs such as IT and client relationship management. The absolute level is taken to be the same for the provision of a loan to KETs companies and an average SME. However, this represents 20-30% of the cost of the loan for an average SME, while being a relatively small proportion of the cost for KETs companies.

The **cost of credit risk** represents the expected loss on the loan. It is equal to the product of the Probability of Default (PD), the Loss Given Default (LGD) and the Exposure at Default (EAD). As shown in the figure below, credit risk accounts for most of the cost of lending to KETs companies (70-80% of total costs) while, for an average SME, it accounts for approximately a quarter of total costs alongside operational cost and cost of capital.

Based on figures mentioned during interviews and observations, the PD for KETs companies is estimated to be approximately 15-20%[47]. The corresponding value for an average SME is in the 1-4% range.

With respect to LGD, KETs companies usually have few tangible assets and IP is rarely used as collateral. As a result and in line with the interviews, lenders generally do not recover the principal of the loan and therefore LGD is assumed to be ~100%.

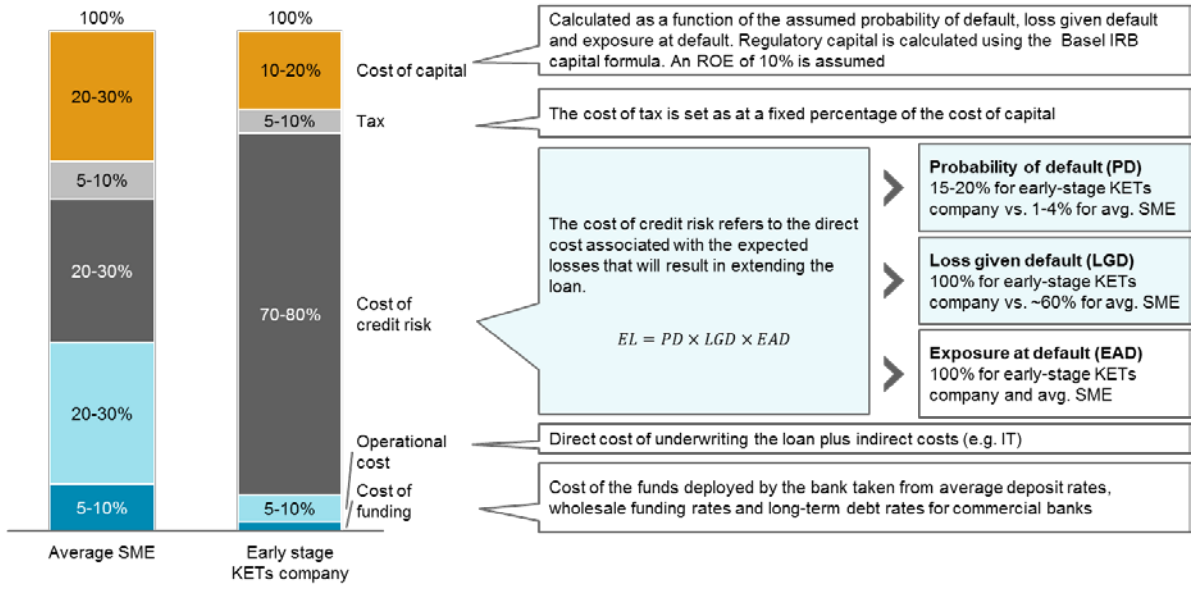
[47] Eurostat shows that ~20% of companies do not survive their first year and 60% do not survive the first five.

Given that the focus is on term loans whose exposure cannot be increased without additional approval, EAD is assumed to be 100%.

The **cost of capital** refers to the opportunity cost incurred by the lender in holding regulatory capital to cover potential unexpected losses related to the loan. First, the regulatory capital is calculated using the Basel II IRB risk weight function[48], using the benchmark PD, LGD and EAD. Commercial banks typically target 10-15% RoE. To be conservative, a target RoE of 10% is assumed. The cost of capital is a direct but non-linear function of the credit risk determinants, resulting in a high absolute cost of capital for KETs projects, but represents a smaller part of the cost than for average SMEs.

The **tax cost** refers to the cost incurred in paying income tax on pre-tax profit. This is calculated based on the income tax rate on cost of capital (i.e. the profit that shareholders would expect).

Figure 8: Breakdown of cost of providing loan[49]



Source: ECB, Basel regulation, interviews, Oliver Wyman proprietary data

"The risk is too high. It doesn't make sense for a bank to lend money to something which will fail with a high probability. Your IRR would have to be in the range of 40%"

– VC/PE fund

[48] Basel Committee on Banking Supervision (2005), "An Explanatory Note on the Basel II IRB Risk Weight Functions"
[49] Source: ECB, Basel regulation, interviews, Oliver Wyman proprietary data

2.1.1. Information asymmetries

One of the core determinants of credit risk is the probability of default (PD), which represents the expected likelihood that the company will default. While, as described earlier, the inherent risk of KETs companies is high on average, insufficient information on the borrower can make it harder for banks to differentiate between companies that are better or worse than average.

Banks use quantitative rating models for most SMEs and corporates, however these models cannot adequately be used for companies with a lack of historical financial information, not being designed for such. The lack of sufficient and high-quality information on KETs companies is a severe bottleneck inhibiting lending by commercial banks; however, the real underlying challenge is the fundamental financial uncertainty of the KETs company.

Interviews confirmed that an extensive financial history is needed, alongside healthy cash flows to truly spur lending. An innovative KETs company at the phase of piloting or scaling up, i.e. at the phase of the typical 'Valley of Death', will likely not yet have achieved significant revenues over a period of more than 1-2 years, and most likely is still a few years out from generating operative profits.

Therefore, of the bank representatives interviewed, about 80% said that it is essential that there is a clear record of financials and cash flows to qualify for a traditional bank lending product, and that the availability of other information, e.g. on the soundness of the technological concept or implementation record, would not make a significant difference. This is in line with the fundamental nature of debt as an instrument that guarantees fixed returns to the lender on the basis of recurring cash flows and not of potential upside or increase in revenue of the company.

"We like to see a proven track record in terms of generating cash."

– Bank

The theory of information asymmetries and screening

Information asymmetry refers to the situation whereby in a given transaction, one party has access to more or better information than the other. As outlined in Akerlof's seminal paper[50] on the used car market, referred to as the "Market for Lemons", the presence of information asymmetries is a market failure that in less severe cases results in inefficiencies and in severe cases can lead to the collapse of the market. In the context of bank lending, information asymmetries may also account for some of the financing constraints experienced by KETs companies. Banks cannot appropriately assess the risk involved in KETs companies and have therefore very little discriminatory power between relatively low-risk and relatively high-risk projects. The lack of differentiation may imply a required average interest rate that is too high for KETs to avoid and potentially too high for the bank to charge (to avoid the perception that they are over-charging). If banks were able to discriminate appropriately between KETs' risks through gathering information – a process known as screening – they would be able to extend credit at a lower interest rate to relatively low-risk KETs companies. The problem of information asymmetries is exacerbated by the fact that higher interest rates deter "safe" borrowers and encourage risk-taking (Stiglitz[51]).

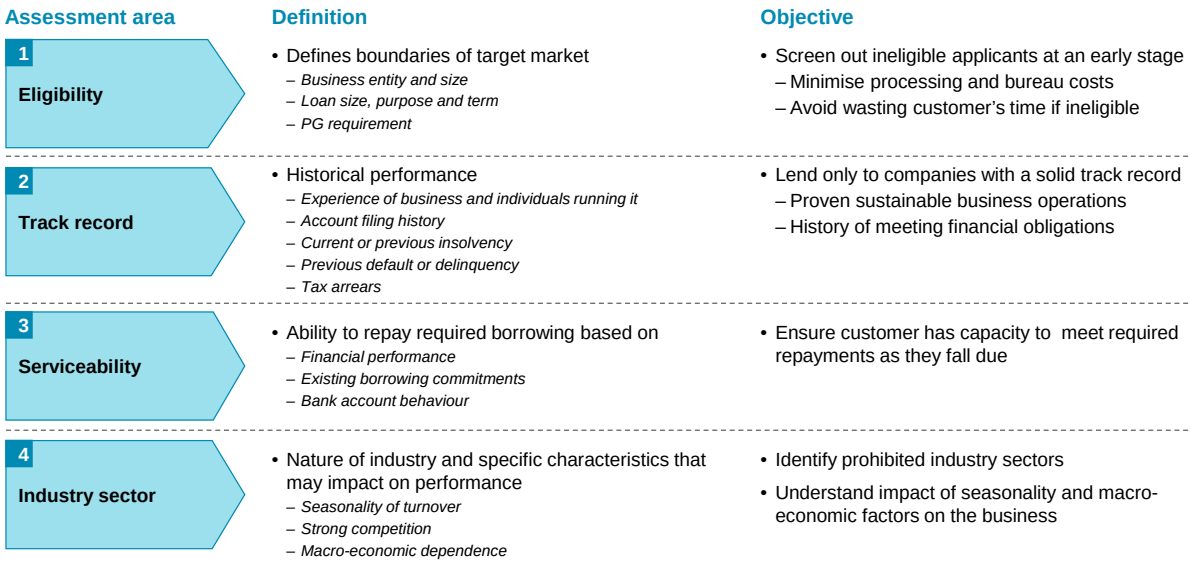
[50] Akerlof, George A. (1970). "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism". Quarterly Journal of Economics. The MIT Press. 84 (3)
[51] Stiglitz, Joseph and Weiss, Andrew (1981),"Credit Rationing in Markets with Imperfect Information", The American

Screening processes used by banks

Screening is employed by banks to mitigate the problems caused by information asymmetries. Banks' screening processes are typically divided into a **pre-screening stage** that is informed by the **overall strategy and risk appetite** of the banks, and a subsequent quantitative **credit assessment that is based on scorecards**, which feeds into the final credit decision and terms of the loan.

The pre-screening stage is used to filter application flow and typically focuses on four areas, as shown in Figure 9.

Figure 9: Overview of pre-screening process and criteria categories



Screening process for KETs companies

- First, the eligibility of the application is assessed given clear boundaries of the target market in terms of business entity and size, and general loan characteristics in terms of balance sheet size, purpose and maturity.
- Secondly, historical performance is reviewed looking at previous defaults or delinquency and the general experience of the business and its management.
- Thirdly, banks review the repayment capacity of the company, looking at financial performance, existing borrowing commitments and bank account behaviour.
- Finally, industry and sector-specific considerations such as competition, seasonality of revenues, and dependence on the macro economy are taken into account.

The result of this process is a high-level filtering of credit applications.

The next stage involves a more granular and quantitative credit assessment. For SMEs this is typically based on statistical scorecard models. The scorecard models consist of a number of relevant risk factors which are identified as predictive of the probability of default. These multifactor models are developed using statistical analysis and expert judgement. The resulting ratings are used to make the credit decision and to price the loan adequately.

KETs companies are particularly vulnerable to the problem of information asymmetries. They involve technologies which are typically very complex and are typically at the demonstration or piloting stage when looking for debt finance, and thus it is difficult for lenders to accurately assess the science, product, and ultimately the market risks involved in extending credit.

Despite the aforementioned challenges, the commercial banks interviewed suggested the due diligence processes followed for loans to deep tech companies do not differ significantly from those used to extend credit to other SMEs. The key issues are the lack of information on highly specific, frontier technologies as a whole, and the lack of experts who understand both the particular technological and business aspects of the companies. In addition, the underlying market for each specific KETs and related sub-sectors (in light of how specialised knowledge that would change this information asymmetry needs to be) is perceived as small in a given country at a specific time; given the high LGD and PD explained earlier and the difficulty to obtain very highly specialised expertise, commercial banks are hesitant to spend the resources to overcome this challenge. While most of the banks interviewed therefore did not have dedicated in-house teams, there were a few players with specialised sector knowledge.

"We are pretty comfortable with our resource capabilities at this point in time. Our expert team has bridged the gap between the technology and the credit team."

– Bank

The majority of banks interviewed did not make use of external resources, as the profitability of the relevant loan was not considered to warrant the cost of the external technology experts.

"We would like to have advisors but the size of the projects is not big enough to be able to involve external advisors. […] A good advisor costs €10-20k which is too high for an SME loan."

– Bank

The credit analysis is predicated on the availability of historical cash flows and, if available, tangible assets which can be used to secure the loan. Technological expertise is lacking, but the main challenge remains how the understanding of the technology can be translated into a credit risk assessment that is sufficiently accurate to provide adequate differentiation between different KETs projects.

"The technology expertise does exist in the market, but making it transferable to risk assessments is a whole different ball game."

– Bank

Lending to KETs companies in practice

Overall, the interviews suggested that a strong financial performance is usually a sufficient condition for lending, removing the need for a full understanding of the technology underpinning the KETs company. **It is however also a necessary condition.** Information asymmetries regarding the technology can be mitigated through the provision of additional information, provided this is

economical in relation to the size and expected return of the loan or investment; however this will not be sufficient to overcome a lack of financial history or collateral.

"Banks are conservative. They need to see cash flows and collateral to lend."

– Venture capital firm

Banks typically need visibility on cash flows for companies in any sector and are not willing to waive this condition for KETs companies given the associated risk. This can be different for other providers of finance. For example, venture capital funds are used to financing clients with no or weak cash flow history and it makes economic sense because they invest equity and generate high upside from successful companies.

"We do not have a strategy towards KETs companies. However, we do have a strategy oriented towards growth companies."

– Venture capital firm

2.1.2. Lack of collateral

The second fundamental driver of credit risk is the loss given default (LGD); that is, the proportion of the loan balance that will not be recovered in the event of default. It is typically calculated by discounting the expected recovery cash flows and comparing them to the exposure at the time of default. In the context of KETs companies and other innovative deep tech SMEs, the lack of tangible collateral is a bottleneck in the lending process, as commercial banks usually require collateral, especially in the event of little financial history. While KETs companies commonly have significant intangible assets in the form of intellectual property, patented or not, commercial banks have been reluctant to give it full weight as a form of collateral due to the difficulty in valuing an intellectual property that has not yet demonstrated the ability to generate reliable, recurring streams of revenue and cash flows; due to the difficulty in enforcing rights over such intellectual property, and due to the difficulty of liquidating it, i.e. finding a serious buyer, in the event of default. What is more, when young KETs' scale-ups fail, it is in practice hard to disentangle the core IP from the commercial failure, which further depresses the expectations of liquidation value. Recent advances such as 'patent books' might open up avenues for a change in investor behaviour over time, even then however likely focused on equity, rather than debt investors that generally are willing to take on higher risks.

The use of collateral in lending

The importance of collateral has been thoroughly examined in academic literature, with studies corroborating the fact that more valuable collateral increases the availability and the size of the credit obtained (Gan[52]). There are three broad categories of collateral that can be pledged: tangible assets, financial assets or intangible assets.

Tangible assets collateral refers to real estate, plant, machinery and equipment and is generally seen as desirable due to the relative transparency in valuation and the depth of the secondary markets. Indeed, Leeth and Scott[53] show that the incidence of secured debt is highly correlated with

[52] Gan, J. (2007). "Collateral, debt capacity, and corporate investment: Evidence from a natural experiment." *Journal of Financial Economics*, 85, 709-734.
[53] Leeth, J. and J. Scott. (1989). "The incidence of secured debt: Evidence from the small business community." *Journal of Financial and Quantitative Analysis*, 24, 379-394.

the marketability of the assets. This form of collateral can be used directly to finance the firm's activities with the use of asset finance (e.g. leasing).

Financial assets collateral can take the form of financial assets such as securities or invoices. Typically, for companies with a stable revenue stream receivables finance in the form of factoring or invoice discounting can be used to finance the company's operations. The size of the loan is dependent on the size of the financial collateral and the stability of the company's revenue stream.

Intangible assets collateral can consist of patents, licenses and other intellectual property rights. It is typically difficult to value and to resell and therefore challenging to use as collateral. However, evidence suggests that the availability of patents can be a signal of the new venture's chances of success and may therefore have some informational value (Long[54]).

Identified bottlenecks in using intangible assets as collateral

Most of the economic value for KETs companies lies in the IP that they possess. Typically, KETs companies have limited tangible assets to secure any debt. However, the commercial banks interviewed did not generally use the IP rights as collateral. In the rare cases that this was done, the IP rights did not fundamentally alter the credit decision and were rather taken as an additional security measure.

It is challenging for commercial banks as principal debt providers to use IP as collateral for a number of reasons.

First, for KETs companies with limited historical cash flows, the IP can only demonstrate its value as long as it is able to generate stable, recurring revenue streams. In the absence of this fact, any value of the IP is hypothetical.

"IP has no value until it generates revenue."

– Bank

Secondly, the valuation of IP is difficult, costly and unreliable. The inherent uniqueness of IP makes it challenging to use comparison-based pricing, as no proper proxy can be found. Therefore, any valuations are based on the market potential of the technology, its future uses, and the management's future decisions. This is usually a costly process which, in the case of nascent technologies, can result in a very wide valuation range.

"We do not use IP as collateral because you would need an institution to value it. Valuation is difficult. […] It is better to collateralise against equity of the company."

– Bank

"For very new and innovative IP such as biotech, the valuation of IP by specialists could result in a wide range of values."

– Bank

Thirdly, the **lack of a secondary market for IP** makes reselling the patents and licenses challenging. The lack of liquidity for intangible assets inhibits their use as collateral, as in the event the risk materialises and the KETs company defaults, the lender will not be able to easily recover a part of the loan through the sale of the IP rights. Therefore, even if a revenue-generating IP asset can be valued in a credible fashion, it will still be difficult to use as this value will not be easily realised.

[54] Long, C. (2002). "Patent signals." *University of Chicago Law Review*, 69, 625-680.

"In theory we could use IP as collateral but in reality, if the company goes bust what would we do with IP? We do not have the resources or the expertise to resell it."

– Bank

Finally, IP is a limited hedging tool as it presents a risk akin to 'wrong-way risk'[55]. Indeed, as the company stops generating sufficient cash flow to cover its interest payments, the value of the IP decreases as its potential to generate revenue is revealed to be lower than expected. This is an issue as lenders typically want to hold collateral whose value is not correlated to the probability of default.

"With IP for biotech companies, it's like the Oscars – if you win, you win big, but if you lose, nobody cares."

– Venture capital firm

Recent Trends

While some private sector entities sometimes use IP as collateral, it is usually limited to venture debt or specialist lenders and for larger companies. Specialist lenders and investment management firms have also explored the idea of IP-backed financing. Fortress Investment Group, an investment management firm recently acquired by SoftBank, recruited senior personnel from RPX, a firm specialised in patents, to develop its IP finance offering. The newly-formed group focuses on IP lending with deals going as high as USD 30m[56]. Some US banks have looked at the possibility for insurance companies to insure the IP and use that insurance as collateral.[57] However, this is costly and cumbersome, and the risk of losing the IP is a major deterrent for entrepreneurs.

Moreover, companies such as Ocean Tomo, IP Bewertungs AG, and IP Auctions Inc. run IP auctions, while IP exchanges and marketplaces are provided by Yet2.com. These could in the future facilitate IP collateralisation.

Figure 10 below shows an overview of players in the market for IP in Europe and the US. In Europe, the possibilities for IP monetisation and valuation still lag behind the US.

The poor recovery rates resulting from the lack of collateral does constitute a significant bottleneck in the access to traditional lending by KETs companies and the above challenges result in very limited IP-backed lending on the part of commercial banks. More recent advances such as PatentBooks from the US might have started innovative models that could result in a change of the perceived weight of IP-based collateral by debt providers, however there is too little evidence at present and the relevant models are too early in their development to make a firm statement.

Chapter 3.1.2 provides an in-depth discussion of advances in valuation techniques and their potential forward impact on bank lending.

[55] Wrong-way risk is defined by ISDA as an "exposure to a counterparty adversely correlated with the credit quality of that counterparty". In this study, we extend from counterparty credit risk to traditional credit risk to define the correlation between the risk of default of a borrower and the value of the collateral.
[56] IAM Media, "Fortress makes major move into IP with hire of former RPX president"
[57] Financial Times, "Banks eye intangible assets as collateral", 11 June 2012

Figure 10: Overview of selected IP players in United States and Europe

Type	United States		Europe	
IP Financing Give out loans with Intellectual Property (IP) as collateral	OCEAN TOMO	Ocean Tomo values IP and uses its network to find capital for financing	FRANCE BREVETS	France Brevets provides financing based on IP, taking a share in the licensing revenues when the IP is successful
	FORTRESS	Fortress Investment Group provides IP-backed loans		
IP Valuation Give assessment of the value of IP; assist IP financers in determining value of IP collateral	OCEAN TOMO	Ocean Tomo provides IP valuation services	ipeg	IPEG Consultancy is a Netherlands-based company advising on IP valuation
	inngot	Inngot provides tools to help companies value and manage their IP		
IP monetization Enable the exchange and/or auction of IP, thereby allowing for monetization of IP	OCEAN TOMO	Ocean Tomo provides a marketplace and auctions for IP	yet2com	Yet2 is an American company which also provides a marketplace for IP in Europe
	GENERAL PATENT CORPORATION	General Patent Corporation provides patent brokerage services		

Fragmentation of financing options for KETs companies

A key problem in financing KETs companies is the overall fragmentation of the availability of capital across geographies and along the companies' life cycle. There are three core issues.

- First, there is insufficient subordinated and hybrid debt provided to KETs companies given the early stages of the European venture debt market at large and the aforementioned disincentives for commercial banks to venture into this part of the capital market.
- Second, additional equity capital is necessary for very early-stage KETs companies, as this form of financing is most appropriate given the very high-risk profile of these undertakings at that point in time. In addition, increased equity will have a multiplicative effect on the access to finance of the KETs companies.
- Finally, even if the overall availability of debt and equity is increased for KETs companies, there needs to be adequate supply at every stage of the life cycle to avoid any bottlenecks. This process needs to be fully and transparently coordinated between the different actors at the regional, national and European levels.[58]

[58] The Free State of Saxony has implemented a coordinated approach to develop a cluster focused on nurturing the micro- and nano-electronics industry through coherent coordination at the regional, national and European levels; see case study on 'Saxony's smart specialisation strategy'.

Figure 11: Quotes from venture capital firms on the European financing landscape for KETs

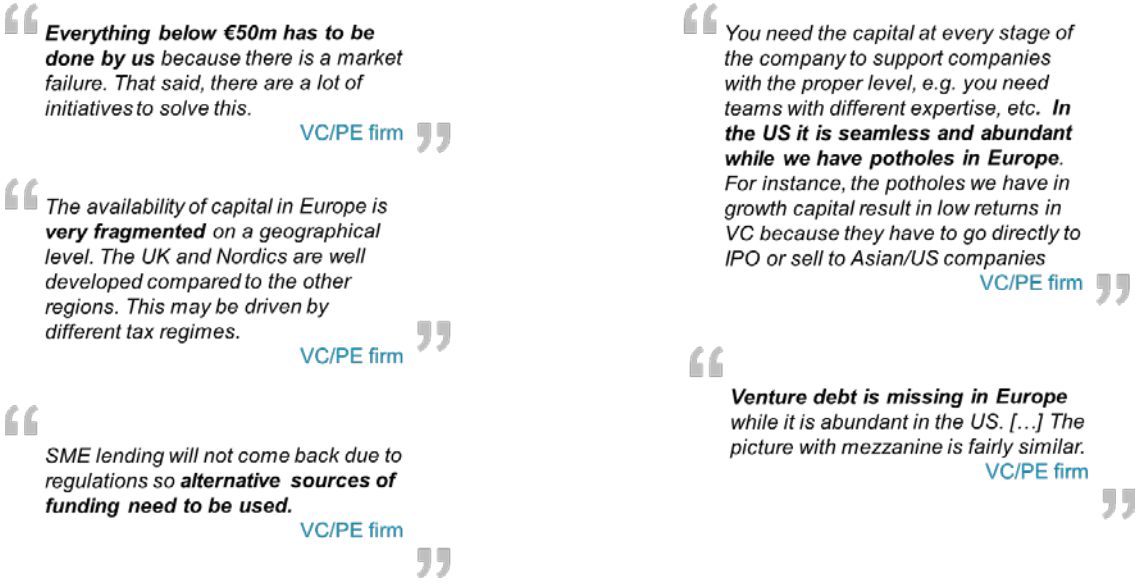
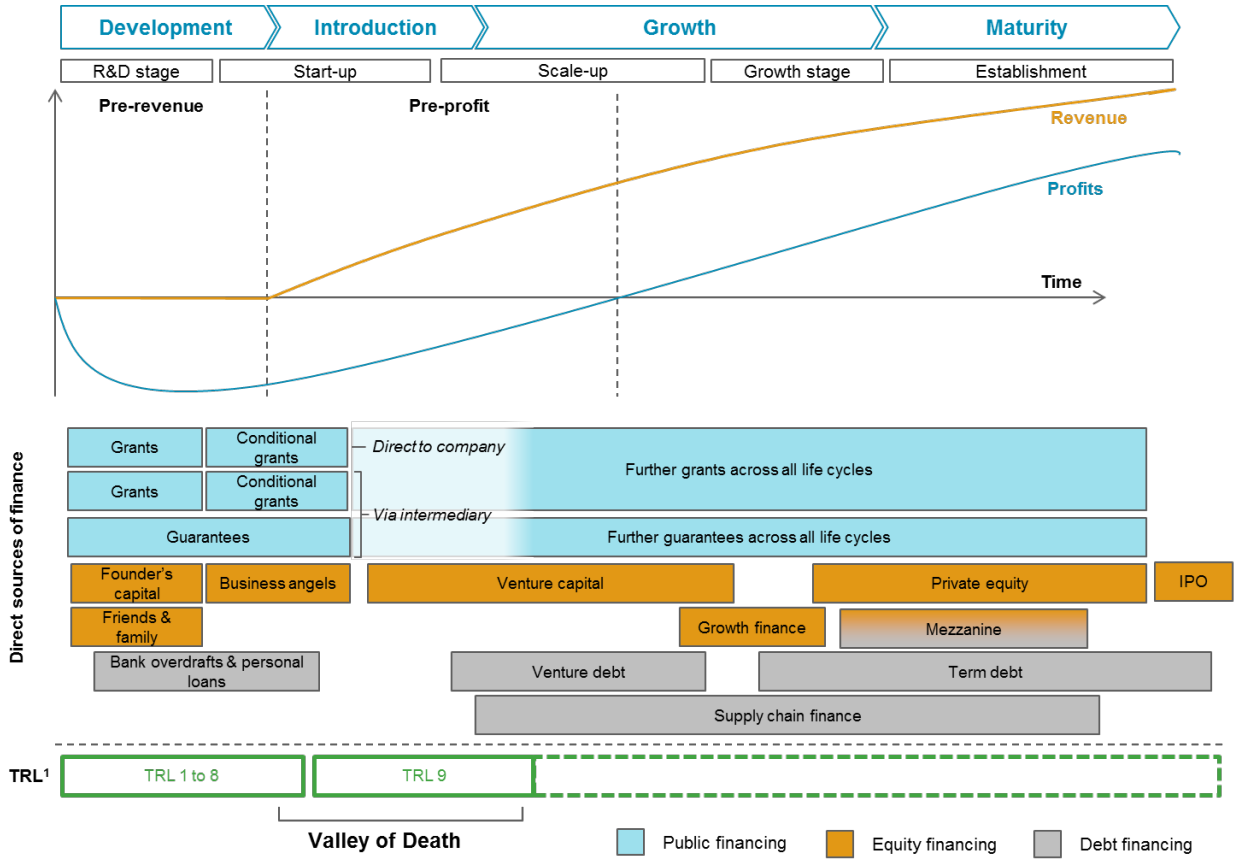


Figure 11 highlights statements by VC/PE (equity) providers that highlight the missing gap in the form of more and more widely spread hybrid capital between equity and debt ('venture debt' or 'quasi-equity'), augmented by the geographic fragmentation of the only readily available alternative, i.e. equity from venture capitalists, that is too concentrated in certain countries/regions in Europe.

Figure 12 summarises the fact that there is a more or less adequate type of capital (debt or equity or hybrids) according to the underlying TRL as well as corporate deployment. A fixed income instrument such as traditional bank lending is only suited once the company becomes operatively profitable and has already demonstrated for a few years its capacity to generate income. Prior to that moment, i.e. in TRL 1-8 and especially TRL 9, higher risk-taking financing instruments are required, e.g. plain equity or, once the company approaches operative profitability and has started to receive first income, venture debt/quasi-equity.

Figure 12: Overview of financing at different stages of the KETs company life cycle



2.1.3. Debt

As demonstrated earlier in this document, traditional senior loans to KETs companies are typically not economically viable for commercial banks and thus, other forms of debt-like financing need to be explored. There are significant gaps in the financing chain between grant financing and traditional bank lending. This gap can be mitigated using hybrid capital, which offers cheaper financing to growing companies or hybrid instruments between loans and grants at earlier stages of the life cycle.

Supply chain financing can provide working capital financing as soon as the KETs company starts to generate revenue. Typically, this can be done through the use of factoring, where the KETs company's account receivables are sold or used as collateral for a loan provided by a third-party factor. Currently, there is a sizeable volume of factoring (estimated at €1.6bn of turnover in 2016[59]) in Europe but there is a shortfall in reverse-factoring and purchase order financing which could improve KETs companies funding. A reverse-factoring platform similar to the Mexican Finance Ministry's '*cadenas productivas'* programme (see case study in chapter 3.2.2) to support SMEs that demonstrates that government can effectively support the industry does not exist in the EU[60]. An alternative to accounts-receivable financing that occurs *after* the service/product has been produced/procured, is an even more upstream, proactive type of funding in the form of contract finance. In this variation of supply chain finance, the credit is extended upon signature of the contract to enable the very production/procurement of the service/product. Especially for KETs companies that are active at scientific frontiers, and have demonstrated a viable piloting line, this type of contract finance could become critical to convince their mid-cap or large-cap buyers of the availability of sufficient funding to execute a more sizeable contract and helps to solve the vicious circle of 'no contract without funding, no funding without contract' that KETs companies in practice often encounter.

> *"Young KETs firms need financing to deliver on the first credible contract to be able to compete with larger competitors."*
>
> - VC/PE firm

Hybrid capital could further offer some cheaper financing options than pure equity. During the early scale-up stage of the company's growth, there is still too often insufficient grant money. This is coupled with the very limited availability of senior debt, which constitutes the next cheapest alternative, given the too high risk expressed in LGD and PD rates of KETs demonstration projects (even the successful ones). In this context, hybrid debt instruments with equity-like characteristics could offer adequate return to lenders and investors, while providing cheaper capital than pure equity to KETs companies as well as avoiding the dilutive effects of equity for the founders as the original risk-bearers (typically venture debt providers do not primarily seek to hold shares in the company and the subsequent sale of executed warrants is frequently observed). Such examples include venture debt, which has been explored by certain banks and is a typically subordinated, unsecured debt tranche[61] with equity kickers or warrants (options to purchase company shares) attached; as well as mezzanine financing and, more generally, junior debt. Returns to investors consist of a usually single digit

[59] Statistics, Factor Chain International (2016)
[60] See paragraph on Supply chain financing, 3.1.4
[61] Senior debt exposure under EIB/EIF InnovFin SMEG

cash interest p.a. and a usually double digit interest component that is secured through the lender's/investor's participation in the upside of the business, for instance through the exercise (and often subsequent sale) of the share options. In the event of a negative business development, the lender/investor bears the risk that this additional return component will not materialise. A more comprehensive offering of such products would alleviate some of the bottlenecks experienced in the financing of high-growth innovative SMEs.

For instance, Europe lags behind the United States when it comes to venture debt. US venture capital-backed firms received USD 2-3bn of venture debt in 2009, whereas European venture debt investments have been in the tens of millions of euros only. These investments have been dominated by the few existing European venture debt companies: Kreos Capital, ETV Capital, Noble Venture Finance, and Silicon Valley Bank (the latter focused on the UK and Ireland to date).

"I have seen some venture debt but, at the early stage, it remains dominated by equity"

– VC/PE firm

While grants are abundant at the very early stages of development, there is insufficient funding before venture capital firms can step in. Indeed, there is insufficient public funding that supports the growth of the company during demonstration and piloting of the product, e.g. in the form of innovation loans and conditional grants. Such products require repayment but are more flexible than traditional bank lending in their requirements. For instance, repayment of contingent grants is dependent on the success of the project. In other words, such a financial instrument enables public authorities to somewhat increase their financial capacity (as they get repaid some of the funding they would provide to KETs companies) while not creating additional pressure on entrepreneurs and new projects (as they do not require repayment in the event of failure). In addition, contingent grants have the advantage of not diluting the shareholders as they are a debt instrument which increases the potential return for investors as it leverages the equity investment.

Overall, the lack of non-traditional debt instruments in Europe, including venture debt, mezzanine and junior debt, hinders the growth of KETs companies and other innovative SMEs. However, there needs to be adequate consideration of the amount of leverage in European SMEs. Indeed, 77% of EU funding for SMEs overall (not distinguished by KETs or non-KETs) was in the form of debt, compared to only 40% in the US[62]. In this light and as suggested by the first joint EIB-EC KETs study already (Recommendations 2 and 5), the lack of non-traditional debt should be reviewed in conjunction with the gap in equity financing.

2.1.4. Equity

The overall need for more and more evenly available equity capital was highlighted as a very strong theme in the interviews conducted across commercial lenders, venture capital providers and public authorities, and by the interviewed KETs companies in the first study. It is expressed in the significantly lower size of the venture capital industry in Europe compared to countries such as Israel, the US or Canada. Increasing the availability of equity capital at all stages of the life cycle, especially in the scale-up phase from funding rounds A to C, can provide for more adequate financing of high-risk ventures and for a knock-on effect via increased debt capacity.

[62] AFME and BCG, (2015), "*Bridging the Growth Gap*"

VC investments in Europe have been estimated at €3.8bn in 2015, compared to USD 59.1bn (~€54.4bn) in the US[63]. Moreover, VC investments represented a share of approximately 0.02% of GDP for the EU whereas this figure was 0.3% for the US. In addition, the average European VC-backed company receives only €1.3m (€356 000 at seed stages), compared to €6.4m in the US (€2.9m at seed stages)[64]. Some European countries such as Finland and Sweden have comparatively well-developed venture capital scenes, but these are still considerably smaller than the leading countries such as Israel, the US and Canada. The European Investment Fund estimates that in 2014, 41% of total investment activity was ultimately backed by the EIF.

Table 2: Financing sources for SMEs, 2013[65]

SME

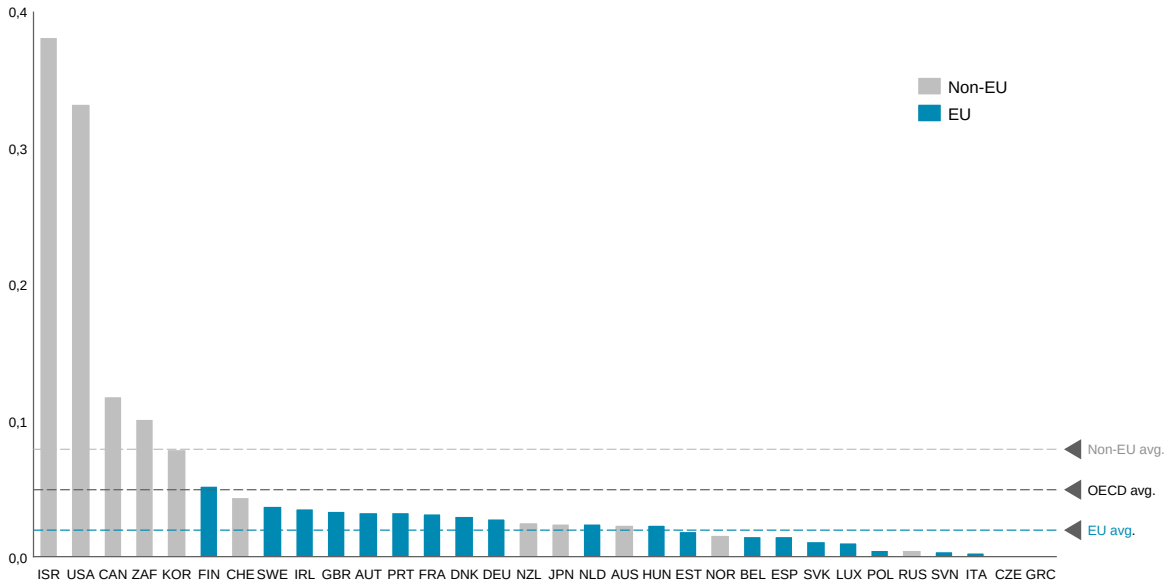
		Stock (of outstanding financing)		Flow (of new financing in 2013)	
	Source	**US (€ bn)**	**EU (€ bn)**	**US (€ bn)**	**EU (€ bn)**
Banks	Loans	464	1 425[1]	281[1]	712
	Securitised loans	30	118	5[1]	36
	Bonds/Equity	Desk research and investor interviews indicated only marginal investments			
	Subtotal	**494**	**1 543**	**286**	**748**
Non-banks	Mutual funds	107	88	10	7
	Segregated mandates	~5	~10	~1	0
	Pension funds	Desk research and investor interviews indicated only marginal investments via funds, mandates or securitisation			
	Insurance				
	SWF				
	Private equity funds	59[1]	32[1]	14[1]	9[1]
	Venture capital funds	104[1]	22[1]	26	5
	Family and friends	371[1]	168[1]	186[1]	84
	Crowdfunding	3[1]	1	1	1
	Angel investing	39[1]	11	20	6
	Subtotal	**688**	**332**	**258**	**112**
Government	Government guarantees and sponsored loans	54[1]	132[1]	27	66[1]
	Subtotal	54[1]	132[1]	27	66[1]
	Total	1 236	2 007	571	926

1. Estimates used, see Appendix 2

As shown above, venture capital investments in Europe have been estimated at €3.8bn in 2015, compared to USD 59.1bn (~€54.4bn) in the US[66]. Moreover, venture capital investments represented a share of approximately 0.02% of GDP for the EU whereas this figure was 0.3% for the US. Some European countries such as Finland and Sweden have comparatively well-developed venture capital scenes, but these are still considerably smaller than the leading countries such as Israel, the US and Canada.

[63] AFME, (2017),"The Shortage of Risk Capital for Europe's High Growth Businesses", p. 47
[64] NVCA 2016 Yearbook, 2007–2015 statistics
[65] AFME and BCG, (2015), "Bridging the Growth Gap"
[66] AFME, (2017), "The Shortage of Risk Capital for Europe's High Growth Businesses"

Figure 13: Venture capital investments as % of GDP, 2015[67]



This view was corroborated by interviews with commercial banks and venture capital firms. There is a general lack of equity capital, especially in the scale-up stages.

"The issue is with the lack of equity and seed funding and subordinated debt."

– Bank

Additional equity is necessary for a number of reasons.

- Equity is particularly well-suited to finance KETs companies as it allows the investor to share the potential upside in addition to the high risk. In this light, the crowding-in of private venture capital achieved by the EIF programmes should be maintained and potentially scaled up[68].
- In addition, increasing the amount of equity in the company leads to an increase in the business's debt capacity. This is due to the fact that the same leverage ratio can be maintained for a higher level of debt, given the increase in equity. This would provide a multiplicative effect in financing and has been cited as a bottleneck for bank lending.
- Finally, various studies show the positive correlation between the innovativeness of the economy and the prominence of the VC industry (e.g. relationship between venture capital propensity and innovation score study, 2015)

"For large loans to early-stage companies, we often request additional equity, e.g. €5m more for a €25m loan."

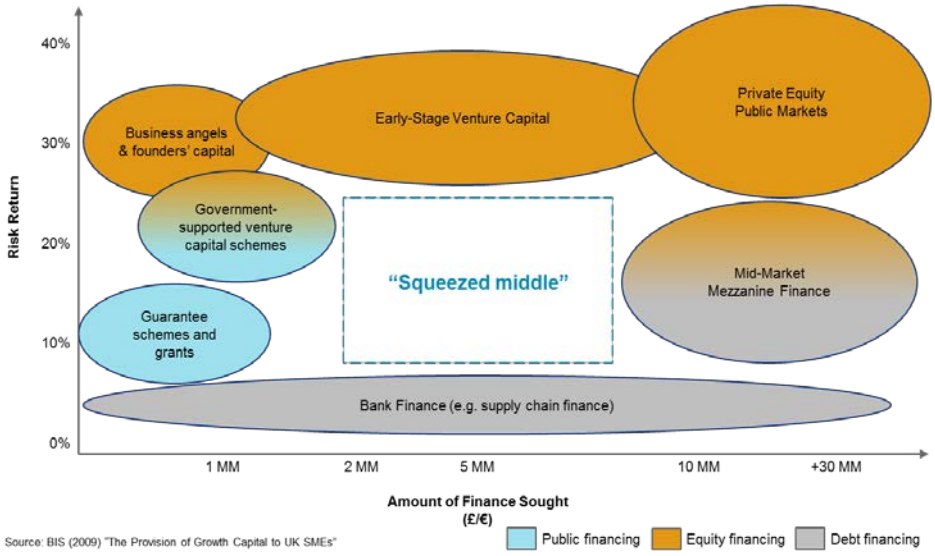
– Bank

[67] OECD, *Entrepreneurship at a Glance*, 2016.
[68] See section 3 on potential solutions.

2.1.5. Adequacy of products depending on risk return

As we have seen, different financial products are adequate for different companies, depending on their risk profile. Traditional debt products are more suited for more mature companies with a track record and stable earnings which make the debt sustainable[69] and more predictable for the lender. On the other hand, equity investments can be adequate for higher-risk companies since return payments (dividends) can be delayed depending on immediate cash flow needs and the investor can profit from the overall value of the company. Figure 14Figure 14 illustrates how KETs companies are "squeezed in the middle". Venture debt may be part of the answer as it limits the dilution of those shareholders that took the highest development risk at the very inception of the company, and provides development space.

Figure 14: Financing options for risk-return profiles and amount of finance sought



In the case of KETs, the figure below Figure 15 illustrates the varying profitability of various financial products offered to a portfolio of ten KETs companies. The products used in this example are traditional debt (which presents low profitability due to the high default rate), venture debt (which meets return targets) and equity investments (which are quite high given the value of the companies at the time of exit). We also take into account the effect of financial guarantees provided by the EIF and national promotional banks (NPBs) to reduce the impact of the lack of collateral.

[69] The company is able to pay back the interest and principal on the loan in line with the agreed schedule.

Figure 15: Illustrative returns of a portfolio of KETs companies for traditional debt, venture debt and equity

From investments in a portfolio of 10 companies…

Based on total investment of 10

Company	Initial investment	Future enterprise value
1	1	20
2	1	15
3	1	5
4	1	1
5	1	1
6	1	-
7	1	-
8	1	-
9	1	-
10	1	-

Key assumptions

- Company portfolio
  - Lifetime default rate – 50% (note that this is low for innovative, high-growth SMEs
  - Asymmetric success
- Leverage of 6% for banks and 1% for funds
- Interest of 5% on bank loans and 13.5% on venture debt (with equity warrant of 15%)
- 0% discount rate and no cost to guarantee

… the debt portfolio would incur a significantly negative return while hybrid and equity portfolios could generate significant positive returns

Based on assumed total investment of 10

Instrument	Net return (net of initial investment)	Return on assets		Return on equity	
		Multiple	Annual IRR	Multiple	Annual IRR
Debt	(3)	(0.3)	-5%	(5.4)	-224%
Debt (with guarantee)	(1)	(0.1)	-1%	(1.3)	-182%
Hybrid	6	0.6	7%	0.6	7%
Hybrid (with guarantee)	9	0.9	9%	0.9	9%
Equity	32	3.2	23%	3.2	23%

- Losses on debt products:
  - more than offset any income from loans, even with guarantees
  - are magnified by the level of leverage banks use
- However, hybrid debt and equity benefit from the significantly asymmetric profile of returns on the few successes in the portfolio
- Note that our assumptions are relatively conservative with regard to the default rates which we would expect to be higher for KETs companies

Source: Oliver Wyman analysis

This example illustrates the challenge in making traditional debt sufficiently attractive for banks to lend to KETs companies due to their inherent riskiness. Equity investments by VC firms are generally a more adequate tool but they may present challenges as they require very high returns and dilute shareholders. In other words, KETs companies face challenges in finding financing between products that yield too low a return to offset losses (e.g. bank debt) and equity investments that require high returns.

2.1.6. Coordinated financial and non-financial strategy

In order to ensure a smooth transition between fundamental research and development and a full-scale commercialisation of a KETs product, there needs to be a robust chain of financing across all stages of the company's life cycle and across geographies. More broadly, adequate coordination between all players is required in producing the networks, knowledge transfers and other non-financial support (e.g. business advice) that are fundamental for KETs companies and other innovative SMEs. This is particularly relevant for KETs companies which, due to the innovativeness of the developed technology and the opening-up of at times completely new markets, typically take longer to reach the operative break-even point.

Sufficient capital across the full life cycle is important for two reasons.

- First, if there is a gap in financing at a given stage, a bottleneck in growth is created. In light of speed-to-market considerations and especially in fields of network economics, this may negate all efforts invested in providing finance at other stages of the life cycle.
- Second, there are negative externalities downstream and upstream if there is insufficient capital at a certain stage. For instance, if there are funding gaps at the growth stage, the exit opportunities for earlier-stage investors are limited and may occur at discounted prices. Similarly, insufficient capital upstream will reduce the number of investment opportunities available for the financial intermediary.

> *"You need the capital at every stage of the company to support companies with the appropriate level of financing."*
>
> – Venture capital fund

While geographic concentration of investments is observed in other regions of the world (e.g. venture capital investments in the US are highly concentrated in three states: California, New York and Massachusetts), the level of fragmentation of capital in Europe appears to be a particular challenge for investors. Indeed, investors see some regions with a high availability of equity capital (e.g. UK, Nordics) and many other regions facing more difficulties. A number of participants during our interviews, especially equity investors, highlighted that the current fragmentation of Europe, especially with regard to laws and regulations, tax and the diversity of cultures, are challenges for investors and lenders to provide capital across the entire region.

> *"The availability of capital in Europe is very fragmented on a geographical level. The UK and Nordics are well developed compared to the other regions. This may be driven by different tax regimes."*
>
> – Venture capital fund

This challenge was also highlighted by the European Committee of Regions in a recent opinion[70]. In particular, it pointed out that "financial instruments at local and regional level are still not available in all Member States and regions, optimal use cannot be made of the available instruments and experiences, and the involvement of the private sector is often confined purely to carrying out orders, which increases the need for support for local promotional financial institutions."

[70] "Opinion of the European Committee of the Regions — Working together for jobs and growth: the role of national and regional promotional banks (NPBs) in the investment plan for Europe"

As shown in the figure below, there are certain stages of the KETs' product development and commercialisation life cycle where there is insufficient capital available. This is particularly true in the market introduction and growth phases. In fact, it is most prominent around the scale-up/growth stage that occurs in the transition between these two life-cycle phases. This gap can be remediated through the use of new products such as conditional grants and innovation loans, or through increasing the capacity of existing ones, such as venture capital and venture debt. Overall, the interviews of this study confirm that still today there is a clear perception that there is insufficient availability of capital at this stage, independent of efforts by public authorities.

Figure 16: Availability of financing at different stages of the life cycle for KETs companies

Source of finance		Development	Introduction	Growth	Maturity
Government funding	Grant	✓	✓	✓	✓
	Conditional grants	×	×		
	Innovation loans		~	~	
Equity financing	Angels	✓	~		
	Venture capital	~	~	✓	
	Growth financing			~	
	Private equity				✓
	IPO				✓
Debt financing	Venture debt		~	~	
	Term lending			~	✓
	Supply chain financing			~	✓
Overall availability		Financing available	Gaps	Some gaps	Financing available

Gaps in government and equity funding ✓ Sufficient funding ~ Funding to be expanded × Insufficient funding

> *"There are no public sector products to support companies at the scale-up stage despite some initiatives by government."*
>
> – Bank

More broadly, it is crucial to ensure transparent and consistent coordination between the different actors that provide capital across the technology development and product commercialisation life cycle. The challenge is for public authorities to provide a clear, easy to access and to understand overview of all the public support available – at the regional, national and European levels. At present, while there is a wealth of information about public funding available, this is extremely challenging to navigate – not only is the information still too scattered and not sufficiently linked up between national/regional and EU levels, it is also dominated by policy language and terms that commercial entrepreneurs are unlikely to be familiar with. Lastly, it is too often split by narrowly defined eligibilities which further obscure the availability of what type of support for what type of company. Any support provided by different public authorities such as local development agencies, NPBs, the EIB, the EIF and the EC needs, however, to be complementary and integrated into the existing initiatives, with the imperative to be easily understandable for the end user. A successful strategy would ensure that KETs companies and other new ventures and SMEs have adequate visibility, the right understanding and easy application access to all the financial products, support

schemes and knowledge transfer initiatives provided by the public sector in the first instance, and by the private sector in addition as a second step. The EC is well-placed to act as a central coordinator of such information across Europe and the various policy levels.

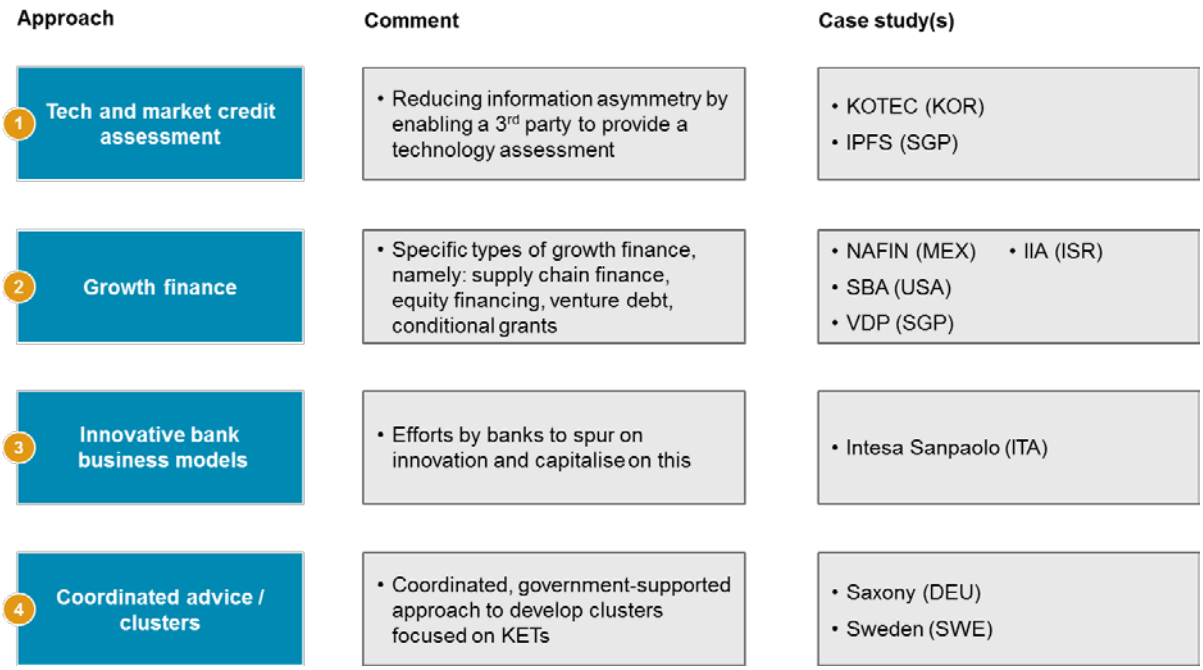
> *"Navigating through the various aspects of support by the public authorities is very time-consuming and difficult."* – *Bank*

3. Evidence of best practice solutions from case studies

Summary

Several potential solutions have been identified that aim to address the bottlenecks discussed in Section 2. These are supported by case studies of national and regional authorities, and are assigned to four categories.

Figure 17: Innovative approaches used to overcome identified bottlenecks



Technology and market credit assessment

Reducing information asymmetries would allow banks (and other capital providers) to better assess the risks involved in investing in KETs companies. By providing assessments of KETs companies' technologies, governments can increase transparency as a measure of companies' viability where no financial track record is available.

We have observed KOTEC in South Korea[71] providing a technology credit rating that informs investors' decision-making. A tech risk rating tool was built based on data from grant giving, based on 500 000 technology appraisals over 20 years. This tool is used to support loan underwriting by banks.

Furthermore, governments can assist investment in KETs companies by facilitating the use of IP as collateral. By supporting the valuation of IP, potential investors will know its value as collateral and the likelihood of monetisation.

[71] See paragraph 'Korea Technology Finance Corporation – Technology Assessment'

The Intellectual Property Financing Scheme in Singapore[72] is an example of enabling IP to be used as collateral. IPFS is a SGD 100m financing scheme aiming to enable IP-rich companies to monetise their intangible assets. It subsidises the cost of the IP valuation so that it can be used as collateral for loans from partner banks. The Singaporean government underwrites part of the loan. The practical impact of this initiative still remains to be seen as of today (with only very few loans provided that way yet).

Growth Finance

Several countries have had success in spurring innovation by providing various forms of growth finance. Equity financing, venture debt, supply chain finance, and conditional grants are all examples of successful growth financing schemes.

Equity financing has been particularly successful in the United States, where the Small Business Administration's Small Business Investment Companies (SBIC) programme, providing higher returns to private investors than to the public backing, is credited with creating the country's vibrant venture capital market. By co-investing with small VC funds it has managed to spur the development of technology companies. Among the companies to have received financing from SBIC are Amgen, Apple, Intel, Tesla, and Sun Microsystems.

Venture debt provides financing to higher risk, IP-rich companies by allowing creditors to partake in the upside. It is therefore a hybrid instrument combining debt and equity characteristics that can be applied earlier than commercial bank lending and later in the stage than equity. Furthermore it has no dilutive effects and preserves the higher return rewards available to the original risk-takers, i.e. the founders and first investors. We will therefore look at the VDP programme launched in Singapore by its innovation agency SPRING[73] as well as the European Growth Finance Facility of the EIB.

Supply chain finance refers to various financial products that allow small companies to smooth out their payments to suppliers while waiting on payments from clients. Factoring, for example, enables a company to sell its invoices to a third party at a discount. By immediately receiving the cash, without having to wait for payment by its clients, the company generates cash flow that can be used to service interest or pay suppliers. The Mexican government has created a successful reverse-factoring platform that accounts for 75% of all factoring transactions. A similar approach in Europe could improve the environment for KETs.

Conditional grants are grants that convert into loans if a company becomes able to repay it. By giving out these products, rather than traditional grants, governments can over time increase the pool of capital available for investment as grant money is returned by successful companies. Israel's Innovation Authority has provided these types of grants for 20 years.

Innovative bank business models

Large banks have also identified opportunities with high-growth, deep tech SMEs and attempted to capitalise on these. This may consist of setting up venture debt or venture capital arms; creating dedicated in-house expert teams; or setting up incubators, innovation centres, or seed investment capabilities. For instance, Intesa Sanpaolo runs three initiatives for high-growth, deep tech SMEs. It

[72] See paragraph 'Intellectual Property Office of Singapore – Intellectual Property Financing Scheme'
[73] See paragraph 'SPRING – Venture Debt Programme'

has set up a start-up seed initiative, innovation centres in key European hubs, dedicated innovation teams, and large venture funds[74].

Coordinated advice/clusters

Governments can optimise the environment for KETs companies by coordinating their efforts around the activities of other players. This could consist of ensuring that key financial products are made available, or of providing support to clusters.

For example, Sweden's Ministry of Finance takes an active role in ensuring finance is available to companies at all growth stages[75]. It does this by setting up its own ventures or by supporting other players.

The Free State of Saxony in Germany likewise ensures that financing is available for companies within its "Silicon Saxony" cluster. It does this by coordinating with e.g. the European Investment Bank. Moreover, it supports a trade association that ensures that local KETs companies, larger manufacturers, universities, research institutions and public authorities communicate and cooperate[76].

Technology and market credit assessment

As discussed in Section 1, a major bottleneck in traditional lending to KETs companies resides in credit risk, which is mainly driven by high default rates and lack of collateral.

One of the factors driving the high default rates is information asymmetries – traditional banks face significant difficulties when valuing KETs' technology due to their limited understanding of the specific "deep tech" and the market it is operating in. This is a costly process which requires significant expertise – and has therefore not been worth the opportunity cost for many banks.

This section explores different approaches to technology and market credit assessment that aim at mitigating information asymmetries and thus allowing better assessment of the credit risk involved and increasing the availability of financing for KETs companies, notably the use of a "technology credit scoring tool" as observed in KOTEC in South Korea. This approach has created greater transparency for private-sector investors and a clear rationale for the allocation of public resources including conditional grants. However, there were some limitations in that the approach could only differentiate between lower-risk companies that are able to receive conditional grants vs. higher-risk companies. An enhanced rating system supported by a structured database would help provide more granular differentiation between higher-risk and lower-risk companies, and thus allow banks to effectively lend to the firms that have an adequate risk profile, thereby reducing their average probability of default. This will increase the inherent attractiveness of the market and stimulate lending.

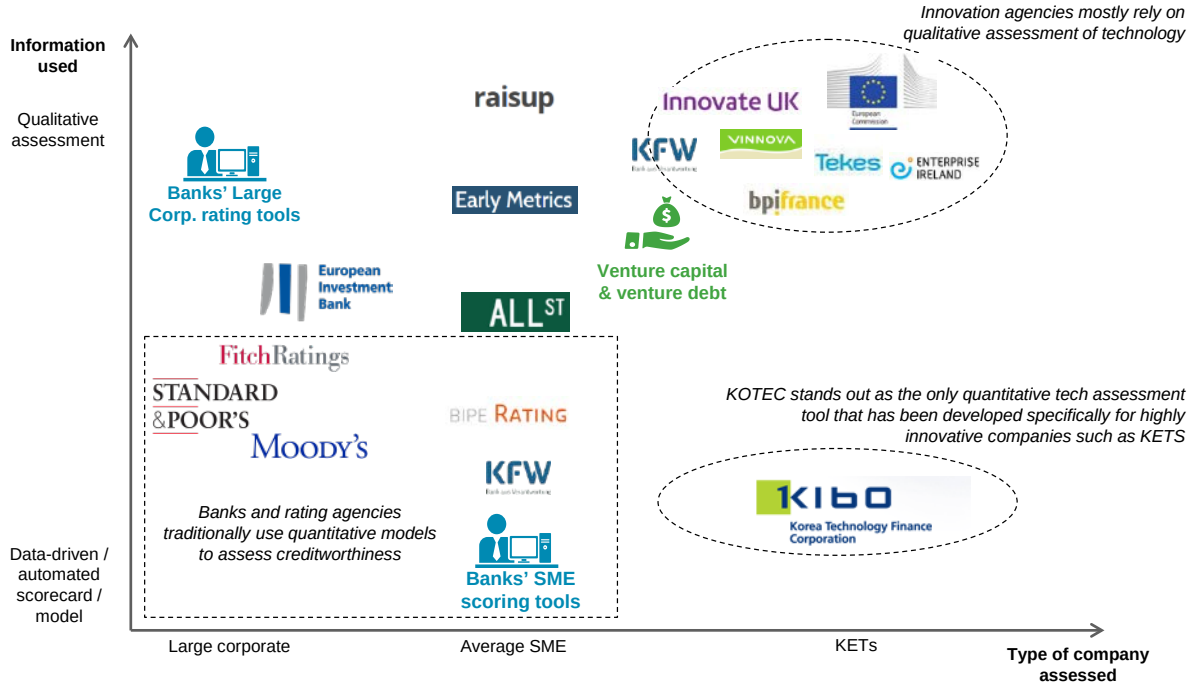
The section also reviews approaches that have been taken to use IP as collateral. Some governments have indeed put in place schemes to facilitate the use of intangible collateral; however, few to date have succeeded in finding a cost-effective solution for early stage SMEs.

[74] See paragraph 'Intesa Sanpaolo'
[75] See paragraph 'Chain of financing in Sweden'
[76] See paragraph 'Saxony's smart specialisation strategy'

3.1.1. Using technology and market credit assessment to overcome information asymmetry

Various approaches are currently used in the market to assess the creditworthiness of companies, from data-driven to more qualitative methods. Figure 18 represents the various potential approaches to assess creditworthiness and innovation.

Figure 18: Schematic representation of existing scoring tools



There are three broad types of approach that could be explored to reduce information asymmetries: producing market-level studies, subsidising the cost of technology assessments incurred by lenders, and developing company-specific technology assessments.

Table 3: Potential approaches to tech assessment

	1. Market potential assessment	2. Subsidising tech assessment	3. Technology credit rating
Description	Public authority gathers significant data on a sector, especially data relevant to financial actors (e.g. demographics of the sector, probabilities of default)	Public authority subsidises part of the cost of conducting a qualitative tech assessment (e.g. tech readiness, IP review, market potential, etc.)	Public authority conducts company-specific assessment of creditworthiness, including technology assessment as a key component
Examples	• EC's KETs observatory • IDA's market assessments	• KfW	• KOTEC's KTRS
Pros and cons	+ Increases transparency in the market + Would benefit all lenders and investors (i.e. debt, hybrids and equity) + Could support further public intervention + Limited cost − May not have a direct impact on lending/ investing	+ Mostly reduces operational cost for banks + Limited cost + May reduce some credit risk − Operational cost is not a major cost for deep tech, high-growth companies − Overall impact likely to be limited	+ May increase available information + Could be used for conditional grants − High cost − Existing example, KOTEC, seems to rely more on high guarantees than tech assessment − Overall impact likely to be limited as regards increasing bank lending
Potential uses	European institutions could increase information available on the KETs observatory with data on public funding received from national/regional bodies, sectoral studies, and increase the Observatory's visibility to investors	Some NPBs could provide this type of support in specifically targeted sectors but remain limited/focused	A technology credit assessment could be used to support decisions regarding allocation of public resources (e.g. conditional grants)

3.1.1.1. Market potential assessment

Reducing the information asymmetries with respect to KETs companies could be accomplished by conducting and publishing market potential assessments on the different KETs sectors and sub-sectors.

Description of market potential assessments

Currently, lenders have comparatively little understanding of the KETs landscape in terms of its demographics, challenges and potential. There is information on the overall distribution of KETs by geography and the relative density of such companies, as provided by the KETs Observatory[77]. There would, however, be considerable value in conducting market potential assessments with a focus on the companies' financials.

A market-level study would include the demographics of KETs sectors including, among other things, the number of companies, their size and other core characteristics, their geographical distribution and their typical capital structure. The core focus of such a report would be on the financials of the KETs companies and average default rates, loss ratios and other relevant metrics for investors. Additional information on trends in funding and technology within the sector would help provide a clearer overview of the market's potential from a lender and investor point of view.

Such an assessment would require strong collaboration between technological experts and experienced investors and bankers, in order to ensure that the content is relevant to financial institutions and capital providers.

Rationale for using market potential assessments

The purpose of an EU-wide market potential assessment is to provide data and transparency on the KETs landscape. This will enable banks and investors to obtain a better understanding of the opportunities and challenges of the sectors and should thereby help reduce the information asymmetries that inhibit lending.

The success of such an initiative is reliant on the report being focused on the financial and business aspects of KETs and being perceived as an objective depiction of the KETs landscape.

Examples

There is currently no EU-wide KETs study assessing the markets' potential. While there have been individual studies on certain deep tech sectors, they usually do not cover all life cycle stages and do not analyse the market through the lens of an investor or lender.

The Israel Innovation Authority (IIA) publishes yearly reviews of the state of the innovation economy with a focus on the deep tech industry[78]. It is, however, targeted at policy makers and makes recommendations on how to foster further growth in innovation.

Publications specifically aimed at providing relevant financial data to financial intermediaries are not commonplace on a large scale.

Potential actions

The required next steps would include a thorough baselining of existing reports across levels (EU, national, regional), which includes screening, categorisation and storage of reports and underlying

[77] EC, KETs Observatory
[78] Israel Ministry of Economy and Industry, *Israel Innovation Authority report*, 2016

data in a digital library available for public authorities. An inter-institutional working group of national innovation agencies, EU bodies and promotional banks, coordinated by the EC, could accomplish the mapping and subsequent exchange of relevant studies and research. The working group could ensure adequate representation of financial and investment experts and define future reports and coordinate their production. The data collection process would need to be well coordinated to ensure that a representative picture of the KETs landscape is given. Initial EU-wide market-level support should not be prohibitively expensive in terms of resources.

> *"The usefulness of a KETs market assessment by public institutions depends on whether the incentives are aligned with providing a neutral overview, rather than painting a pretty picture."*
>
> – Bank

3.1.1.2. Subsidising tech assessment

A second option in reducing information asymmetries faced by lenders is providing subsidies to technology assessments undertaken by banks.

Description of technology assessment subsidies

The few banks that conduct technology assessments when extending credit to innovative SMEs typically do so using external resources, which can add considerable operational cost in providing the loan.

This cost can be reduced by subsidising the technology assessment with public money. A scheme could be launched where parts of the cost of technology assessment from a network of qualifying firms and experts about KETs companies in an active phase of due diligence by credited lenders/ investors would be borne by the public sector.

Rationale for using market potential assessments

Reducing the cost of technology assessments by bearing a portion of the cost would incentivise lenders to extend credit by reducing the information asymmetry and the operational costs of providing loans.

Examples

Currently, no such scheme exists on a large scale in Europe. While there are no large-scale examples of direct subsidies provided for technology assessments for banks, Korea's KOTEC effectively provides an indirectly subsidised technology appraisal to lenders. As described in the KTRS case study (see chapter 3.1.1.3), technology certifications and financial analysis are provided for the most creditworthy companies. Banks can directly make use of those assessments to inform their credit decision. Note that part of the cost is still borne by banks as they provide partial funding to KOTEC through quasi-taxes.

Potential actions

The next steps would include the creation of a network of firms and individual experts whose technology appraisal services are borne by commercial banks; there would also have to be a process for the public sector to determine which investors can enjoy such subsidised appraisal services, i.e. across the financing chain (debt and equity), only debt providers (commercial banks), all of them or

only below a certain lending size etc.. Note that the moral hazard aspect of providing these subsidies is reduced by the fact that part of the cost of the technology assessment is still incurred by the lender.

Overall, this measure will not, however, address the underlying issue for bank lending. The maximum such an assessment could achieve is to reduce the assessed probability of default of the associated KETs projects; however given that those are at a magnitude higher than what commercial banks require for their traditional lending, even with such assessment the risk return profile remains unattractive for bank lending.

3.1.1.3. Company-specific technology credit assessment

While most loans to SMEs require a due diligence process to be completed, there is rarely a need for deep sectorial expertise, as there would be a sufficient financial track record to provide information on the creditworthiness of the client. With earlier-stage companies there may often be little cash flow history and financial information. In fact, this problem is exacerbated with KETs companies as they employ at times very disruptive and innovative technologies which may further increase the uncertainty around the marketability prospects.

An appraisal of the company's technology and its market potential could be an input to the decision-making process as to whether to provide public funding. This can be done via standardised questionnaires rating the technology in terms of its risk and commercial viability along with analysing the business plan and the managerial capability. Such an assessment would have to be conducted by highly-trained technology experts from academia and industry, experts in that particular technology of the KETs project more so than the sector itself. More advanced versions could incorporate external quantitative factors on macroeconomic indicators and integrate information automatically to arrive at a technology rating, as done by Korea's KOTEC Technology Rating System. It is important to note that, given that KOTEC gives 85-100% guarantees, this is essentially a "forgivable loan" approach.

Table 4: Credit scoring dimensions

Factors	Dimensions	Traditional credit scoring		Innovative credit rating (e.g. Big Data)	Public scoring authorities		
		Banks	Credit rating agencies		Promotional banks	Innovation agencies	KOTEC
Country	Economic	✓	✓	✓	~		✓
	Institutional & governance	✓	✓	✓	~		✓
	Legal	✓	✓	✓	~		✓
	Financial system	✓	✓	✓	~		✓
Industry & competitive positioning	Industry risk (e.g. growth trends, mkt structure, cyclicality)	✓	✓	✓	✓		✓
	Competitive position	✓	✓	✓	✓		✓
Financial	Cash flows and leverage	✓	✓	✓	✓		✓
	Profitability	✓	✓	✓	✓		✓
Behavioural	Leadership & strategy	✓	✓	✓	✓	~	✓
	Management and team capacity	✓	✓	✓	✓	~	✓
	Past behaviour (e.g. account)	✓	✓	✓	~		✓
	Big data (e.g. social media)			✓			✓
Technology	Technology readiness					✓	✓
	Market potential					✓	✓
	Potential impact on overall innovation					✓	✓
Examples		Banks' SME scoring tools	STANDARD &POOR'S FitchRatings	BIPE RATING	KFW	VINNOVA Innovate UK	KIBO

Some companies have developed more automated approaches (e.g. artificial intelligence) and leveraged other data sources (e.g. social media) to support lending to small companies. That said, most of these companies target small but stable SMEs rather than innovative, high-risk companies.

Broader practices relating to company-specific assessment

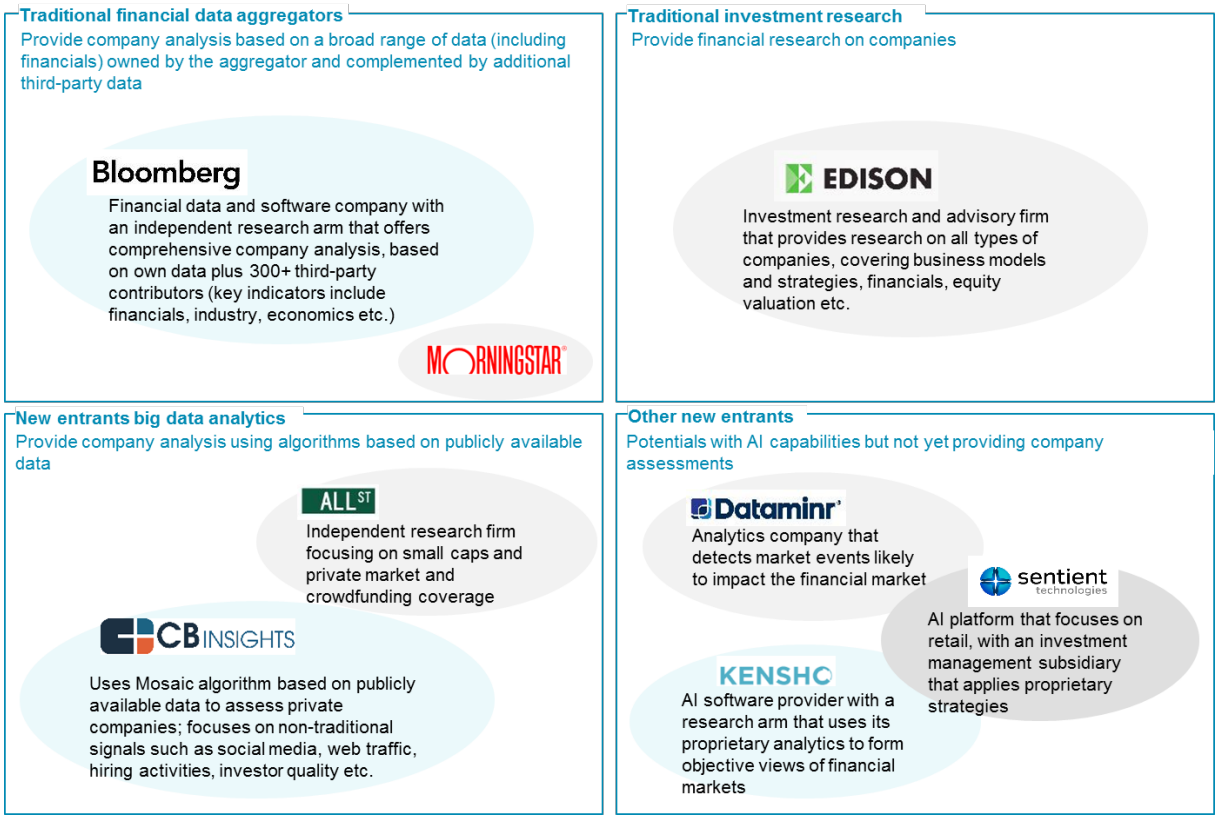
There are a range of potential approaches to company assessment based on current practices across different types of providers. The traditional financial data aggregators synchronise a broad range of data to facilitate investments, while new entrants using big data and analytics have adopted non-traditional indicators (based on data sources such as social media and web traffic) and sophisticated algorithms to provide quantitative assessments of companies' potential.

Table 5 provides a summary of the approaches and assessment dimensions of the different groups of providers, while Table 4 provides an overview of the different categories of providers.

Table 5: Approaches to company assessment across different providers

Type	Example provider	Description	Key scoring dimensions
Traditional financial data aggregator	Bloomberg	Comprehensive company analysis complemented by an independent research platform	**Industry** **Country** **Financial**
Traditional investment research	Edison Independent Research	Financial research on all types of companies	**Financial** **Business strategy** **Equity valuation**
New entrants big data and analytics	CB Insights	Assessment of private companies using Mosaic algorithm based on publicly available data, using non-traditional signals	**Momentum** (company's performance relative to peers using social media, news sentiment, web traffic, hiring etc.) **Market** (industry of the company based on funding, hiring activities, industry sentiment etc.) **Money** (financial strength and viability based on financial history, burn rate, investor quality)
	All Street Research	Produced short report on small caps with focus on analysing historical financials and business strategies	**Financial** **Business strategy**
Other new entrants	Kensho	AI software provider – provides a platform rather than a service	N/A, while these are interesting providers with AI capabilities, none yet provide business, technology or credit rating assessments
	Dataminr	Market-moving events publication company	
	Sentient Technologies	AI platform company	

Figure 19: Overview of broader practices of providers



New forms of big data aggregators and users of artificial intelligence have emerged that enable a much wider, deeper and different set of information about companies, the product, technology and management to be screened than traditional rating reports, usually based on public information such as financial filings, and at times privileged access to management, have been able to do. Nonetheless, so far most of these providers have focused on non-KETs SMEs with an established track record and operative profitability rather than deep tech start-ups and scale-ups. It will take a minimum of 5-7 years until new assessment methodologies that focus on deep tech projects specifically (once there are such) will have established enough of a track record themselves and can build on a significant database to have credibility in the eyes of financing providers.

While banks and financial intermediaries have already developed their approach to decide on granting loans or making investments (mostly based on the company's financials), most of the commercial banks interviewed did not use any sort of technology assessment. They relied extensively on the company's financials, along with some input on managerial capability and business plan. As a result, companies with very little history of revenues or positive cash flow would not be deemed suitable for credit.

One international case study that suggests an alternative path is possible with appropriate government support is the study of KOTEC, the Korean Technology Finance Corporation. KOTEC is a non-profit financial institution providing credit guarantees and technology appraisals to innovative

and high-growth SMEs. KOTEC developed the KOTEC Technology Rating System (KTRS) as a comprehensive and quantitative way of assessing the commercial viability of and technology risk in new corporations (see case study below). The KTRS tool exhibited a strong performance but required very significant resources to develop and maintain its operations. KOTEC launched efforts to transfer its KTRS model to other south-east Asian countries like Vietnam and Thailand, and in Q3 2017 signed a Memorandum of Understanding with the European Investment Bank to enhance the exchange of information and ideas. More importantly, the guarantees provided by KOTEC have been the core enabler in extending credit to innovative SMEs, with the KTRS rating being primarily used for internal risk management purposes. For further details, see case study on following page.

Public authorities in Europe could build on the KOTEC case and develop a similar structured approach to decision-making. In particular Europe's Research & Technology Organisations could provide critical input into technology assessments, as they possess the necessary know-how and/or access to relevant experts. Such an approach would enable public authorities to provide grants, forgivable loans or innovation loans based on a variety of criteria (primarily based on the technology and the creditworthiness of the company), with different weights depending on the stage of the company. For instance, a loan would be primarily based on creditworthiness while a grant primarily based on innovation and forgivable loans would balance both criteria.

Case study:
Korea Technology Finance Corporation – Technology Assessment

Overview of KOTEC

The Korean Technology Finance Corporation (KOTEC) is a special-purpose non-profit financial institution established in 1989 to help spur economic growth in South Korea through the provision of financial support to new technology businesses with little or no collateral to provide. This is primarily done in the form of credit guarantees based on technology appraisals. KOTEC has been instrumental in providing KRW 280tn[79] in technology guarantees to date.

KOTEC's operations are heavily focused on two pillars: the provision of technological credit guarantees and the technology appraisal that underpins their decision-making. However, KOTEC has grown from a credit guarantee institution into a comprehensive innovation financing agency. Its major operations now include:

Technology guarantee: Guarantees for loans that new technology-based SMEs borrow from financial institutions to start their businesses and develop and/or commercialise their technology.

Technology appraisal: Appraises future values of the technology that a company retains, such as technological competency, marketability and business values, and uses the appraisal results for various purposes in technology financing support. The technology appraisal produces a rating of the risk and potential of the technology as well as a monetary valuation of the market potential of the technology in question.

Guarantee-linked investment: Provides direct equity investment in conjunction with a credit guarantee programme for early-stage technology firms with recognised business competency. More than €30m was invested in 2015.

Indemnity management: Exercises right to indemnity against credit guarantee debtor.

In addition, KOTEC provides management consulting and technology advisory services to companies at different stages in the life cycle. For instance in 2015, free consulting services were offered to over 1 000 companies that were less than one year old, while more than 1 500 more developed businesses made use of the broader advisory services.

Technology appraisal

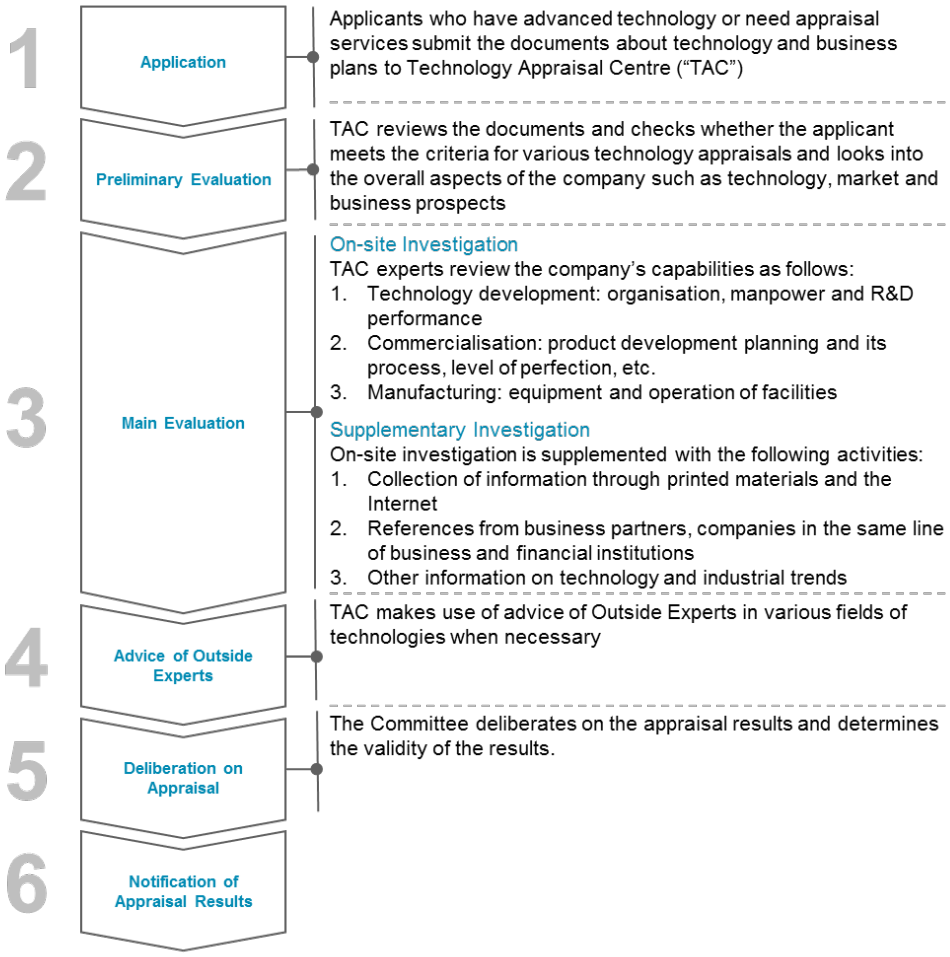
The technology assessment process focuses on the market potential, commercialisation and general prospects of the technology. The technology appraisals first started in 1997 with the opening of the first technology appraisal centre (TAC). Throughout this period, standardised assessment techniques were used and the development of an automated model was initiated. The general process followed can be seen in the figure below.

The first iteration of the KOTEC Technology Rating System (KRTS), a comprehensive and customisable tool used to assess the potential value and growth potential of a technology, was deployed in 2005. Since then, the tool has been refined incrementally and the number of cases assessed has grown to a total of over 500 000, with nearly 55 000 in 2015[80] alone. Over the last few

[79] As of March 2017, €1 = KRW 1 225 such that KRW 280tn ≈ €230bn
[80] KOTEC Annual Report 2015

years, there has been an initiative to deploy the KTRS tool across different countries and, more crucially, the Korean banking system.

Figure 20: Technology Appraisal Process[81]

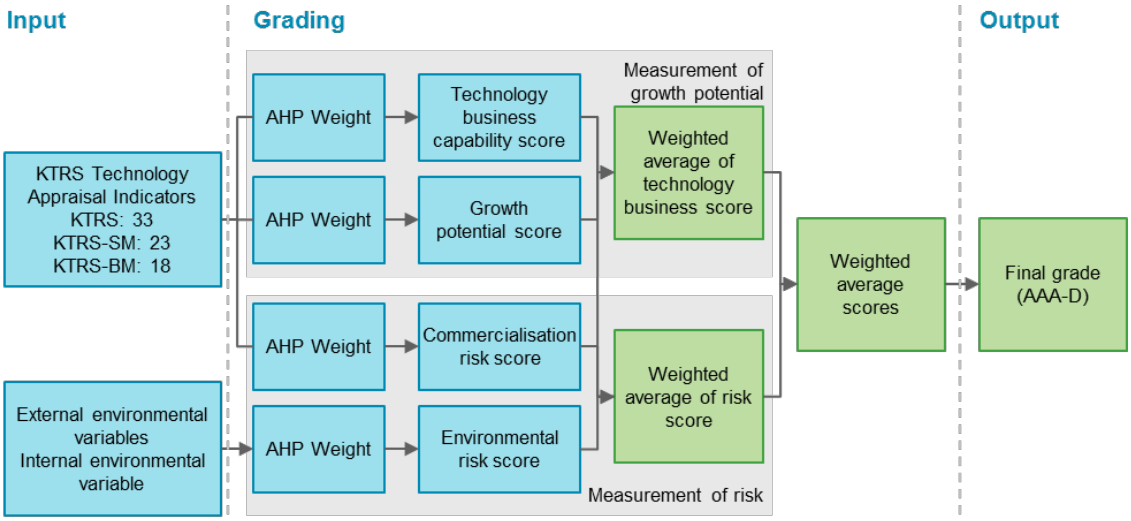


KOTEC Technology Rating System (KTRS)

The KTRS methodology uses a host of input variables ranging from firm-specific criteria such as the "academic background and experience of management executives" or the "level of difficulty in imitating the technology" to broad economic indicators such as the exchange rate and the Korean Composite Stock Index. A technology business score and a risk score are thus produced using statistical techniques. The two scores are then combined in a final grade ranging from AAA (most creditworthy) to D (least creditworthy) which can be used as a predictor for default rates, among other things. The figure below provides an overview of the KTRS methodology.

[81] Sourced from KOTEC website

Figure 21: KTRS methodology



Inputs

The inputs to the model include two sets of variables: KTRS Technology Appraisal Indicators and Environmental variables

There are 33 Technology Appraisal Indicators which measure the technology business capability, growth potential and commercial risk score. The factors used include measurements of the owner's capability, the marketability of the technology and the technology ability, among others. A set of slightly modified indices is used for smaller early-stage start-ups and for small businesses. The full list of Indicators can be found in Appendix C.

The Environmental variables consist of external factors such as interest rates and internal factors such as the presence of a venture authentication.

Note that the KTRS tool allows for flexibility in the inputs as well as in the weighting used in the grading (see next section) and is thus used flexibly across different technological sectors.

Grading

The weighting of each factor in the set of Technology Appraisal Indicators is derived using a structured decision-making system known as Analytic Hierarchy Process (AHP). Weights and scores are produced for the various indicators resulting in a technology business score with 10 levels.

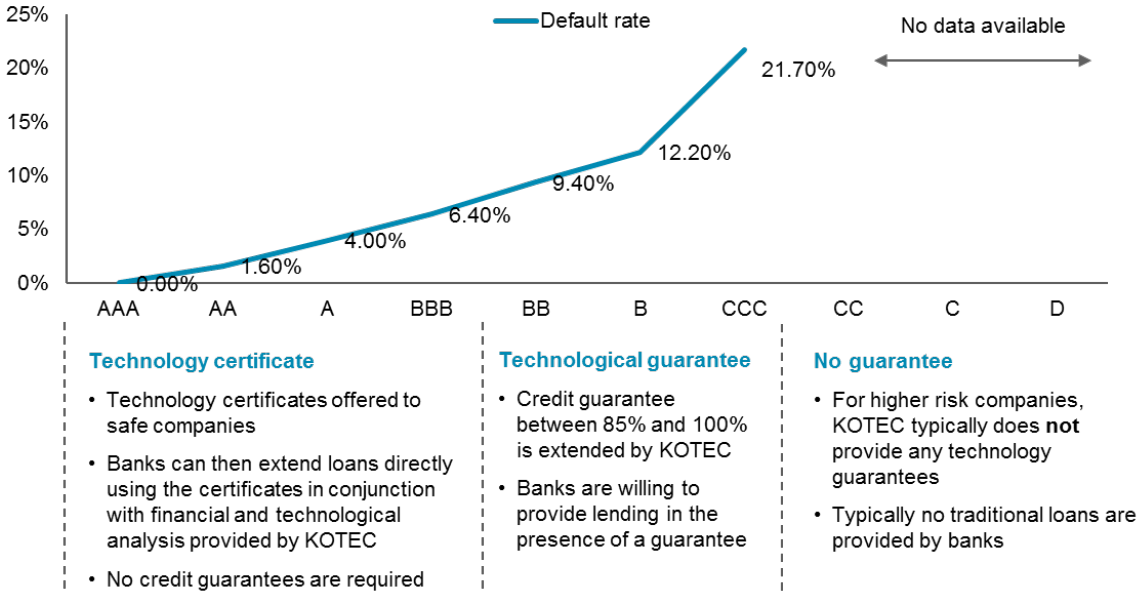
The environmental variables are supplemented with Technology Appraisal Indicators relating to commercial risk and are regressed using a logistic regression model. This produces a risk score, which also has 10 levels.

The two scores are combined to produce a final grade with 10 ranks, ranging from AAA to D.

Output

The rating produced by the model is a measure of the riskiness and technology potential of a given technology business. It is directly related to the probability of default of the corresponding business, displaying substantial discriminatory power, as seen in the figure below.

Figure 22: Default rates by rating bucket[82]



The different applications of the KTRS tool are described below.

In addition, separate technology valuation processes are used to complement this rating and assign a monetary value to the technology in question.

Application of KTRS

Naturally, the performance of the model makes it an attractive tool for the assessment of guarantees and, more generally, credit risk. Currently, KOTEC uses the KRTS tool to support financing for innovative companies.

The companies deemed most creditworthy by the tool (rating of BBB or better) are granted a technology certificate, which provides sufficient information to banks to provide lending. The certification is complemented by a financial and technological analysis to ensure that the banks have an adequate understanding of the business and the technology. Note that this does not include a credit guarantee as these companies are deemed sufficiently creditworthy for banks to extend credit without it being required. The process is shown in the figure below.

[82] "Supporting innovative SMEs in Korea" presentation, Hee Chang Park, 2012

Companies that are deemed medium-risk (rating below BBB but above CCC) are provided with a technological guarantee by KOTEC, as lending institutions would otherwise be unwilling to grant financing. Typically, the coverage of the guarantee is between 85% and 100%.

For companies rated CCC or worse, KOTEC very rarely provides guarantees and banks do not provide financing as these are deemed too risky.

In addition, KOTEC operates a guarantee-linked investment scheme where limited equity investments can be undertaken in certain businesses. The eligibility of a business and the cap of the potential investment amount are determined using the company's KTRS rating.

More recently, KOTEC has become the only designated public institution for the Technology Credit Bureau, in an attempt to popularise and implement KTRS across the private sector and ensure the widespread use of the technology appraisal system.

Impact

Overall, KOTEC has been successful in providing credit to SMEs and innovative companies. For instance, an OECD report[83] on the impact of the 2008 financial crisis on South Korea shows that lending to SMEs increased by KRW 33.8tn[84] in 2009. This represented 67.6% of the overall increase in bank lending for the year. This expansion in lending was primarily driven by three factors. First, banks were encouraged to roll over existing loans if the obligor was not in delinquency. Second, the amount of credit guarantees provided by KOTEC and the Korea Credit Guarantee Fund (KODIT) increased by 34% in 2009.This was coupled with an increase in coverage from 85% to 95% for SME loans with firms in core sectors receiving a 100% guarantee. Finally, direct government spending to support SMEs increased by more than 50% in 2009 compared to the previous year.

There is limited information regarding the impact and effectiveness of the KTRS rating tool. A presentation by the Korea Small Business Institute (KSBI) shows that the proportion of approved loans with reference to a technology appraisal certificate provided by KOTEC was ~94% in 2011.[85] However, the banks contacted in the audit of the scheme suggested that the technology appraisal result is not fully reliable without the loss sharing scheme. In fact, only 60% of banks and 14% of venture capital funds deemed the technology appraisals as reliable. According to the audit exercise conducted by the Board of Audit and Inspection in 2012, the six participating banks stated that most of these loans had been approved *without* making use of the certificate, suggesting that the certificate only confirms the decisions made by banks rather than complementing it.

Overall, KOTEC's efforts, complemented by additional government schemes, have indeed increased lending to SMEs and innovative ventures. There are however three caveats to consider. First, the existing evidence suggests that the increase in lending was primarily caused by the increased guarantees and direct government support, rather than the technology appraisal system. Second, the increased support for SMEs and the failure to scale it back during the crisis created problems of moral hazard by slowing down the pace of reforms conducted by SMEs. Thirdly, as stated by KSBI, equity financing is the appropriate financial instrument for technology financing, but its levels are sub-optimally low. The extent of support in the form of credit guarantees increases the amount of leverage in SMEs and thereby exacerbates this problem.

[83] OECD, (2010), "The Korean Financial System: Overcoming the Global Financial Crisis and Addressing Remaining Problems", Working Papers No. 796
[84] As of March 2017, €1 = KRW 1 225 such that KRW 33.8tn ≈ €28bn
[85] KSBI, "Financing the Technology Innovation of SMEs in Korea", *Korea Institute of Finance*, *World Bank joint conference*

Resources and capabilities

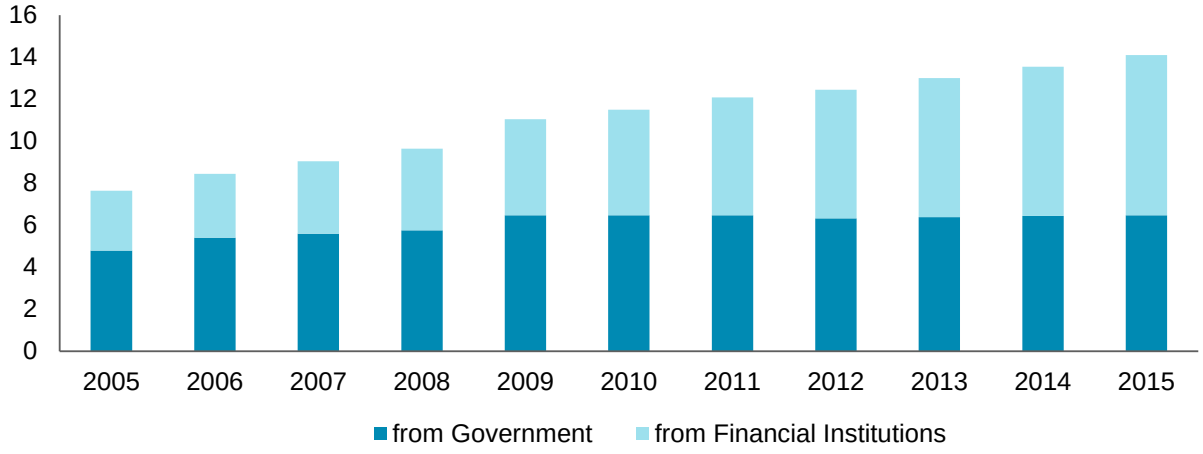
The development of the KTRS tool started in 1999 and required six years of data collection and methodology refinement before the first iteration was deployed in 2005. The data was collected from companies obtaining technology assessments in the dedicated technology appraisal centres.

Currently, KOTEC has 57 technology appraisal centres and employs over 1 100 people, of whom more than 150 are Ph.D. holders in a relevant field. Close to 600 employees are specifically dedicated Technology Appraisal experts. This is supplemented via a pool of more than 1 000 external advisors from the industry, academia and research fields.

In addition, KOTEC requires financing to cover its guarantees and operations. KOTEC's funds are provided by contributions from the government (~€32bn in 2015) and contributions from financial institutions (~€415m in 2015), in the form of a quasi-tax on the monthly balance of their corporate loans. KOTEC has therefore effectively achieved a partial mutualisation of the operational costs and credit risk by banks. This means that these factors become a sunk cost and are therefore less material in the credit decision-making.

The figure below shows the cumulative contributions by the government and the financial institutions in KRW. The total contributions by the government are nearly KRW 6.5tn, or the equivalent of €5.3bn at today's exchange rates. The accumulated contributions by financial institutions have exceeded this amount in the last three years.

Figure 23: Cumulative contributions by government and financial institutions, in KRW tn



3.1.2. Using IP as collateral

As outlined in Section 2.1.2, banks expect KETs companies to have high LGD as they tend to not have sufficient tangible collateral (relative to the size of the loans required). However, KETs companies are typically rich in intellectual property and therefore intangible collateral. A core question therefore is how to make that underlying asset valuable to a potential debt investor.

IP can be identified in a number of categories including patents, inventions, copyrights and trademarks. In addition, IP can include intellectual capital which sometimes is identified as the cornerstone of the value of a company.

As enterprises shift to more open models of innovation based on collaboration and external sourcing of knowledge, they are exploiting their IP in a wider variety of ways: not only incorporating protected inventions into new products, processes and services, but also licensing them to other enterprises or public research organisations, using it as a bargaining chip in negotiations with other enterprises, and leveraging it to attract external financing from banks, venture capitalists and other sources.

However, while their financials show revenue, size, balance sheet total, market cap, profit, etc. it does not cover the various forms of IP. Enterprises with good IP have a much higher value than known from their balance sheet and thereby a value potential for the future.

Thus the valuation of IP is important for all parties, not just financial institutions involved in an enterprise. There is no fully agreed framework for valuating IP as it depends on the underlying assumptions you deploy in any model. In particular, there is a clear distinction between IP that has generated an income stream and IP which has yet to deliver this income stream.

As also outlined in Section 2.1.2, the use of intellectual property for KETs companies as a form of collateral in practice is challenging due to the complexity in valuing and reselling this IP. In theory, programmes that incentivise the use of intangible assets, in particular intellectual property, could foster increased lending by increasing recovery rates.

Using IP as collateral

The main challenges in using IP as collateral against loans include (i) the difficulty in valuing the IP, (ii) the wrong-way risk associated with its value, and (iii) the difficulty to realise the IP's value in the event of a default. The first of these can be tackled by establishing credible valuations by providing data and oversight on existing practices and reducing the cost of IP valuation and licensing through subsidies and common EU-wide patents. The mitigation of wrong-way risk is more complicated to achieve, but could be partially addressed through insurance. Finally, the ability to resell the IP for an adequate value in the event of default is ideally tackled through the creation of an IP marketplace, although this is an ambitious goal in the short term. The latter two paths being more challenging to address, this section focuses on a brief review of valuation techniques and latest trends.

IP valuation techniques and latest trends

The assumptions which influence the value of IP start with determining what elements will be categorised and included in the eligible assets. The complexity and practical challenges around valuing IP are augmented as the enterprise

- may have secured only European and not global protection for a patent;
- may use the IP to establish a dominant position in the market;
- may have to invest in other activities to turn the IP into a product;

- may not be in a position to quantify the scale of funding required to go to the commercialisation phase;
- may decide the IP is too early for the market;
- may decide to generate additional revenue by selling or licensing the IP; and
- may classify the IP as dormant, sleeping, blocking or defending and thus they have limited incentive to define its value. However, there can be tangible financial benefits for the enterprise if it protects another revenue stream.

Within this context the challenge is to define and determine the value of IP and how it can be considered from a revenue stream perspective. The value is not static and depends completely on the purpose, e.g. internal, M&A, raising finance etc. Valuing IP is particularly challenging for early-stage technologies because it is difficult to apply valuation approaches due to a lack of comparable data. To add to the challenge, enterprises have their own valuation practices which may vary from one to another, even in the same sector. In addition, intermediaries play an important role in the valuation and exploitation of IP. As innovation processes have become more open and enterprises have begun to source more of their technology needs from external sources, markets for technology have expanded, and with them the role of intermediaries. The complexity is further exacerbated as some countries provide financial and/or taxation incentives for licensing IP, particularly related to patents. The various mechanisms deployed in countries can influence the overall value of IP.

There are some emerging best practice methodologies for valuing IP that have developed which provide some guidance and a framework to assist financial institutions in valuing the asset base of a company. In addition, some tools provide a preliminary screening of the value of a patent portfolio and this information can be used by patent attorneys and capital investors. However, most mainly focus on patents and this is only one element in the overall value of IP. In practice, costs of the valuation process such as required money and time should also be taken into consideration.

The value of IP has more relevance for early-stage enterprises and equity-type finance, e.g. venture capital, rather than larger enterprises. This is relevant because financial institutions are familiar and have a process to monetise tangible collateral whereas IP is not tangible and therefore the ability to monetise this, if the need arises, presents a different type of challenge for financial institutions.

The various methods of IP valuation are discussed below:

Qualitative patent valuation methods

Qualitative valuation methods attempt to rate and score patents based on factors such as the strength and breadth of patent rights and their legal certainty. These methods have often been used for the purpose of internal patent management, due to their relative simplicity compared to quantitative valuation methods.

Quantitative patent valuation methods

Quantitative valuation methods seek to calculate the monetary value of the patents, involving three major approaches: cost approach, market approach and income approach. An emerging quantitative approach uses option pricing theory to value patents.

The cost approach is based on the cost of obtaining a patented invention by either internal development or external acquisition. This approach relies on calculations of the reproduction and the replacement cost of the patented invention. A patented invention with equivalent utility would be an invention that performs the same functions but may accomplish the required tasks in a different way. Despite its vast potential for application in other settings, the cost approach is not

widely used in the context of patent valuation because it does not reflect the future economic value of the valued patents. This approach may nevertheless be helpful in accounting systems, which are based on historical costs and where dictated by taxation methods or as a supplement to the income approach.

The market approach uses comparable patent transactions in the market as a basis to obtain the value of the patent subject to valuation. However, the low number of exchanges and the lack of transparency about their characteristics make this approach less reliable and useful than others. The market approach faces other difficult challenges such as the need to make adjustments for comparability when the difference between the subject patent and the comparable patent is not negligible.

The income approach attempts to calculate the present value of the projected future income flow arising from the subject patent during its economic life. The discounted cash flow method allows an estimated future income flow to be converted to a present value by discounting estimated future income flow with an appropriate discount rate.

Application of three main quantitative patent valuation approaches to different purposes

	Cost approach	*Income approach*	*Market approach*
M&A	-	++	++
Financial accounting	+++	-	-
Taxation *Corporate tax* *Inheritance tax*	 +++ -	 - +++	 - *
Sale price	++	++	*
Licence	+	+	+
Collateral	-	+++	*
Infringement litigation	-	++	+
Internal management	-	++	+++

Source: Watanabe, 2002.

In addition to the aforementioned three main quantitative approaches, more recent methods include:

The option approach is an alternative quantitative patent valuation method which is increasingly gaining acceptance. The option pricing theory was originally developed for pricing financial options, which are defined as "a right but not an obligation, at or before some specified time, to purchase or sell an underlying asset whose price is subject to some form of random variation". The application of the concept of options is not limited today to financial assets, as it also applies to non-financial assets, known as real options. One limitation of existing valuation methods is their difficulty in dealing with managerial flexibility, a problem that can be overcome by this approach. The real option method is able to take into account the flexibility of patent management, which can in turn be considered as a series of options.

PatentBooks aggregate large groups of patents pertinent to commercially significant products according to product requirements, enabling manufacturers to license all the necessary patents in a single transaction that is instantaneously and universally accessible. PatentBooks enable manufacturers to access multiple product-specific patents in a single transaction at a competitive price. Patent owners receive a new license revenue stream that maps both subscribers' success and respective patent quality.

The aforementioned analyses suggest that enterprises have an increasing range of mechanisms at hand to seek to extract value from their IP. However, for the one most widely used by financial intermediaries to assess collateral, the 'income approach' absolutely requires a pre-existing, stable and recurring revenue stream to the IP. For early-stage KETs or KETs scale-ups, this precondition is often not (yet) given, thus this approach is not likely to help spur debt lending as a means to bridge the scale-up KETs' financing gap. The research shows that there continues to be a need to find a credible IP valuation approach, particularly for IP that has no specific current income stream attached.

Lessons from other countries

While a number of attempts have been made to increase the use of IP as collateral against bank loans for KETs companies, there is limited evidence that such schemes have succeeded in addressing the key challenges identified. Neither risk-sharing schemes (e.g. IPFS) nor valuation models (e.g. KOTEC) have generated the trust and liquidity required for highly innovative and disruptive businesses, as KETs are.

In Singapore, the Intellectual Property Office of Singapore (IPOS) introduced in 2014 the IP Financing Scheme (IPFS) to help IP-rich companies monetise their IP for business growth and expansion, based on external valuation and risk-sharing mechanisms with partner financial institutions. For further details, see case study on following page.

Malaysia also launched an Intellectual Property Financing Scheme, conducted through Malaysian Debt Ventures, the public technology financing company. The initiative aims to extend RM 200m (~€45m) of IP-backed financing directly, with a 50% guarantee and 2% rebate provided by the government. In early 2015, two years after the launch of the programme, the scheme had already provided over €10m in loans to 11 companies, with more than double that in the pipeline.

While Korea's KOTEC uses its technology appraisal system to value the IP of companies, it is not used as collateral for loans.

Practical impact on bank lending

Fundamentally, the challenge with IP valuation as a lever to increase commercial bank lending remains that even for companies with proprietary technology across markets, and that have demonstrated that they produce a recurring revenue stream, banks de-emphasise the relative importance of intangible collateral in their credit allocation decision. This is because of fundamental concerns about the real value that can be achieved in the event of a default, once litigation and execution challenges to seize the asset have been cleared.

It is also structurally hard to liquidate such IP given the potential difficulty of disentangling the failure of the project overall with the specific validity of the core technology behind the project (contrary to selling property or machines with a more intrinsic value on their own).

Thus, while a promising field for research, and innovative models emerging, it is not clear yet how these developments will translate into a practical impact on commercial lending practices.

Case study:
IP Office of Singapore – Intellectual Property Financing Scheme

Overview of IPOS

The Intellectual Property Office of Singapore (IPOS) operates under the Ministry of Law and aims to support the innovation ecosystem and build expertise in IP by developing the right legal regime.

In 2013, Singapore unveiled a comprehensive initiative to become an IP hub of the region with the development of the IP Hub Master Plan. Three strategic outcomes were identified as a result of the plan. First, Singapore aims to be a central marketplace for IP transactions and management. Second, it aims at being a hub for IP filings for both local and international companies. Finally, Singapore aims to also provide full coverage for IP dispute resolution.

In this context, IPOS plays a central role in helping coordinate these initiatives and achieve the desired outcomes. While IPOS handles a large number of tasks related to IP filing, handling, management and resolution, it recently introduced the possibility for businesses to access finance by valuing their IP and using it as collateral.

The Intellectual Property Financing Scheme (IPFS) is a SGD 100m financing scheme under which companies can monetise their IP and obtain funding for future growth. The scheme is in place until the end of March 2018. The premise of the scheme is that financial institutions will be more ready to lend to smaller and more innovative businesses if collateral with a concrete value – the intellectual property of the firm – is provided.

The IPFS application process takes place in three steps:

1. Companies and partnerships registered in Singapore apply for a preliminary assessment at one of the Participating Financial Institutions (PFI).
2. An intellectual property value from the approved Panel of Valuers determines the value of the portfolio of intellectual property rights. The cost typically ranges between SGD 5 000 and SGD 50 000, where IPOS subsidies are granted. See table below.
3. A formal application is submitted to the PFI and a loan is potentially granted, using the IP as collateral. The final conditions of the loan are determined by the PFI as they are best placed to assess the riskiness of the client.

A key challenge in providing IP-backed loans stems from the fact that the valuations of intangible assets are inherently more complex to undertake as there is greater uncertainty around the future cash flows that they may generate. As a result, IPOS is determined to produce more consistent IP valuations and increase trust by establishing a Centre of Excellence in IP valuation, disseminating best practices and conducting research on the topic.

In addition, IPOS will provide a valuation subsidy to successful IPFS applications in order to encourage more firms to obtain financing through this scheme. The valuation subsidy is capped at the lower of:

- 50% of the IP valuation cost
- 2% of the value of the IP

- SGD 25 000

As an indication, IPOS provides an average valuation cost for reference, as shown below.

Figure 24: Typical pricing of IP valuation, in SGD

	Quick assessment	Small (<50 man-hours)	Medium (50-80 man-hours)	Large (>80 man-hours)
Pricing	5 000-10 000	15 000-27 500	20 000-50 000	>32 000

The Singapore government partially underwrites the loans issued by participating financial institutions in order to share the risk and encourage more lending by the financial institutions.

The four participating financial institutions are:

- AFC Merchant Bank,
- DBS Bank Ltd,
- Oversea-Chinese Banking Corporation (OCBC) Ltd,
- United Overseas Bank (UOB) Ltd.

The first IPFS loan was granted by DBS in June 2016, two years after the launch of the programme. The loan was extended to Masai Group International, a Singapore-owned footwear company, with significant intangible assets in the form of brand image and a unique design aimed to help with posture. The IP was already proven in value given the strong sales track record of the company and was therefore easier to assess than the IP related to new disruptive technologies. In addition, the Masai Group had already obtained significant access to bank lending and capital markets as witnessed by its USD 200m in debt in 2013.

The loan was used for the further growth of the brand and IP, as well as for additional R&D and product development.

Growth finance

As outlined before, there is a limited range of financial products which are appropriate to KETs companies at different growth stages. It is therefore critical for KETs companies' growth to ensure that sufficient capital is readily available and in the right form at the right time (i.e. through the right instruments).

In this section, we look at a number of growth finance products that are vital to bring KETs companies from the start-up phase to maturity. Firstly, equity financing is discussed as the most appropriate method of financing high-growth, high-risk early-stage KETs companies.

As companies reach the growth stage and revenue generation becomes likely, different growth finance solutions should be considered. We look at supply chain finance, venture debt, and conditional grants as measures that can be used to finance companies in later stages of their development.

3.1.3. Increase and enhance support in equity financing

While increasing the availability of debt financing to smaller KETs companies can contribute to reducing the existing funding gap, equity financing is critical in ensuring that there is a full chain of financing for growing KETs companies. Equity instruments are indeed a more adequate financial instrument to finance high-growth, high-risk companies such as early stage KETs companies, as they better capture the value from their risk-return profile. Moreover, increasing the use of equity will improve the level of leverage of these companies and therefore enhance their ability to borrow when they need to, thus having a multiplicative effect.

While European, national and regional promotional institutions are already very active in increasing the availability of equity capital through direct and indirect investments, there remains a significant need for more equity financing and there is room for more effective public instruments. There are clear gaps in the availability of equity financing in a number of geographies and across the life cycle (e.g. growth financing). In addition, some instruments could be used more broadly in Europe to crowd in private-sector actors, especially fund-of-fund structures with asymmetric returns (such as those achieved by the SBIC and Yozma programmes in the US and Israel respectively).

Policy measures used in some countries

As shown in 2.1.4., there are a number of countries with very developed venture capital scenes, such as Israel, the US and Canada.

Israel's venture capital industry was born in the mid-1980s but grew significantly in the 1990s through the government-led initiative, Yozma. The initiative offered attractive tax incentives to foreign venture capital investments in Israel and promised to double every investment using government funds. It is widely credited with the sixtyfold increase in Israel's venture capital industry that was observed from 1991 to 2000, per Silicon Israel.

The US has also achieved a vibrant venture capital scene through the Small Business Investment Company programme launched as early as 1958. The scheme allowed existing venture capital funds to leverage their investments through the provision of government debentures. For further details, see case study below.

Lessons learned

Several policy measures have been found to increase the availability of equity capital.

As described in further detail in section 1, policy measures need to be taken at all levels to ensure that there are no gaps in the availability of equity capital through all the stages of the life cycle of a company, especially early stage, as the lack of capital in one stage impacts the returns downstream (due to a lack of exit opportunities) and opportunities upstream.

European, national and regional promotional institutions could complement their current approach to equity investing (mainly as co-investors and *pari passu* fund-of-fund investors) with funds-of-fund structured with an asymmetric return profile. This could be achieved in a number of ways. One approach could be to essentially leverage the fund, as the SBIC programme does, thus increasing potential returns for investors and reducing the risk for the government (as it is paid back first). An alternative approach would be to reduce the downside risk (e.g. through guarantees). A combination of both approaches could be achieved by providing to the other private-sector investors the option to buy back the NPB's investment at a pre-defined rate, thus providing protection against downside and increasing return in the event of success.

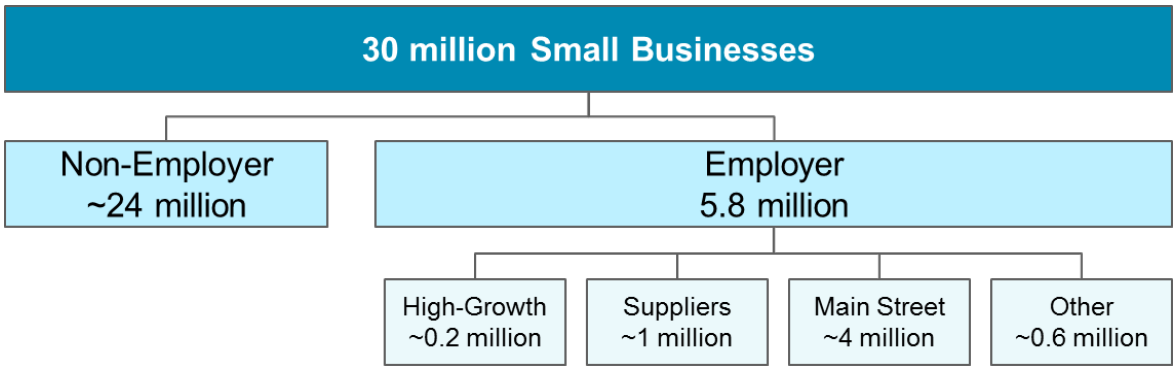
The difference between the SBIC and e.g. the EIF equity investment into European venture capital funds is that the SBIC uses a government-backed debt product to leverage equity funds. This means that for one, the government is participating not as a high-risk equity investor but as a creditor that can expect a guaranteed return. Second, this means that the original equity partners in the VC fund do not need to accept alternative equity partners next to them with whom to share the potentially high rewards ('asymmetric returns'); lastly, the model enables existing private venture capital to be 'leveraged' much faster and at a larger scale than direct equity investments allow (because a limited amount of debt can be used to increase the available equity fund size). Therefore it is a particularly valuable tool to support VC funds at the small end of the spectrum and in traditionally less covered geographies. Professor Karen Mills, previously administrator of the SBA under the Obama administration, emphasised in our interview that according to her personal experience with the SBA and its various support options, advisory services and financing tools, the SBIC specifically may be the single one instrument most to credit with improving financing to deep tech, high-risk SMEs in the US.

Case study:
Small Business Administration – Provision of capital

Overview of Small Business Administration

Small businesses play an important role in the US economy and have been central to job creation in the last 20 years. Indeed, there are more than 30 million businesses with fewer than 500 employees, accounting for 60% of total net job creation[86].

Figure 25: Overview of small businesses in the US



Out of the ~5.8m firms that are not sole proprietorships, there are around 200 000 businesses that are identified as high-growth and have a disproportionate effect on job creation and the economy.

The Small Business Administration (SBA) is both a driver and a result of the relative importance of small businesses in the US economy. Founded in 1953, the Small Business Administration is focused on supporting SMEs through four programmatic functions. First, the SBA provides capital to small businesses that would have otherwise had challenges in obtaining funding. Second, counselling services and entrepreneurial development are offered in over 1 800 locations throughout the US. Third, as per the mandate of the SBA, 23% of government contract dollars are allocated to small businesses. Finally, the SBA has an advocacy role in ensuring that the interests of small businesses are protected; this is further complemented by research on the small business environment.

Focusing on the first of these functions, the SBA facilitates the provision of capital to small businesses through three main channels. First, the SBA directs a loan programme consisting primarily of the provision of credit guarantees on loans provided by partnering banks, credit unions and other institutions. Secondly, the SBA administers the Small Business Investment Company (SBIC) programme that aims to provide long-term capital to small businesses by capitalising professionally-managed investment firms which focus on SMEs. Typically this is done in the form of debentures, which ensures that the Government has seniority in repayments while the private sector keeps all the upside. Finally, the SBA manages the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programmes aimed at providing grants to small businesses in order to help them engage in federal research and development and collaborate with research institutions.

[86] Mills, K and McCarthy, B, (2016), "The State of Small Business Lending: Innovation and Technology and the Implications for Regulation", Harvard Business School, Working Paper 17-042

SBA Loans

Since its inception in 1958, the SBA has been guaranteeing small business loans granted by partnering institutions through its SBA Loan programme. While different types of credit are available, the 7(a) loan is the most common product.

Under the SBA 7(a) loan programme, the SBA guarantees loans negotiated between a borrower and an SBA-approved lender where the exact terms of the contract are determined by the two parties. While there is no minimum loan amount, the maximum loan size is USD 5m, with an average loan amount of ~USD 370 000. The guarantee given by the SBA typically covers between 75-85% of the loan balance and requires a fee between 0.25-3.50% depending on the loan size. The interest rate structure, while determined by the lender, is capped at the prime rate plus an additional 2.25-2.75%, depending on the loan maturity[87].

Additional guarantees are provided for loans designated for the purchase of equipment or for disaster relief. Furthermore, small loans of up to USD 50 000 are provided by intermediary lenders through the Microloan programme.

Overall, the SBA Loan programme has been implemented on a large scale, providing capital to the system with USD 20-30bn of financing being deployed every year. Nonetheless, this programme is more appropriate for established small companies which have a financial history and are typically not in deep tech, high-growth sectors. Early-stage innovative companies still face challenges in obtaining bank finance due to their risk profile, even when SBA guarantees are provided.

SBIC programme

The Small Business Investment Company (SBIC) programme was launched in 1958 in order to facilitate the flow of long-term capital, such as equity, to small businesses. This initiative is particularly targeted at younger, innovative companies that face difficulties obtaining funding from traditional lenders.

The SBA licenses qualified investment firms as SBICs, which then use their own capital in addition to funds borrowed with an SBA guarantee to make equity and debt investments. The 313 licensee firms (SBICs) obtain funds from debentures that are issued by the government and then resold on the market at a low cost, given the SBA guarantee. As a result, these firms have access to cheap funding which they can then deploy without having to share any of the upside. Typically, the SBICs' funds are matched at a ratio of 1-to-1 or 2-to-1 using SBA funds.

Figure 26: The SBIC investment process – Example

[87] SBA website

The SBIC programme focuses on increasing the funding and attractiveness for small VC firms. The set-up focuses on increasing the financing capacity by increasing the total funding through debentures. This results in a "leveraged" structure that magnifies returns (and losses in the downside). It focuses on increasing financing for smaller VC funds as it is capped at USD 150m and the SBICs need to invest their funds in small businesses with net income of less than USD 6.5m over the two years prior to investment.

As a result, the returns are asymmetric: the government has lower downside risk as it has seniority over other creditors, but the private sector SBICs obtain all of the upside. This is mutually beneficial, as the SBICs effectively leverage their returns, while the government cost to the programme is reduced due to the higher seniority. The additional downside risk existing for SBICs, given the higher order of the debenture in the repayment waterfall, does not deter investors to make use of the programme as there is a self-selection process where only SBICs with expected high returns are willing to draw down the funds.

Overall, the SBIC programme is often credited with being instrumental in developing the venture capital industry in the US. Currently, there are 313 licensee firms managing over USD 28bn in assets. In 2016, the programme provided USD 6bn in financing to 1 200 small businesses, and thereby helped to sustain 122 000 jobs. A multitude of very large technology firms, such as Apple, Intel and Tesla, have received funding from SBICs during their earlier growth stages. More interestingly, the programme has zero cost to the taxpayer as the debentures have higher seniority and funds are typically recovered.

SBIR/STTR grant programmes

The above financing initiatives are complemented by the provision of research and development grants. Following the success of programmes such as DARPA in fostering innovation, the SBA launched the Small Business Innovation Research and the Small Business Technology Transfer Programmes to ensure that the most innovative and deep tech businesses have access to funding for their research and development.

The SBIR is a competitive programme encouraging small businesses to engage in federal research and development that is likely to be commercialised. It has four main goals: stimulate technological innovation, meet federal research and development needs, encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons, increase private-sector commercialisation of innovations. Every year, federal agencies with external R&D budgets over USD 100m need to allocate 3.2% of their budget to these programmes. Such agencies include the Department of Energy, the Department of Defence, the Department of Health and Human Services and NASA, among others. Funding is then granted to small deep tech businesses where the size of the grant is dependent on the phase of the research.

The STTR is a similar programme where additional focus is given to the collaboration between research institutions and small businesses.

3.1.4. Supply chain financing

Supply chain financing (SCF) refers to various financial products that allow small companies to smooth out their payments to suppliers while waiting on payments from clients, e.g. factoring. Authorities could work closely with large corporates and identify opportunities to improve supply chain financing as SCF has the potential to:

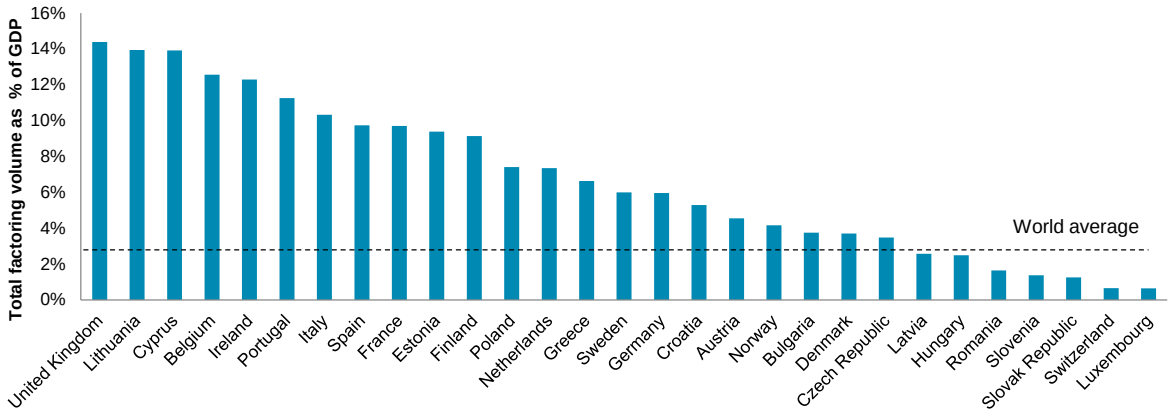
- Increase access to financing
- At a cheaper cost to KETs companies (e.g. through reverse factoring, purchase order financing)

Currently, factoring volumes in Europe are higher than the world average (in % of GDP), but can be substantially increased using a pan-European working capital financing strategy.

Types of supply chain finance

Supply chain financing is a form of receivables finance that can provide working capital financing as soon as an early stage KETs company starts to generate revenue. While factoring is widely used in a number of European countries (as shown in Figure 27), supply chain finance remains underutilised. For instance, C2FO believes that only USD 3tn of the USD 46tn of trade credit is financed through supply chain finance.

Figure 27: Total factoring volume as a percentage of GDP, Europe, 2014[88]



Typically, this can be done through the use of factoring, where the supplier (KETs company)'s account receivables are sold, or used as collateral for a loan provided by a third-party factor. This effectively allows the KETs company to obtain cheap financing, as the credit risk borne by the factor is based on the creditworthiness of the buyer, which will typically be a large corporate with a solid credit rating. This concept can be improved upon by having buyers initiate the process and factors only buy invoices from validated buyers – a process known as reverse factoring, which further reduces the credit risks and operational costs faced by factors. Finally, purchase order financing can further extend the amount of financing by using purchase orders as collateral.

[88] Factor Chain International and World Bank

Invoice discounting and factoring

Factoring refers to a transaction where the supplier of a product or service will sell its accounts receivable at a discount to a third party.[89] It essentially enables a smaller supplier to access more and cheaper financing based on the credit risk of the buyer of its products.

Indeed, suppliers of products are often paid with a delay (e.g. 60 days) following the delivery of the product. With factoring, the supplier can sell the invoice it issues to the client at a discount to a financial intermediary, the factor. The level of the discount (and therefore the cost of financing) is primarily driven by the credit risk of the buyer so, if the buyer's credit risk is significantly better than the supplier's (as is often the case for large corporates buying from SMEs), the supplier can benefit from the buyer's easier access to financing and lower cost of funding.

There are three clear benefits for a small informationally opaque SME. First, factoring provides financing which can be used for working capital purposes and can be rolled over to finance growth. This amount may be non-negligible as accounts receivable can represent a significant portion of the balance sheet of SMEs and of its annual revenue, and if rolled over, present a sizeable term loan. Secondly, this allows higher-risk companies such as early stage KETs to borrow at the credit risk attached to the receivables, which will typically be much lower than that of the company itself. Finally, early-stage KETs companies can outsource their screening and collection activities to the factor which may lead to reduced cost due to the economies of scale.

Reverse factoring

While factoring providers can be beneficial to innovative SMEs, there are still some important operational costs faced by the factor. For instance, the factor may need to evaluate the creditworthiness of each buyer that is part of the accounts receivable sold by the supplier. While this could be mitigated by the factor having recourse to the supplier, there is an alternative, more efficient way in achieving this – reverse factoring. Reverse factoring refers to the process through which only invoices from validated buyers are factored. Typically, this process is started by the buyer and involves the use of a reverse factoring platform which significantly increases transparency, reduces the operational costs of the process and eliminates supplier fraud. This translates into cheaper credit for suppliers.

NAFIN, one of Mexico's promotional banks, launched the *Cadenas productivas* programme in 2000 in order to develop reverse factoring in Mexico. Its objective is to improve the financing and liquidity situation of SMEs at lower cost. To that end, NAFIN provides technological infrastructure that facilitates reverse factoring transactions.

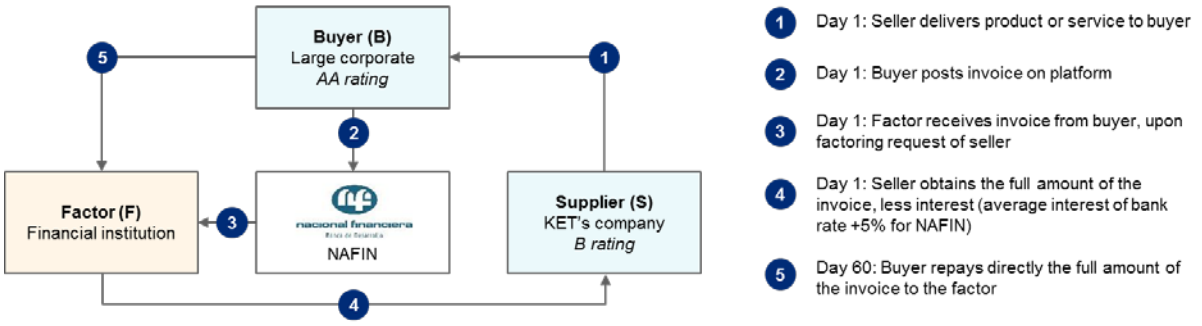
Cadenas productivas offers a simple and centralised online platform for reverse factoring transactions. Buyers recognised by NAFIN specify the suppliers that are part of their "productive chain". Lenders choose to factor receivables offered by suppliers on NAFIN's online platform. NAFIN centralises information for financial intermediaries and offers technical assistance to suppliers.

NAFIN has become the leading factoring provider in Mexico as its turnover grew at 17% p.a. over the period 2007-2011. NAFIN now accounts for 75% of all Mexican factoring transactions and its network includes >600 buyers, ~90 000 suppliers and ~40 financial intermediaries.

[89] Note that invoice discounting refers to a similar process in which the accounts receivable are used to collateralise a working capital loan. Throughout this section we will refer to factoring, but the general conclusions and recommendations could also be applicable for invoice discounting.

The figure below illustrates the role of NAFIN in reverse factoring.

Figure 28: NAFIN reverse factoring process[90]



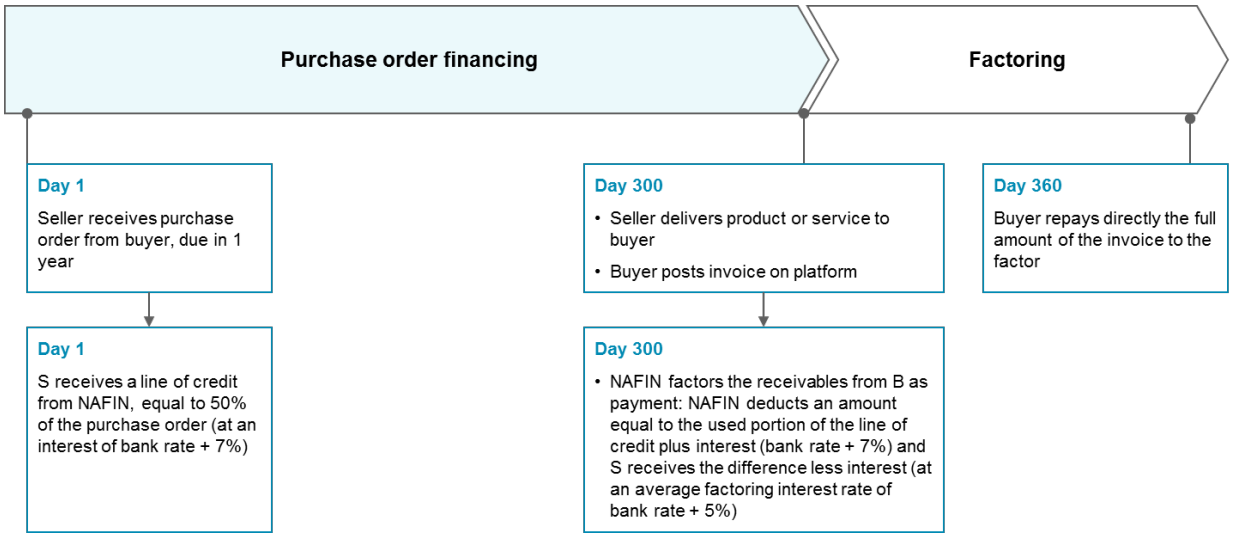
Purchase order financing

The concept of receivables finance can be extended to purchase orders. There are two fundamental differences. First, the underlying asset used is a set of purchase orders rather than invoices. Second, given that there is inherently more risk underlying purchase orders, e.g. in the form of delivery risk from the supplier, the purchase orders are not sold, but rather used as collateral for a line of credit. This effectively enables the supplier to obtain financing as soon as the purchase order is received. Given that KETs companies' products require significant production and delivery times – sometimes a year or more – obtaining financing as soon as a purchase order is received bears significant benefits. In effect, purchase order financing can be viewed as a measure to reduce information asymmetries as an early-stage KETs company can demonstrate the viability of its technology by showing evidence of expected future cash flows.

Note that this differs from traditional purchase order funding which involves the factoring company paying the firm supplying the raw materials or intermediate products to the supplier of the larger corporate.

[90] Klapper, L. (2006), "The Role of Factoring for SME Finance", Access Finance Issue No. 15 and Klapper, L. (2006), "Export Finance for SMEs: The Role of Factoring", World Bank, Trade Note 29, and Klapper, L. (2005), "The Role Of Factoring For Financing Small And Medium Enterprises", World Bank Group Policy Research Working Paper

Figure 29: Purchase order financing through NAFIN[91]



Lessons learned

Supply chain finance is an important product for high-growth SMEs, including KETs, and its prevalence could be improved through a number of tools, e.g. a pan-European reverse factoring platform or provision of guarantees on loans for purchase order financing.

A reverse factoring platform, similar to Mexico's NAFIN, would offer supply chain financing similar to factoring and invoice discounting while limiting fraud and operating costs. Purchase order financing could be used to extend reverse factoring financing from ~60 days (based on invoices) to multiple months or even years (based on purchase orders). European and national authorities therefore need to have the mandate, strategy, products and operating model to address challenges in SMEs' access to working capital financing.

[91] Klapper, L. (2006), "The Role of Factoring for SME Finance", Access Finance Issue No. 15

3.1.5. Support the development of venture debt in Europe

Venture debt/quasi-equity is a type of financial instrument offered to venture-backed high-growth start-ups. The ventures are usually at an early stage of relatively low revenues, which do not yet have operative profitability, and typically have limited tangible collateral to secure the loan. In addition, venture loans are a hybrid instrument as part of the funding will be accompanied by equity warrants. These instruments are typically very suitable for financing innovative, high-risk companies as they offer a cheaper and non-dilutive alternative to pure equity financing.

Venture loans can be very flexible instruments, but they share a common set of distinguishing characteristics. First, they are extended to higher-risk companies that typically have already had a round of venture capital funding in the form of direct equity investment. Second, they are extended for relatively short terms of around three years or less as they are typically used to leverage venture capital and extend the cash runway until the next round of funding or until the company is profitable. Finally, venture loans are very often complemented by a minor stake of equity warrants which allow the creditor to share the upside with the company.

As mentioned above, venture loans are extended to higher-risk companies and the equity warrants represent a minor stake, usually between 10-20%, of the loan. As a result, venture loans typically require interest in the 10-15% range for riskier companies. When loans are extended to finance equipment, rates are usually lower as tangible collateral is available.

Table 6: Typical characteristics of venture loans, 2010[92]

Terms & conditions	Typical benchmark
Typical term	3 years
Average annual interest rate	10%-15%
Typical size of a loan	GBP 1-5m
Warrant size (% of loan)	10-20%

.

Rationale for venture debt

Venture debt is a product that has the potential to benefit, in particular, early-stage KETs companies as well as finance providers.

For KETs companies, there are three main benefits:

- First, this product can bridge funding gaps to a next round of equity financing or perhaps, bank lending, given that lenders are appropriately compensated for the risk profile of the company.
- Second, venture debt is less dilutive than equity financing, ensuring that the entrepreneurs have a larger share of the upside. This means that venture capitalists' returns are magnified and lower equity financing is required. It also means that the initial risk-takers, in the form of entrepreneurs and first investors, preserve their (higher) rewards.
- Third, the presence of warrants ensures that the incentives of the entrepreneur and the creditor are aligned as the creditors also have a share of the upside of the project (Green[93]).

[92] "The Rise of Venture Debt in Europe", BVCA, May 2010

This further enables entrepreneurs to benefit from the expertise of the venture loan provider as the product is typically provided by funds with experience in growing early-stage companies.

On the lender side, there are three main benefits of such a product:

- First, venture debt investments in companies backed by venture capital funds enable lenders to reduce the average probability of default of their loans. This is due to the fact that venture -backing acts as a positive signal of the commercial viability of the technology, and may even act as a substitute for the presence of a historical stream of positive operating cash flow (Fischer and Rassenfosse[94]). Venture debt providers therefore make use of the expertise of the venture capital funds.
- Second, venture debt providers typically require a lien on IP to reduce moral hazard with regard to the owners of the company. The above two points result in a lower risk cost for the loan as the expected loss is reduced.
- Third, the higher interest charged and the potential upside provided by the equity warrants ensure that venture debt providers are compensated more than adequately for the risk taken.

Current situation in Europe

A 2010 BVCA study[95] estimated that venture debt in Europe represented GBP 50-250m vs. USD 2-3bn in the US. The size of the industry is orders of magnitude smaller as it is closely linked with the presence of venture capital funds. While difficult to obtain accurate figures, it is estimated that 15-20% of all US VC is in the form of venture debt. This compares with 8-10% in the UK and ~5% in Europe. [96] Given that Europe's venture capital funds invest €3-5bn p.a.[97], a simple calculation would suggest that venture debt could represent up to €1bn of investment a year.

In the UK, British Business Bank (BBB) has launched an initiative to promote venture debt called "Help to Grow". The programme has two core features: providing a shared first loss guarantee and co-investing alongside the funds' other investors.

Alternatively, certain commercial banks have started providing venture loans. Clydesdale Bank has extended more than GBP 105m in loans to 33 companies through its Growth Finance division thanks to the Enterprise Finance Guarantee and ENABLE second loss portfolio guarantee[98] provided by the BBB. Other examples include Intesa's €120m venture debt fund, making use of 15 specialised technology experts.

The EIB has started to implement a venture debt/quasi-equity product via the European Fund for Strategic Investments (EFSI) since 2015 under the name of the 'European Growth Finance Facility'. This product is situated between a typical venture debt and a standard loan in the sense of longer

[93] Green, R. (1984), "Investment incentives, debt, and warrants." *Journal of Financial Economics*, 13, 115-136.
[94] Fischer, T. and de Rassenfosse, G., "*Venture Debt Financing: Determinants of the Lending Decision*", 2012
[95] BVCA, (2010), "The Rise of Venture Debt in Europe"
[96] AFME, (2017),"The Shortage of Risk Capital for Europe's High Growth Businesses"
[97] Invest Europe, "2016 European Private Equity Activity"
[98] A second loss guarantee covers the second tranche of losses, i.e. losses *beyond* a pre-defined threshold (to be contrasted with a first loss guarantee which guarantees losses *up to* a certain threshold and *pari passu guarantees* where counterparties share proportional losses)

average terms, lower warrant size and average annual interest rate. The EIB seeks a target return commensurate to the risk taken, including one or more elements of: cash interest, compound interest (PIK), warrants, profit participation etc. The EIB finances up to 50% of eligible project costs, with the rest of the funding to be provided by third parties. The eligible company needs to demonstrate that they have:

- Sustainable capital structure
- Raised equity in the past (series B, C rounds)
- Stable and experienced management team
- Professional corporate governance and code of conduct
- Sustainable business model, business plan and strategy providing credible growth perspectives.

The first EIB venture debt operation was closed in January 2015 with Innocoll AG. Since then more than 1 500 financing requests have been reviewed. The target for 2017 is to close about €800m-1 000m in signatures.

Policy measures used in other countries

SPRING, Singapore's innovation agency, has set up a Venture Debt Programme in conjunction with local banks where venture loans are guaranteed at 50% by the government. (See case study). In addition, the government-owned Temasek co-invests with UOB.

The UK's BBB has recently launched the Help to Grow initiative which, among other products, enables the BBB to invest in funds focused on hybrid instruments, such as venture debt and mezzanine financing, either through a *pari passu* investment or through asymmetric returns (with prioritised repayment).

Lessons learned

Currently, two options exist for fostering growth in venture debt: providing incentive schemes in the form of government guarantees on venture loans, or investing in venture debt funds to directly increase the scale of investment.

First, it is possible to put in place programmes aimed to incentivise capital providers to extend more venture loans. This can be done in a similar fashion to BBB and SPRING by providing guarantees. For instance, Clydesdale Bank makes use of the ENABLE programme put in place by the BBB to guarantee the loans that it makes. Another example is the Spanish investment firm Inveready which has recently launched a venture debt fund and leverages the InnovFin guarantee provided by the EIF. Another InnovFin SME financial intermediary, Innovation Norway, provides start-up loans.

In addition, investment in venture debt funds provides a direct way of increasing the amount of VD capital available. For instance, the EIF launched a Mezzanine Fund of Fund for Germany, which while aimed at later-stage companies, showcases the idea of co-investment in hybrid capital products. The EIF's InnovFin SME Guarantee gets enriched to cover subordinated debt as well as more traditional senior exposures.

More broadly, the present findings and case studies confirm the first study's insight into venture debt as a particularly suitable instrument to support young, high-growth KETs companies on the verge of scaling up.

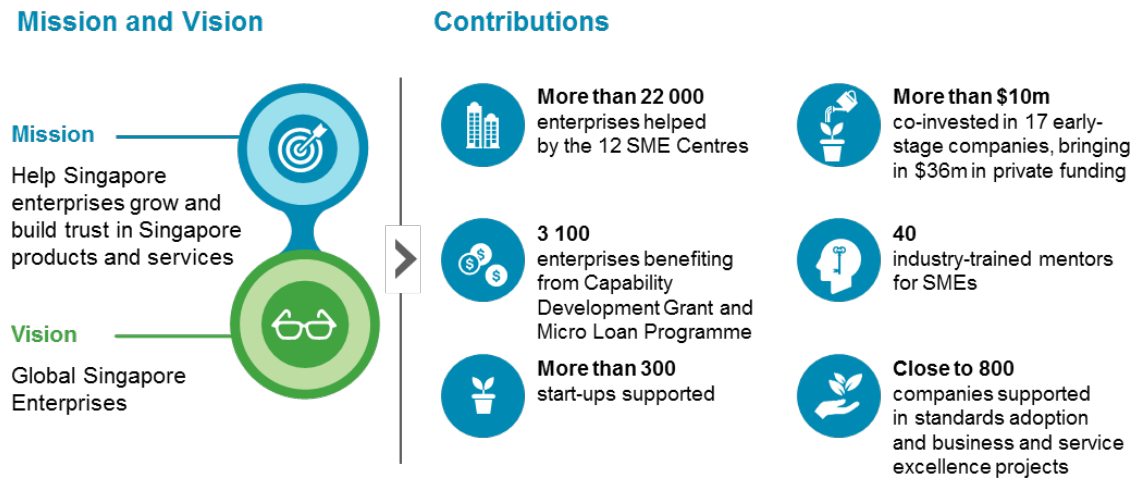
Case study:
SPRING – Venture Debt Programme

Overview of SPRING

The Standards, Productivity and Innovation Board (SPRING Singapore) is a statutory board under the Ministry of Trade and Industry with a dual mandate to enable enterprise in Singapore and to help build trust in Singapore products and services. The agency was formerly known as the Productivity and Standards Board, established in 1996, and was renamed as SPRING in 2002 during a shift in focus towards the innovation economy.

SPRING provides comprehensive services to start-ups and growing SMEs ranging from advisory services and incubator programmes to a wide range of financial support schemes.

Figure 30: Mission, vision and contributions of SPRING



On the advisory side, SPRING partners up with incubators and accelerators to provide support and advice while covering the main costs of partner programmes. In addition the 12 SME centres across Singapore provided more than 22 000 enterprises with advisory services in 2015, and helped them develop through consulting schemes such as the Innovation & Capability Vouchers.

In addition SPRING provides an array of financial support solutions to start-ups and SMEs. For instance, grants are given to early-stage start-ups through the ACE Scheme. In addition, equity-based co-financing is conducted under SEEDS Capital, SPRING's investment arm. Growing SMEs can also make use of grants of up to 70% of project costs under the Capability Development Grants, micro-loans under SGD 100 000 and tax deductions, among others. More recently, SPRING launched a Venture Debt Programme to enable the provision of riskier loans to SMEs in conjunction with a number of partner institutions.

Venture Debt Programme

In 2015, SPRING announced its pilot Venture Debt Programme (VDP) that complements current government loan financing. The VDP aims to provide access to financing to companies which are IP-

rich but lack tangible assets, by sharing the risk of venture loans granted by partnering financial institutions. SPRING's rationale for the provision of venture debt is addressing the gap between traditional bank loans and equity investments for such high-growth companies[99].

The scheme was launched in 2016 and aims to provide up to SGD 500m in venture debt loans through the participating financial institutions.

Participating financial institutions for the Venture Debt Programme include DBS Bank Ltd, Oversea-Chinese Banking Corporation Ltd (OCBC), United Overseas Bank Ltd (UOB) and Innoven Capital.

Application process

The venture debt loans provided under the VDP follow a 2-step application process.

First, the participating financial institution meets with the SME (consultation) to verify that it is eligible for the programme. The eligibility criteria for this scheme are that the company:

- must be registered and operating in Singapore with at least 30% local shareholding;
- must either have group sales of less than SGD 100m or fewer than 200 employees.

Second, an application is submitted to the PFIs with all required documentation. If successful, a loan is disbursed. Note that PFIs will have their own eligibility criteria for the provision of venture debt. For instance, DBS requires tech start-ups to be backed by DBS's partner venture capitalists. They should have raised at least SGD 1m of Series A funding, be incorporated for at least two years, be in operation for at least one year and have demonstrated that their business model is commercially viable.

Loan provision: terms and financial guarantees

The loans provided under this scheme have a balance of up to SGD 5m and are designated for business expansion purposes such as project financing or M&A activity. Most importantly, the loan has warrants attached, giving the granting institution the right to purchase equity and thus share in the upside.

In addition, 50% of the risk is taken on by SPRING through the provision of a loan guarantee.

The exact terms of the loan with respect to interest rate structure, repayment structure, and collateral and warrant structures are determined by the Participating Financial Institutions.

Example of venture loan

One of the first venture loans granted through the scheme is a SGD 1m loan extended to Ascenz Solutions through OCBC in May 2016. Ascenz Solutions is an operational risk intelligence solutions company for the maritime industry and therefore has a large number of intangible assets. Venture debt was therefore an appropriate solution to the relative difficulty in obtaining traditional bank lending. The loan will be used to finance R&D and expand in Europe.

[99] "SPRING Singapore Launches $500M Venture Debt Programme with DBS, OCBC and UOB for High-Growth Enterprises", April 2016

3.1.6. Supplement grant offering with conditional grants

Currently, public institutions in the EU provide direct financing to early-stage innovative companies through two main tools: grants and loans. Grants are usually provided at the very early stages of R&D and product development and are typically not designed for the commercialisation and scale-up stages. The full cost of grants is borne by the provider as no amount of money is recovered. At the other end of the spectrum, institutions also provide loans (sometimes called innovation loans) at relatively favourable conditions. The cost of this type of funding is lower for the provider as not all repayments are made and not all capital is lost. However, such loans are usually extended to already established companies and are therefore not often provided to companies such as early-stage KETs.

Similar to best practices around the world, such as evidenced by Israel's Innovation Agency and the Small Business Administration in the US, EU public institutions could offer funding to early-stage KETs and innovative SMEs through grants or loans contingent on success, which would help build founders' equity in the initial stages. Conditional grants are a hybrid between grants and loans with a repayment schedule conditional on the success of the project. If the KETs project fails to generate sufficient revenue and the project fails, the debt is forgiven and the conditional grant effectively becomes a standard grant. If substantial revenue is generated, the conditional grant is to be repaid, with small amounts of interest, making use of sales royalties.

Table 7: Summary of grants, conditional grants and public sector loans

Level of risk to lender

	Grants	Conditional grants	Public sector loans
Description	• Grants provided for R&D or innovation purposes • Usually provided by public institutions • No repayment needed	• Grants where principal repayment is conditional on company achieving sales • Typically level of interest rate is low	• Loan with required repayment of principal and interest • Varying degrees of forgiveness depending on institution
Examples	• EC • SBIR, STTR	• Israel Innovation Agency	• NPBs • Innovate UK
Pros/Cons	✓ Provision of finance at risky stages, where potential social benefit is large but may be privately not profitable × No repayment of grant, thus institution requires outlay of funds	✓ Beneficial to company as no downside risk ✓ Losses are less severe for funding institution as the principal is repaid if company is successful ✓ Forces greater discipline × No sharing of upside for funding institution ~ Increases cash burden , but this is not material in case of success	✓ Lower risk for lender ✓ Full upside for business × Business needs to have solid financial performance to obtain access to this type of funding
Relevant stages	• Seed • Early-stage	• Early-stage • Growth	• Growth • Maturity

☐ Area of focus

Conditional grants have the benefit of increasing the capacity of government to finance innovation through the "recycling" of these funds, while continuing to reduce the downside risk for innovators. This "recycling" of funds could have a significant impact. For instance, assuming a 50% chance of failure in a portfolio of projects, the funding capacity provided to KETs companies could be doubled in the longer term. In addition, such a tool could be beneficial to both early-stage KETs and larger corporates for high-risk RDI projects.

Examples

The Israel Innovation Authority is a prime example of the use of conditional grants. In fact, this is currently the core instrument at the disposal of the IIA. Its emergence developed through the use of standard grants as early as the 1960s. As successful companies were able to repay some of the grant money, conditional grants became the standard tool, ensuring that more funding for innovative SMEs became available. For further details, see case study on following page.

While a number of countries offer "innovation loans" that present some similar characteristics as conditional grants, most of these products assume repayment of the loan. Tekes, the Finnish innovation agency, offers innovation loans to SMEs which can be used to fund R&D and piloting activities. The loan is typically granted at a low interest rate for 7-10 years, with a grace period of 3-5 years.[100] Similarly, Innovate UK, the UK innovation agency, is developing innovation loans.

Lessons learned

Innovation agencies and promotional banks can collaborate to develop an offering of conditional grants. These grants would require repayment in the event of success (ideally with some interest, potentially linked to a success indicator such as revenue) but not in the event of failure of the project. Collaboration between promotional banks and agencies is critical as such a financing tool relies on the expertise of both institutions – the innovation agency for grants and technology, and the promotional bank for risk management. Their collaboration would translate, among other things, into a "technology credit assessment" that would assess the technology and its market potential and translate it into an assessment of the credit risk of the company.

Public authorities can also consider going one step further and develop income-linked loans. The repayment of such loans is a function of the level of revenues or profit of the company. The use of income-linked loans as a financial instrument combining financing and risk management characteristics has been debated by academics for many years (e.g. Robert Shiller in *The New Financial Order*)[101] and used in some areas (e.g. student loans in the UK). Some academics, such as Bruce Chapman in Australia[102], have started debating their use in innovation financing.

It is important to note that both products could be targeted at early-stage KETs but also to large companies for highly innovative projects. Indeed, highly innovative projects may present too much risk for large corporates. However, conditional grants significantly reduce the downside risk and could enable large corporates to undertake higher-risk RDI projects.

[100] Tekes news release, "Tekes increased its funding for young, innovative growth companies"
[101] Shiller, Robert, "The New Financial Order: Risk in the 21st Century". Princeton University Press, 2003
[102] Bruce Chapman, "Income Contingent Loans as Public Policy", The Academy of the Social Sciences in Australia. Canberra, 2006

Case study:
Israel Innovation Authority – Conditional grants

Overview of IIA

In the 1970s, the Office of the Chief Scientist (OCS) was established to help increase economic empowerment within the civilian sector through the funding of research and the development of economic policies. As the venture capital industry expanded exponentially in the 1990s, the OCS gained further prominence through its focus on incubators and R&D funding. A vibrant start-up scene emerged in Israel and entrepreneurship and innovation became the main engine behind economic growth. The OCS was recently succeeded by the Israel Innovation Authority (IIA) – an independent public entity with a mandate to stimulate the Israeli economy by fostering growth through innovation. The renaming of the institution is accompanied by a shift in strategy and an increased focus on innovation.

The objectives and functions of the IIA are to develop the innovation infrastructure in Israel, to create jobs in the industry and incorporate technological and scientific human resources, to promote innovation by distributing grants and providing financial support and to connect the economy with the global innovation industry, among others.

As a result, the IIA's activities include the provision of financial support to companies across the different stages of the enterprise's life cycle and the administration of technological incubator programmes to support early-stage companies. In addition, the IIA is in charge of a number of R&D collaboration initiatives between the academic and commercial sectors.

These objectives and activities are enabled through targeted divisions focused on a particular activity or stage in the life cycle of the company. Currently, this includes a Start-up Division focused on pre-sale companies, a Growth Division focused on early-stage companies, a Technology Infrastructure Division focused on collaboration between industry and academia, an Advance Manufacturing Division focused on the implementation of research, an International Collaboration Division focused on cooperation with other countries and a Societal Challenges Division focused on improving the effectiveness and quality of public sector services.

Financial support and grants

While the IIA offers traditional R&D grants, its primary financing tool for SMEs is conditional grants, i.e. grants/loans whose repayment is contingent on the success of the project or company.

Description of conditional grants

Conditional grants are a hybrid between grants and loans. If the project fails and does not produce revenues, the principal is lost and is effectively treated like a grant. On the other hand, if the project succeeds and generates sufficient revenues, sales royalties are collected by the IIA until the principal is repaid with a small amount of interest payments, thus being effectively treated like a loan.

As a result, conditional grants limit the downside risk faced by new technology ventures while allowing the public sector to benefit from the potential upside of successful projects and therefore increase its financing capacity.

The advent of this instrument was motivated by the fact that Israel invested heavily in R&D as early as the 1960s. The main tools at this stage were standard grants given to companies for R&D

purposes. As some successful companies were able to return the funds to the IIA, conditional grants were born in the mid-1980s, allowing for more financing of innovative SMEs.

Technology assessment

Currently, in order for a company to qualify for a conditional grant, it first has to meet the eligibility criteria for the particular conditional grant. Different funds are available to support innovative companies across the full life cycle and across a variety of industries. The next section elaborates on the variety of funds available.

If the company meets the requirements of the first round, a comprehensive professional assessment is conducted by an engineer qualified and experienced in the relevant field and an accountant. The engineer provides some insight into the technological risk and feasibility of the proposal while the accountant analyses the financial statements. Currently, the accountant does not look into different financing options but is expected to do so in the future, when a richer arsenal of financial instruments will be available at the IIA's disposal.

If the R&D proposal and technology is deemed promising and with an adequate level of technology risk, a conditional grant is given to cover a portion of the expenditures, where the exact amount depends on the fund and the company.

Currently, the technological assessment results are not and cannot be shared with third parties. There is only some feedback given to successful applicants.

Example of programmes

IIA aims to support the whole innovation ecosystem throughout the different stages of the companies' life cycle.

For instance, the Start-up Division is focused on entrepreneurs with innovative ideas and early-stage start-up companies. The IIA provides a supportive framework for the establishment of a company and development of a concept into a commercial product through its 18 technological incubators. In addition, the Technology Innovation Labs promote collaboration between established companies and start-ups to foster knowledge transfer. Finally, financing can be obtained in the form of grants for fundamental research or through the Tnufa Incentive Program. Tnufa provides conditional grants of up to ~€50 000 for a period of up to two years aimed at initial business development and building an initial prototype.

The Growth Division then provides funding for more mature companies that are in sales or pre-sales growth stages. For instance, the R&D Fund provides a conditional grant of 20-50% of the approved R&D expenditures of the firm.

Larger companies are also incentivised to innovate. For instance, generic R&D arrangements are put in place by the Growth Division for companies with revenues of more than USD 100m. Full grants of up to 50% of the approved R&D expenditure are given to such companies for projects executed in cooperation with other Israeli companies.

In addition, certain sectors are promoted by providing additional grants. For instance, the R&D for Space Technology fund provides grants of up to 85% of the approved R&D expenditure for a period of 36 months to companies whose product and research is focused on the field of space technology.

Development of new products

The IIA is undergoing restructuring and is expected to deploy a wider arsenal of financial tools. In particular, the IIA announced that it will start lending directly to companies using traditional loans by depositing money at financial institutions and ensuring that a loan is provided to the qualified entities.

This will provide more flexibility to structure the loans and select the adequate level of risk that the IIA should take. In addition, it enables the IIA to recover greater proportions of the deployed funds and thus potentially finance further innovative companies.

Resources and capabilities

The IIA is a product of multiple decades of investment in the innovation economy. It co-exists with a vibrant venture capital sector and an overall culture geared towards entrepreneurship.

In 2014, the IIA's budget was around NIS 1.6bn (~€340m[103]), of which 70% was allocated to the R&D Fund.

[103] Using June 2014 exchange rates.

Innovative bank business models

We have identified alternative approaches taken by commercial banks to finance deep tech SMEs. Although these innovations show promise, they are still in their infancy and not proven.

Banks have identified the gap in financing that many smaller businesses face, in particular in KETs. As Intesa Sanpaolo notes, providing early support is a way for banks to differentiate themselves from the competition given the highly commodified nature of banking products. As a result, some banks have begun a number of initiatives to finance deep tech SMEs. These initiatives broadly consist of three categories: in-house expert teams, incubators and seed investments, and venture funds. We discuss Intesa Sanpaolo in our case study below, because it employs all three categories.

In-house expert teams

Several large banks have set up dedicated "innovation" teams, often with a specific sector focus. Innovation teams often have a broad remit and tend to focus on multiple topics:

- Developing new products to improve the bank's offering – ranging from FinTech solutions to digital appliances – often by functioning as an internal idea incubator and accelerator.
- Tracking developments in technology and staying on top of how these might affect the bank's business model.
- Researching emerging trends in the bank's markets.
- Engaging with the outside world by supporting start-ups, e.g. by providing seed capital or introductions to potential investors – see next heading.

A large number of banks across Europe have set up innovation teams, including BBVA (ES), Intesa Sanpaolo (IT), Deutsche Bank (DE), Rabobank (NL), and Bank of Ireland (IE). These can vary from small outfits to large departments. It should be noted that in most cases experts have a financial background with sectorial expertise in KETs, as opposed to specialised technology experts with a technology/engineering background.

Incubators and seed investments

Several banks have set up incubators to support start-ups, esp. targeting FinTech companies. Two examples in the United Kingdom are Barclays and Santander. Bank-backed incubators have two advantages: Players in FinTech have direct access to institutional financial players while banks can stay on top of innovations in their domain, and may develop an early relationship with a successful future client.

Some FinTech founders have shown scepticism, as they believe banks set up incubators to control innovations and copy the technology if necessary. More generally, banks may attempt to stay in touch with innovations, or to generate returns, by engaging in seed investments. This also introduces banks to potential future clients.

Venture funds

A few banks may have initiatives to invest in deep tech SMEs through venture capital or venture debt. This provides them with a source of high potential returns, and may also complement their other innovation initiatives. In general, bank venture funds focus on late-stage start-up companies. Seed investments, and early funding series, tend to be the domain of angel investors and non-bank affiliated venture capital firms. It is important to note that these venture funds are separate

businesses, at times situated in SPVs/off bank balance sheet, with independent personnel, governance and decision-making mechanisms.

Lessons learned

The private sector, especially banks, has supported KETs technologies through their own initiatives. Many of these initiatives are recent, and clear success stories have yet to emerge. Nonetheless, they provide potential models that could in the future be adopted or supported by public agencies to ensure better coordination of the efforts made, economies of scale with respect to the expertise cost and a higher leverage as higher volumes of investments are required.

Case study:
Intesa Sanpaolo – Start-up Initiative

Intesa Sanpaolo is one of the largest Italian banks, based in Turin. It is of interest for this study because of its multiple initiatives targeting high-growth, small companies.

Intesa Sanpaolo Start-Up Initiative

Intesa Sanpaolo's Start-Up Initiative is an incubator-type programme where promising technology start-ups are taken through a selection and training process. This culminates in a presentation with potential investors and corporations. The potential investors include Intesa Sanpaolo's own venture funds.

Process

The process for the Start-Up Initiative consists of six steps. It always targets an event focused on a specific industry, e.g. 10 May 2017 saw a FoodTech event, while 29 September 2016 covered Fashion and Design.

1. **Scouting** – ideas can be submitted online where they are processed, screened, and assigned to a target event.
2. **Tutoring and business coaching** – in the weeks leading up to an event, Intesa Sanpaolo provides training sessions to help entrepreneurs craft high-level business plans tailored to investors. This is done in cooperation with Maverick Angels, a Silicon Valley investor network.
3. **Evaluation and Selection** – industry and technology experts sit on a panel that evaluates candidates and moves some forward.
4. **Arena Meeting** – selected start-ups go through to the Arena Meeting, where they can pitch to an audience of potential investors.
5. **Follow-ups** – Intesa Sanpaolo collects feedback from interested investors and facilitates interaction with them and the businesses.
6. **International Roadshow** – further Arena Meetings are organised in key locations (e.g. London, Frankfurt, New York, San Francisco) for entrepreneurs to maximise their network/business opportunities.

Technology focus

The Start-Up Initiative is focused on technology first and foremost. The following areas recur yearly:

- Social ventures
- Biotechnologies and life sciences, and healthcare and medical devices
- ICT, digital media and online services, and electronics and automation
- Mobile and mobility
- Cleantech and renewable energies
- Nanotechnologies and high-performance materials

Innovation Centres

Intesa Sanpaolo currently has two innovation centres, based in Turin and London. Each fulfils slightly different functions. Intesa Sanpaolo believes that finance is a highly commoditised product – they can differentiate themselves by supporting small ventures early on.

The Turin Innovation Centre is "inwardly focused", and monitors trends in FinTech that could affect or benefit Intesa Sanpaolo. It is headed by Intesa Sanpaolo's Chief Innovation Officer, Maurizio Montagnese, to design "the bank of the future". Around 100 employees manage projects involving around 2 000 staff, focusing on original ideas to support, particularly in the area of FinTech. The total cost is €250m a year.

The Innovation Centre has led to Intesa Sanpaolo being a founding partner of The Floor, a dedicated FinTech start-up hub. Other founders are Santander, HSBC, and RBS.

Its other project is the London Innovation Centre. This is used to accelerate non-UK start-ups in London, as its ecosystem is deemed to be highly supportive. Intesa Sanpaolo works together with the Italian Chamber of Commerce, Imperial College, UK Trade and Investment, and the university business incubator SETsquared.

Venture funds

Intesa Sanpaolo is currently restructuring its venture fund capacities. It announced in May 2016 that it was teaming up with Quadrivio, a venture capital fund, to launch a combined €120m fund. This would serve as an umbrella for Intesa Sanpaolo's existing investment vehicles. Intesa Sanpaolo's venture funds are one of the potential investors for entrepreneurs identified through its Start-Up Initiative.

Coordinated advice/clusters

Government can play a significant role in spurring on KETs companies by ensuring the overall environment is conducive to their growth. In this section, we discuss two ways that the government can take a primarily coordinating role to create a KETs companies-friendly business environment.

Firstly, we look at how a full chain of financing can be ensured. This would guarantee that appropriate types of finance are available for KETs companies throughout all growth stages.

Secondly, we assess measures that governments can take to encourage the creation and flourishing of clusters that drive specific sectors.

3.1.7. Offer a full "chain of financing" throughout the firm's life cycle

As outlined in section 1, a key bottleneck in the financing of early-stage KETs is the lack of coherent funding across all stages of the life cycle. Funding gaps have adverse effects as they can negate all efforts to increase financing at other stages of the life cycle, and have knock-on effects by reducing exit opportunities and potential investments. While the above potential solutions aim to bridge some of the funding gaps that early-stage companies face, there is a need for continuous review and identification of market failures and gaps in financing. This continuous assessment of market failures needs to be performed at all levels: European, national and local.

At the European level, the establishment of the EIB InnovFin Advisory team contributes to that aim as it provides advice to improve investment conditions through activities which are not project-specific. For instance, it prepared a concept paper covering the latest trends in innovative financing instruments for Infectious Diseases R&D, outlining the need for a new, higher risk-taking, Infectious Diseases Finance Facility. This facility has since been implemented by the EIB with a high single-digit number of loans already signed.

At the national level, governments, innovation agencies and National Promotional Banks (NPBs) are well positioned to review the financing landscape and identify potential financing gaps and market failures. In November 2015, the European Commission published a communication to the European Parliament and to the Council highlighting the role of Promotional Banks in addressing these market failures.[104] This communication highlighted the importance of NPBs in "catalysing long-term finance". While some countries have had a promotional bank for a long time (e.g. Germany, France, Italy), a number of countries have recently established an NPB, such as Portugal, Greece and Ireland. More recently, the European Commission approved in August 2016 the creation of Malta Development Bank and the Dutch cabinet announced in March 2017 that they will establish Invest-NL to better coordinate its actions and focus on market failures.

Examples

The following case study on Sweden's financing landscape illustrates how the country has ensured a continuous offering of financing products for innovative companies through the use of grants (e.g. Vinnova, universities) as well as innovation loans and direct equity investments (e.g. ALMI), all with the aim of crowding in private-sector actors. Most recently and to further improve the financial offering, the government has established a new vehicle to support equity financing in innovative companies through a fund-of-fund structure (Saminvest), potentially with asymmetric returns.

[104] European Commission, "Working together for jobs and growth: The role of National Promotional Banks (NPBs) in supporting the Investment Plan for Europe", November 2015

Local and regional entities also play a key role, especially with regard to establishing a smart regional strategy. For instance, while KfW plays a role in providing financing to SMEs across Germany, the Saxony regional development bank, Sächsische Aufbaubank (SAB), ensures that the financing of innovative companies in the region is sufficient and aligned with the regional strategy. This needs to be coordinated with local government, e.g. the Ministry of Finance of the Free State of Saxony, as well as with the private sector.

This point was further highlighted by the European Committee of Regions in its "Opinion of the European Committee of the Regions – Working together for jobs and growth: the role of national and regional promotional banks (NPBs) in the investment plan for Europe". The Committee "calls for a significant increase in the role of local authorities in the creation, operation and evaluation of the impact of promotional banking in regions that do not yet have their own promotional instruments. This can be achieved either by giving local and regional authorities a bigger say in the strategic focus and governance of national promotional banks or by complementing the services offered by national banks through the creation of regional (local) promotional banks. These would cooperate closely with the national bank."[105] The European Committee of the Regions also highlighted "the considerable importance of giving local and regional authorities a greater say in the choice of financial solutions serving interests at local level. Failure to consider the position of local and regional authorities often results in support for investments which are incompatible with regional operational programmes and local strategies." [106]

Lessons learned

The government can play a positive role in ensuring KETs companies have access to finance throughout all its funding stages. This has been achieved in Germany and Sweden through a combination of direct government assistance, and government support to finance providers.

[105] European Committee of the Regions, "Opinion of the European Committee of the Regions — Working together for jobs and growth: the role of national and regional promotional banks (NPBs) in the investment plan for Europe", *Official Journal of the European Union*, 1 July 2016
[106] Idem.

Case study:
Chain of financing in Sweden

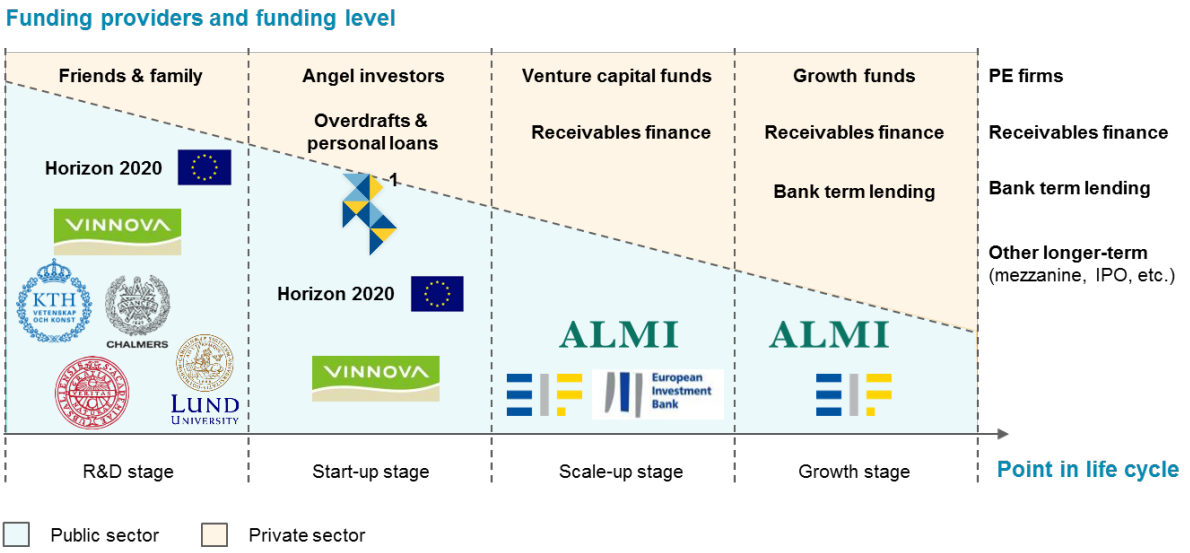
Sweden is often credited with having created a vibrant innovation ecosystem and a successful infrastructure to support it as the main engine of economic growth. In fact, Sweden was ranked second in the world in terms of innovativeness under the latest publications of the 2017 Bloomberg Innovation Index and the 2016 Global Innovation Index.

This has been enabled by a comprehensive and integrated innovation ecosystem, channelling advisory services and financial support throughout the life cycle of the emerging companies. The development of a comprehensive financing chain covering the full life cycle of the company is particularly useful to the successful support of innovation through KETs companies and other deep tech SMEs. In particular, a coordinated effort across all key agencies in providing funds at the earlier stages of growth and scale-up can bridge the "Valley of Death" during which the amounts of grant funding become limited and the availability of equity financing remains scarce.

Overview of Sweden's financing landscape

Sweden's innovation ecosystem aims to provide adequate funding at all stages of the life cycle, through the complementary support offered by the public sector and private sector. There is indeed a focus on addressing market failures that manifest themselves as funding gaps, and ensuring that the private sector is crowded in.

Figure 31: Provision of funding at early stages of life cycle



1. SISP: Swedish Incubators & Science Parks. Combination of private sector organisations and programmes run with public agencies

Note: There are a number of additional players, such as Industrifonden and Norrlandsfonden, which were originally founded by the government but now have independent operations. Other actors include Energimyndingheten (involved the the EU's Green fund) and RISE (Research Institutes of Sweden)

Financing across key stages of SMEs' life cycle

R&D Stage

At the initial stages of development, where the core activities are focused on fundamental research and product development, funding is provided primarily in the form of research grants by universities and other public institutions. The universities in Sweden are highly geared towards research and development as witnessed by Sweden's number 5 spot in the Bloomberg Innovation Index world ranking with respect to R&D expenditure as a % of GDP and the proportion of the population engaged in R&D activities. Universities geared towards technology are a hub for R&D and start-ups, creating the initial impulse needed for commercial innovation. For instance, KTH's innovation hub has been providing free advice to start-ups to around 300 companies per year, for the last 10 years. Moreover, KTH Innovation allocates funds from its own fund KTH Holding, as well as ALMI, Vinnova and Propell to pre-seed companies and thereby help catalyse the start-up process.

In addition, Vinnova – Sweden's innovation agency – works closely with universities under its "Knowledge Triangle" programme in order to foster interaction between education, research and innovation and thereby ensure that the R&D output in the universities is fully utilised. Vinnova is also the intermediary channelling EU funds under the Horizon 2020 programme.

Start-up stage

At the start-up stage, the funding is still primarily based on grants. For instance, Vinnova provides two levels of grants aimed at investigating market conditions and developing the first working prototypes. Companies that are less than five years old can obtain "level one" grants of up to SEK 500 000 (~€50 000). Vinnova invests SEK 2.7bn annually, targeting 2 400 research and innovation projects. This is supplemented by R&D grants by the EC. In addition, Vinnova collaborates closely with Swedish Incubators & Science Parks (SISP) to develop science parks and increase the availability of early-stage seed funding.

Moreover, private-sector actors such as angel investors and seed funds start providing support at these stages. For instance, the STING incubator supports Stockholm-based start-ups primarily in the ICT, cleantech and life sciences sectors. Similarly, Propel Capital, a seed fund with private angel money, has helped fund ~60 start-ups linked to the STING programmes since 2014.

Scale-up stage

During the scale-up stage, companies can make use of venture capital funding provided by the private sector as well as funding provided by ALMI in the form of equity co-investments or innovation loans.

ALMI is a government-owned enterprise established to remediate the funding gaps existing in the current chain of financing, and provide additional advisory services. In this context, ALMI's main focus is in the provision of capital through two main instruments: high interest rate loans provided to early-stage companies that banks won't lend to and equity co-investment alongside venture capital funds through ALMI Invest.

Co-investments are typically made in conjunction with smaller venture capital funds and share the risk involved in an early-stage KETs company. Due diligence is conducted separately by ALMI, with ~40 investment managers across eight regions. In 2016, ALMI invested a total of SEK 172m in 113 existing and 44 new portfolio companies. ALMI also extends innovation loans that are forgiven if the commercialisation of the product is unsuccessful and no revenues are generated.

Late growth stage

During the growth stages of the company, funding is provided through a number of players.

First, ALMI provides innovation loans and guaranteed loans using the EIF's InnovFin guarantee scheme. In 2016, ALMI granted over 4 500 loans totalling SEK 3.3bn to innovative companies. Typically, these loans bear a higher risk than what is accepted by commercial banks. As such, ALMI aims to fill a funding gap without crowding out the private sector.

In addition, growth funds are willing to invest in such companies, given the greater financial history and certainty around the company's cash flows. This is complemented by supply chain finance as companies are already generating revenues. In later stages of the company's development, traditional lenders provide capital as the risk profile of these companies becomes adequate for bank loans.

Future developments

Sweden is currently reviewing its risk capital activities and assessing ways to strengthen its financial ecosystem. As a result, the government has established a new vehicle to support equity financing in innovative companies through a fund-of-fund structure – "Saminvest AB". The main goal of this entity is to fund early-stage, high-growth SMEs by providing capital to emerging venture capital funds.

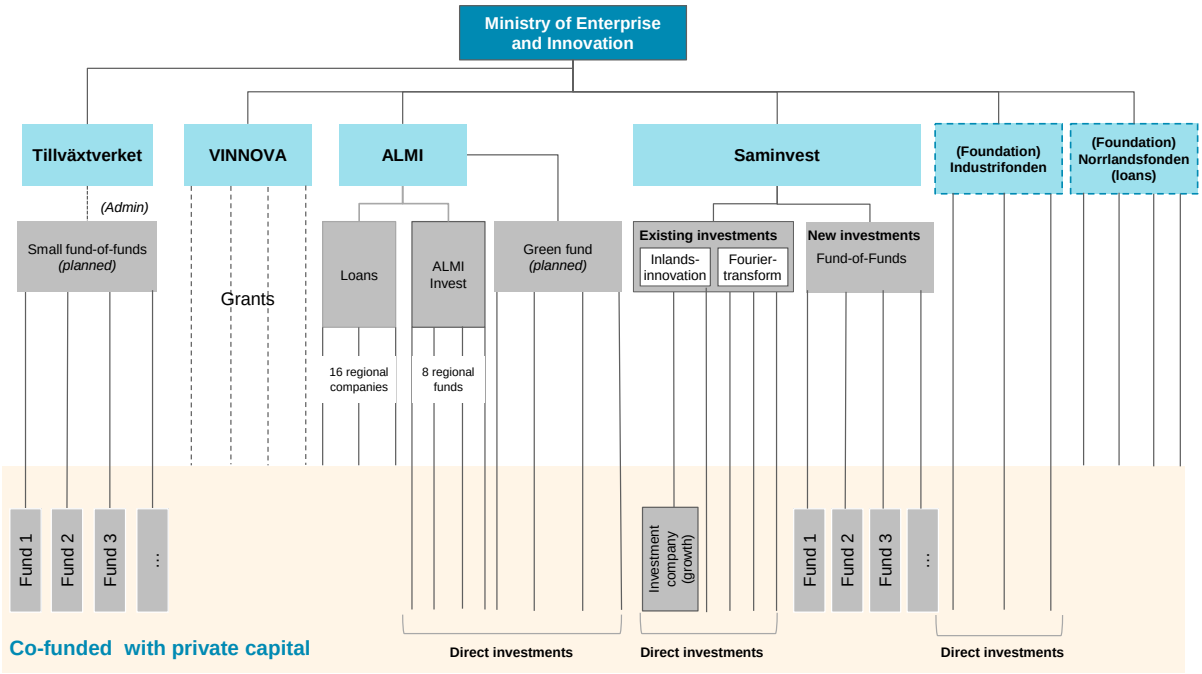
While a number of operational elements around Saminvest are being finalised, its mission will be to provide capital to privately-managed venture capital funds. This is in stark contrast with the government's previous risk capital activities, which entailed making direct investments via two companies (Fouriertransform and Inlandsinnovation[107]). In addition, Saminvest may allocate capital to seed funds (e.g. funds in close proximity to universities) to help foster innovation at the very early stages, but its main mandate will be to crowd in private sector capital at the scale-up and growth stages. To crowd in private investors, asymmetric return profiles will be considered. The asymmetry will, for instance, be present in the form of greater upside achieved by the private sector investors, as compared to Saminvest. This could potentially be achieved by Saminvest waiving returns after a particular profit threshold or by covering the administration costs incurred in investing. The idea behind this is to ensure that private-sector venture capital funds find the offering sufficiently attractive. This form of leveraging of returns has proved successful in the United States, through the SBIC programme conducted by the Small Business Administration over the last 50 years.

An additional interesting feature of Saminvest is the introduction of a 'production demonstration fund' ('*demonstrationsanläggningsfond*' in Swedish). The fund will provide investments (under the fund-of-funds umbrella) in new technology or processes where significant investments are required to go from small-scale prototypes to commercial-scale products. The fund will target technology that has proved to be viable on a small scale and where there is commercial demand while the perceived risk level in the scale-up phase is too high for private capital.

As shown in Figure 32, the Swedish government is coordinating efforts to ensure to have a suite of financial products that cover all stages of the life cycle of innovative companies. In this context, Saminvest is part of a broader effort to ensure that there are no funding gaps in the chain of financing and that market failures are addressed in an efficient way by crowding in private sector capital providers.

[107] The companies will not make any new investments and will focus on managing (and exiting over time) existing investments. The companies are managed as subsidiaries in Saminvest.

Figure 32: Overview of Sweden's government-related financing ecosystem with Saminvest



3.1.8. Strategic focus on clusters

While identifying and addressing gaps in the financing chain should be a key aspect of improving access to finance for KETs companies, it is critical to have a focused strategy at the regional level and across the supply chain of the cluster. A cluster is defined as a group of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers and skills. A strategy at the cluster level could leverage the smart specialisation framework encouraged by the EC and would ensure adequate coordination amongst the different actors.

Recent regional policies by the EC have been focused on the nurturing of clusters of economic activity through smart specialisation strategies. Smart specialisation strategies have been used to drive a more effective innovation policy and push interregional cooperation in new value chains across borders. Linking research and innovation actors with industrial stakeholders helps to exploit complementarities in the development of products and process design. This holds the potential to help build and reshape EU-wide value chains by encouraging the synergy of investment between the private and public sectors. It is important to highlight five key features of clusters[108].

- First, the critical mass of the cluster is important as agglomeration economies and spill-over effects are magnified by having more economic activity.
- Second, related industries matter as the full value chain should be engaged. This is particularly relevant with the increasing cross-industry nature of value chains.
- Third, the location matters as economic interaction and geographical proximity are highly correlated.
- Fourth, linkages and network effects are crucial and therefore platforms for cooperation need to be fostered.
- Finally and most importantly, clusters are inherently difficult to create as they emerge in a cumulative process that leverages existing advantages of the ecosystem.

In this context, smart specialisation strategies can be encouraged in order to magnify existing strengths. More importantly, there should be a focus on providing financial and non-financial support to the full value chain of the relevant KETs sector, and on ensuring networking and linkages across the value chain and between interdependent industries. In addition, while the development of the cluster should be pursued on a regional level, funds and support should be leveraged and coordinated across the local, federal and European levels.

Examples

The Free State of Saxony provides an example of a successful smart specialisation strategy. Saxony developed a strategy for the local micro- and nano-electronics cluster, ensuring that financing is available through grants and bank lending in coordination with KfW and the EIB and EIF initiatives. Moreover, linkages across the full supply chain were fostered by creating projects and initiatives such as Smart City. This was further promoted through a number of trade associations such as “Silicon Saxony”, which ensured that local KETs companies, larger manufacturers, universities, research institutions and public authorities could communicate and cooperate (See case study). Other countries have managed to develop their innovation ecosystem by focusing on particular

[108] European Commission, (2016), “Smart Guide to Cluster Policy”, *How to support SME policy from Structural Funds – Guidebook series*, No. 11

sectors. For instance, Israel focused its resources on the deep tech sector, specifically medical and communications technology. Resources were invested to ensure that a complete ecosystem emerged, with support at the R&D and start-up stages through grants and incubators. Conditional grants were given at the commercialisation stages and a highly-developed venture capital landscape through Yozma and other initiatives ensured sufficient equity financing for the growth stages. South Korea is another example of a coordinated strategy on a small-scale level which ensures that innovation thrives.

Similarly, ECSEL is a joint undertaking that coordinates funding for RDI projects across EU, national/regional and private stakeholders. ECSEL complements other European instruments for funding of R&D projects. It offers funding for RDI projects with systemic and strategic impact for smart, sustainable and inclusive economic growth. In particular, ECSEL focuses on:

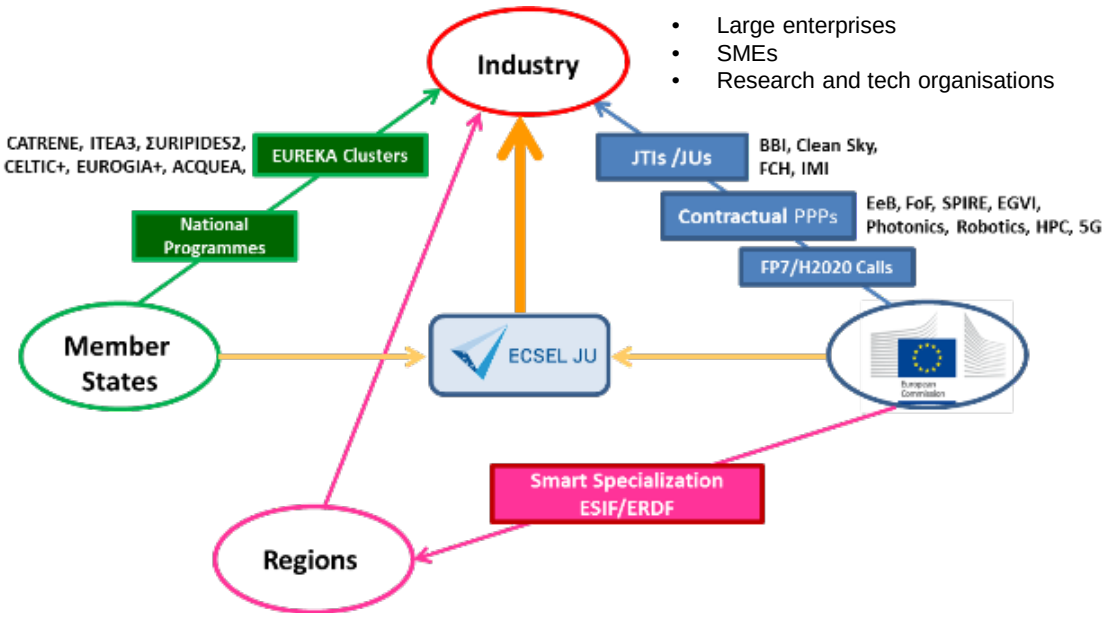
- Key applications (e.g. smart mobility, smart society, smart energy)
- Essential capabilities (e.g. semicon process equipment materials, design technology, cyber physical systems)

ECSEL JU focuses on two main funding instruments:

- Innovation Actions
  - Large-scale, integrating projects;
  - Pilot lines and test beds, large demonstrators and zones of full-scale testing;
  - Specifically include higher TRLs (4 to 8).
- Research and Innovation Actions
  - RD&I projects that should not work in isolation but cluster with other ECSEL actions;
  - Typically addressing lower TRLs (2 to 5)

Its functioning is based on a tri-partite funding model involving the private sector. It is a PPP model with 3-way funding involving the European Union (€1.17bn, via EC/H2020), the ECSEL Participating States (>€1.17bn) and the Private Members (~€5bn minus grants).

Figure 33: Illustration of ECSEL JU's tri-partite funding model



Lessons learned

Several governments have focused their efforts to support KETs companies on specific clusters. This enables them to hone in on key industries, collaborate more effectively with other institutions, and supports the development of a productive ecosystem. Existing initiatives such as the Vanguard Initiative can be leveraged to ensure the build-up of such ecosystem.

Case study:
Saxony's smart specialisation strategy

Overview of the Silicon Saxony cluster

The EU's regional and cohesion policies have made extensive reference to clusters and smart specialisation. A cluster is defined as a group of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers and skills.[109] Smart specialisation, in turn, refers to strategies for integrated, place-based economic transformation with a particular focus on regional strengths and technology and innovation. The Free State of Saxony, one of Germany's federal states with a population of 4.1 million, provides a pertinent example of smart specialisation in the semiconductor and electronics industries – the so-called "Silicon Saxony".

The formation of the Silicon Saxony cluster began with the "Arbeitsstelle für Molekularelektronik" in Dresden – the leading semiconductor research institute in East Germany. Over subsequent decades, multiple government research programmes in the microelectronics sector were developed in the region. Private-sector companies started locating there in the 1990s, when Siemens created SIMEC – a microelectronics centre that was later taken over by Infineon. Nowadays, the region is responsible for every second microchip produced in Europe and supports 2 100 enterprises and 51 000 employees in the ICT sector. This is complemented by a strong research landscape composed of nine universities with approximately 45 000 students in fields relevant to micro- and nano-electronics. This is complemented by a large number of research institutes and a number of technology transfer structures such as 20 technology centres and incubators.

Figure 34: Map of Free State of Saxony and Silicon Saxony cluster[110]

[109] European Commission, (2016), "Smart Guide to Cluster Policy", *How to support SME policy from Structural Funds – Guidebook series*, No. 11

[110] Silicon Saxony

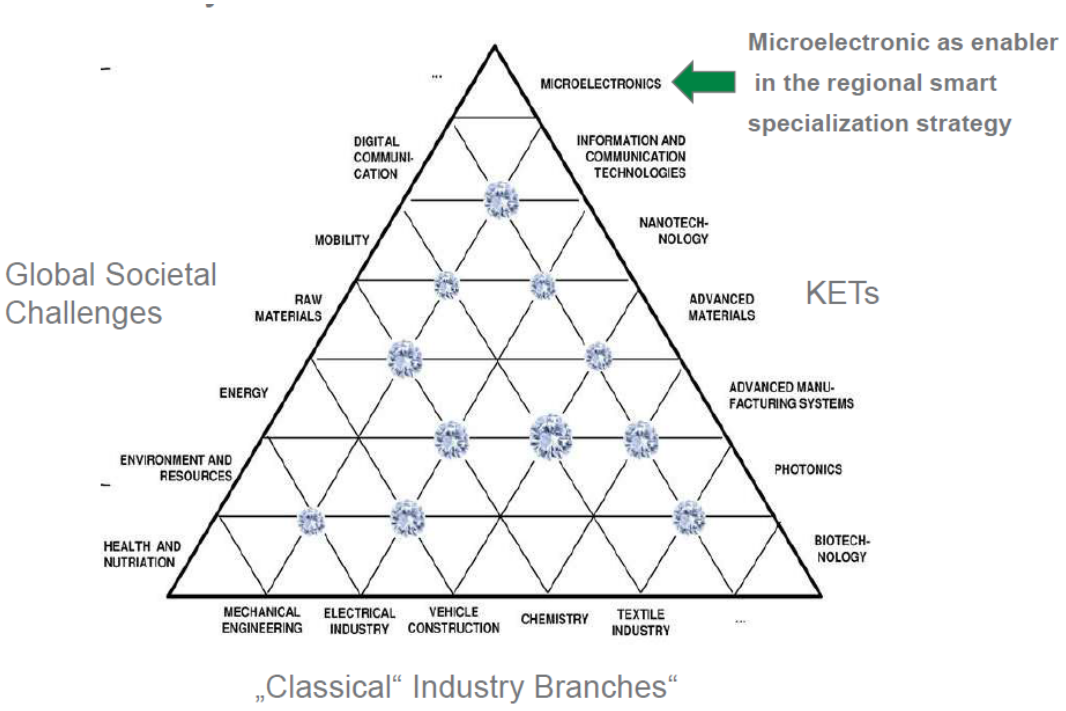
Saxony's smart specialisation strategy

Saxony's smart specialisation strategy acknowledges the challenges that are faced by the region and attempts to leverage its strengths. In particular, there is a focus on ensuring support across the value chain, encouraging linkages between different industries, where applicable, and fostering knowledge transfer between the different actors in the region.

Overall strategy

The objective of the strategy is to address challenges in the form of weaknesses at the end of the value chain, lagging entrepreneurship as witnessed by the lower intensity of start-ups compared to the rest of Germany, and the insufficient use of knowledge transfers and linkages across industries. This entails coordination between the EU-wide Horizon 2020 programme policy, the nationwide "High-tech Strategy for Germany"[111] and the regional innovation strategy[112]. The smart specialisation strategy reviews the classic industries available in the region against the backdrop of regional and global societal challenges and leverages KETs, and the microelectronics sector in particular, as a key enabler for this strategy.

Figure 35: Smart specialisation strategy[113]

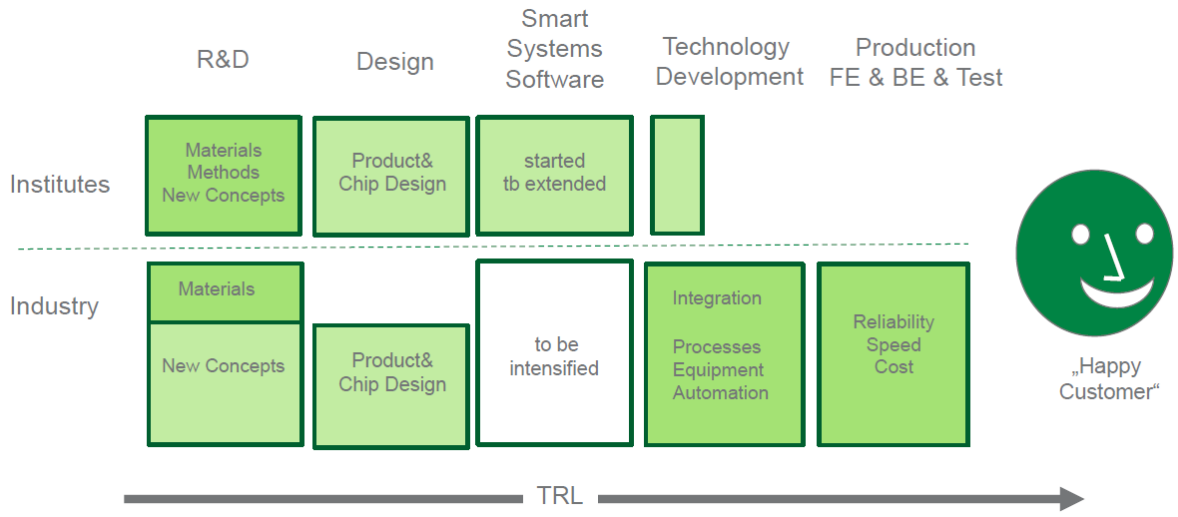


Identification of gaps in the value chain

More concretely, there is an effort to ensure that there is adequate support across the entire value chain. This is done by reviewing the potential gaps observed in the industry and institutes in the microelectronics industry. For instance, the strategy identified a need to intensify efforts in "Smart Systems Software".

[111] Ministry of Education and Research (BMBF)
[112] The State Ministry for Economic Affairs, Labour and Transport (SMWA)
[113] Rüstig, J., SMWA, (2014), "Smart Regional Financing for Key Enabling Technologies"

Figure 36: Gaps in value chain[114]



Cross-KETs strategy

Saxony's smart specialisation strategy also focuses on linkages between the different industries in the region. While there is a clear focus on the micro- and nano-electronics sector, interdependencies with other prominent deep tech industries are nurtured. For instance, Organic Electronics Saxony, a trade association focused on the application and coordination of regional, federal and EU projects showcases the links between biotechnology and microelectronics.

The inter-disciplinary nature of KETs ensures that synergies are created by promoting collaboration between these different technologies. This is demonstrated by the presence of clusters such as Biosaxony, which leverage the existing electronics capabilities to produce biosensors and enhance regional biotechnology and medical technology capacity. In addition, the nanotechnology developments in the region are leveraged in the fields of bioengineering and bionanotechnology. This is primarily driven by research institutes such as the BioInnovation Center Dresden and the Max Planck Institute of Molecular Cell Biology and Genetics.

Financial tools

From a financing perspective, the regional government identified gaps in financing and attempted to address these market failures through the provision of grants. The regional universities provide the crucial infrastructure to distribute research grants and foster innovation by playing a regional R&D hub role. Once R&D grants are no longer pertinent, additional financing in the form of grants and subsidised loans is provided by the Sächsische Aufbaubank (SAB), the regional development bank. As companies grow, they obtain access to bank lending through guarantee programmes supported by KfW – the national development bank. Additionally, KfW increases the capacity of venture capital by investing in private funds through its "ERP-Venture Capital – Fondsinvestments" programme. The programme launched in 2015, has a total commitment of €400m and includes investments in venture capital funds focused on KETs such as advanced materials. More recently, the programme expanded its scope to include venture debt funds. Nonetheless, the local ministries acknowledge

[114] Rüstig, J., SMWA, (2014), "Smart Regional Financing for Key Enabling Technologies"

that there is still limited venture capital funding, which is currently addressed by other private-sector actors such as family offices, as well as through additional grants and loans by public authorities such as the SAB.

A coherent and coordinated financing approach at the European, national and regional level is required to achieve adequate funding at all stages of the life cycle. At the European level, research grants are provided under the Horizon 2020 programme and are then distributed through the regional network of universities, among others. InnovFin guarantees are also provided for loans to innovative companies which are distributed by the SAB in conjunction with KfW. At the national level, grant funding is obtained as part of the "High-tech Strategy for Germany". In addition, KfW plays a key role in providing financing to SMEs across Germany and works closely with both EU institutions and regional development banks. At the regional level, SAB coordinates funding from EU and national institutions and provides additional funding in the form of loans and grants.

The integration of these different funding providers is illustrated by a co-financing programme targeting micro- and nano-electronics initiatives launched by the EU in 2014. The ECSEL programme, a partnership between the private and public sectors for electronics components, leverages support worth €500m from the federal government and €200m from Saxony's government. In addition, €80m of funding is provided by the regional government for KETs Pilot Lines.

Knowledge transfer and collaboration platforms

Finally, there is additional focus on providing knowledge transfer services and non-financial support through networks leveraging the various actors in the cluster. For example, the Silicon Saxony trade association is focused on the semiconductor, electronic, microsystems and software industries and aims to provide a communication and cooperation platform to its members. The association, founded in 2000, links over 300 manufacturers, suppliers, service providers, education institutions, research institutions and public institutions[115]. While Silicon Saxony performs a wide variety of functions, its core aim is to foster connections, forums and intelligent cooperative partnerships among its members to facilitate knowledge transfer, synergies, and close business relationships.

[115] Silicon Saxony

4. Recommendations

Summary

The market failure in financing of KETs companies requires a strategic and comprehensive public-private response. There is a clear case for a joined-up approach of EU and national bodies involved in providing support to KETs companies, as well as repurposing and refining existing public sector financial schemes to improve the draw for private capital across the KETs life cycle.

We identified nine potential solutions that could address those challenges. We then assessed them based on their expected impact on KETs' access to finance and the cost/effort involved in establishing the solution. This enabled us to prioritise the solutions and gather the most impactful ones in three groups.

Figure 37: Bottlenecks and potential solutions

Bottleneck	Cause		Potential solutions
High credit risk for KETs companies relative to SMEs	Information asymmetries as credit reports are non-existent	>	1 Reduce bank information asymmetries (to reduce PD)
	Lack of collateral, in particular usability of IP as collateral	>	2 Increase bank collateral (to reduce LGD)
Fragmentation of financing options across company lifecycle	Grants, supply chain financing, equity financing, and debt financing are necessary at different stages of a firm's lifecycle	>	3 Lending platforms for institutional investors
			4 Support financing throughout the supply chain, esp. with role of large corporates
			5 Supplement grant offering with conditional grants
			6 Support the development of venture debt
			7 Increase and enhance support in equity financing
	Limited availability of appropriate capital at some stages, depending on national context, in particular to obtain debt financing	>	8 Offer a full "chain of financing" throughout the firm's life cycle
			9 Strategic focus on cluster

The above figure shows how the main bottlenecks to due diligence and risk assessment of KETs projects that this study identified are broken down into underlying causes, with potential solutions addressing these. The precise nature of each potential solution is outlined in more detail below, in Table 8.

Table 8: Definition of solutions

	Potential solutions	Assessment		Rationale
		Expected impact	Cost / effort	
1	**Reduce information asymmetries (to reduce PD)**	M	H	• Effectiveness of tech credit assessment is unclear but would require significant investments and running costs • Subsidising tech assessments or producing market assessments would only marginally improve assessment
2	**Increase collateral (to reduce LGD)**	M-L	H	• No known examples have succeeded in increasing use of IP as collateral • Increased transparency in IP transactions could, however, have some benefits to improve IP valuation
3	**Lending platforms for institutional investors**	M-L	L	• Costs likely to be limited as could be performed through investments in funds or provision of guarantees • While such platforms could increase capital availability to large, stable SMEs, it is unlikely to benefit early-stage KETs as institutional investors will provide similar products to banks (traditional loans) and have limited appetite for high-risk companies
4	**Support financing throughout the supply chain, especially with role of large corporates**	H	M	• Requires focus on working capital and collaboration with large corporates • Could result in significantly increasing availability of capital at lower cost
5	**Supplement grant offering with conditional grants**	M-H	M	• If targeted well, "recycling" of capital could result in significantly increased grant capacity based on some changes to the processes
6	**Support the development of venture debt**	M	M-L	• Requires some changes to mandates and focus but could leverage existing knowledge and processes (e.g. equity investment tools) • Could result in increased capital availability for scale-ups
7	**Increase and enhance support in equity financing**	H	L	• Some changes to current approach to equity investments could significantly increase the attractiveness of equity investments and therefore increase available capital and ability to leverage
8	**Offer a full "chain of financing" throughout the firm's life cycle**	H	H	• Requires significant work within each European, national and regional promotional institution and coordination between them • Could, however, result in significantly improved availability of capital
9	**Strategic focus on cluster**	H	H	• Similarly, requires significant work at the regional level with coordination at all levels but could result in significantly improved results

Legend "Impact" reflects expected increase in financing to early-stage KETs (in availability and cost)
"Cost/effort" reflects the difficulty in achieving that impact at a proportionate cost

To prioritise among the suggested solutions, each solution is assigned a value from High (H) to Medium (M) and Low (L) for "Expected impact" and for "Cost/effort". The former reflects the expected increase in financing. The latter reflects the estimated difficulty of achieving the expected impact at a proportionate cost.

Figure 38: Impact and cost/effort assessment of potential solutions

	Potential solutions	Assessment		Rationale
		Expected impact	Cost / effort	
1	**Reduce information asymmetries (to reduce PD)**	M	H	• Effectiveness of tech credit assessment is unclear but would require significant investments and running costs • Subsidising tech assessments or producing market assessments would only marginally improve assessment
2	**Increase collateral (to reduce LGD)**	M-L	H	• No known examples have succeeded in increasing use of IP as collateral • Increased transparency in IP transactions could however have some benefits to improve IP valuation
3	**Lending platforms for institutional investors**	M-L	L	• Costs likely to be limited as could be performed through investments in funds or provision of guarantees • While such platforms could increase capital availability to large, stable SMEs, it is unlikely to benefit early stage KETs as institutional investors will provide similar products as banks (traditional loans) and have limited appetite for high risk companies
4	**Support financing throughout the supply chain, esp. with role of large corporates**	H	M	• Requires focus on working capital and collaboration with large corporates • Could result in significantly increasing availability of capital at lower cost
5	**Supplement grant offering with conditional grants**	M-H	M	• If targeted well, "recycling" of capital could result in significantly increased grant capacity based on some changes to the processes
6	**Support the development of venture debt**	M	M/L	• Requires some changes to mandates and focus but could leverage existing knowledge and processes (e.g. equity investment tools) • Could result in increased capital availability for scale-ups
7	**Increase and enhance support in equity financing**	H	L	• Some changes to current approach to equity investments could significantly increase the attractiveness of equity investments and therefore increase available capital and ability to leverage
8	**Offer a full "chain of financing" throughout the firm's life cycle**	H	H	• Requires significant work within each European, national and regional promotional institution and coordination between them • Could however result in significantly improved availability of capital
9	**Strategic focus on cluster**	H	H	• Similarly, requires significant work at the regional level with coordination at all levels but could result in significantly improved results

Legend "Impact" reflects expected increase in financing to early stage KETs (in availability and cost)
"Cost / effort" reflects the difficulty in achieving that impact at a proportionate cost

Figure 39 below shows how the solutions map in terms of expected cost/effort compared to expected impact on KETs companies' actual access to finance.

We identified three distinct groups which correspond to the categories of recommendations: a high-impact, low-cost group in the bottom-right corner, a high-impact, high-cost group in the top-right corner, and a medium-impact, medium-cost group in the centre of the graph.

Figure 39: Mapping of recommendations across expected impact vs. cost/effort

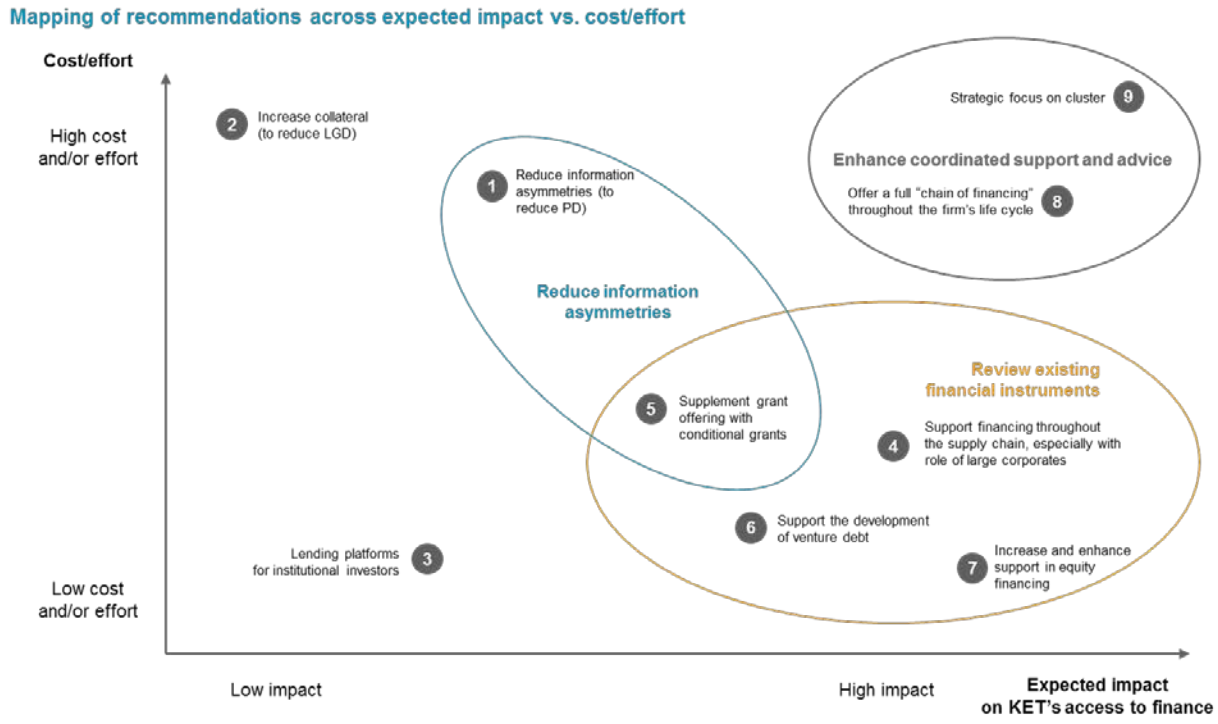
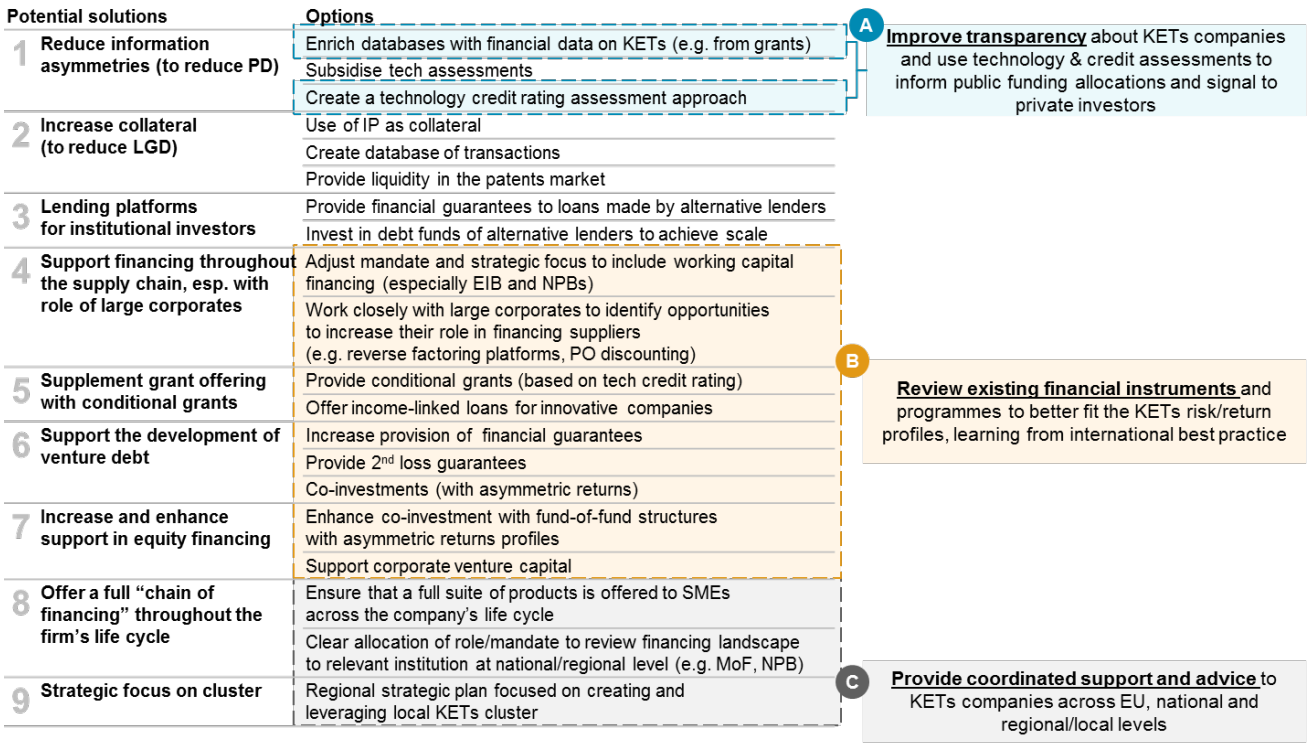


Figure 40 outlines how the potential solutions map to the recommendations in this report.

Figure 40: Grouping of recommendations



In summary, best practice evidence from Israel, Korea, Saxony and the US suggests that targeted participation can be structured to address market failures and avoid market distortion. It is clear that all recommendations will require a large group of stakeholders to coordinate their actions to maximise the impact of public-private participation across the three groups of recommendations. We therefore recommend the creation of an ad-hoc "KETs strategy implementation group" tasked with developing a master implementation plan, assigning implementation accountabilities, coordinating key stakeholders, reporting on progress and ensuring feedback loops into each recommendation as the market evolves.

Ahead of the launch of such implementation programme, an initial phase of preparatory work will have to be completed in advance. The preparatory work should aim to ensure that key stakeholders are identified and agreed upon, that each of the key stakeholders is mobilised and equipped with the right infrastructure and product capabilities for the launch date.

As immediate next steps, we recommend to set up a "KETs strategy implementation group" including members of relevant stakeholders, especially from the EC and the EIB Group, national innovation agencies and promotional banks. The group's mandate would be to first define for each project the features of the deliverables and then agree on an implementation plan.

- For recommendation 1, the identification of existing data, the definition of an approach to include these in a KETs database, and definition of the structure of the "tech assessment" (especially key fields that could be required and need to be collected in the database).

- For recommendation 2, the definition of an enhanced product for equity, venture debt and forgivable loans in addition to a review of existing public funding instruments to make them more inclusive for capital intensive, high-risk, late break-even type of KETs projects.
- For recommendation 3, review the existing programmes and define the main options to be discussed with member states. During the preparatory phase, the group would agree on the implementation roadmap for each of these projects.

Table 9: Recommendations

Core recommendation		Description	Examples
A	**Reduce information asymmetries about KETs companies by developing a European Information Sharing Platform** and, in the medium term, a technology credit assessment tool to support public decision-making processes	• Enrich databases with additional data on KETs that receive public money (e.g. grants, loans), especially financial data • Leverage gathered information to perform industry and company-specific analysis • Use a data-driven approach to allocate public resources (e.g. grants) and provide a valuable market signal	• South Korea's KOTEC
B	**Refine existing financial instruments** and programmes to better fit the KETs risk-return profile	• Review comprehensiveness of chain of financing offered to KETs • Innovation agencies to offer contingent grants • EIB and NPBs to complement their suite of products with financial products with a more adequate risk-return profile for high-growth, high-risk companies – Hybrid instruments (especially venture debt) – Equity funding – Supply chain financing	• Israel's conditional grants (IIA) • Singapore's Venture Debt Programme • UK's Help to Grow (BBB) • USA's SBICs (SBA) • Israel's Yozma programme • Mexico's cadenas productivas (NAFIN)
C	**Enhance the enabling environment for KETs companies by fostering "joined-up" innovation ecosystems and regional clusters**	• The EIB, NPBs and local innovation agencies should – Provide essential business advice (e.g. strategy, investor/financier readiness, technology development) – Facilitate industry networking in order to connect small KETs companies with enterprises critical to their development (e.g. potential customers, suppliers, universities) • This coordinated approach will deliver a complete chain of financing by coordinating the use of financing instruments at EU, national and local levels, and by catalysing the right sources of private capital	• Sweden • Saxony • ECSEL JU

Recommendation A – Reduce information asymmetries about KETs companies by developing a European Information Sharing Platform and, in the mid-term, a technology credit assessment tool to support public decision-making processes

Our first recommendation is to improve transparency *about* KETs companies, their location across Europe, their product/technology offering and their funding and other forms of support received from public institutions/authorities; in a first step, bringing together such information in a central IT platform is a critical way to bring an overview to public agencies about ongoing KETs activity in Europe by geography, type, and gaps in the public funding chain; this holistic view and understanding may provide fertile ground to improve coordination across levels (EU, national, regional) and geographies. Ultimately over time, as the underlying database and inter-agency cooperation grows, such improved transparency can form the basis for public authorities to develop and deploy a technology credit assessment that informs public funding allocations and increases the credibility and signalling value of the latter.

The EC, innovation agencies and promotional banks already hold significant data on KETs companies, such as data on companies that received/applied for the SME Instrument or other grants (e.g. more than 31 000 companies applied for the SME Instrument) as well as which firms received equity or debt financing from national or EU level promotional banks. We therefore recommend the development of a structured, central IT database that pulls together and makes easily searchable information about support provided on the basis of *public* funds.

The advantage of pulling together this existing public data is for public authorities at all levels to have a comprehensive overview of KETs activities across European regions, and for public finance providers such as the EIB or national promotional banks to easily identify those KETs companies that their peers have considered worthwhile to support and who going forward might need the next step of capital in the financing chain. In a first step, such database could be accessible only to accredited members of national/EU level banks, innovation agencies and public authorities such as ministries or the EC. To such select audience, the database could equally provide contact information for the lending or assessment teams that stand behind public funding providers, making it possible for follow-on financiers to reach out and enquire about further information including e.g. confidential assessments about the technology, quality of management and business prospects, as well as financial data (e.g. from public accounts). Such option would require the ex-post or (going forward the ex-ante) consent of the company to share confidential information across public bodies, which could be requested either on a case-by-case basis or as a blank cover. Evidence from the IFA work suggests that a good portion of applicants/borrowers would be open to giving this consent if they see a potential funding advantage behind it. Setting up a tight confidentiality and data protection framework around that IT platform would be a critical task for any implementation group.

This database could ultimately, over a series of years, provide the input to a public sector "technology credit assessment". This assessment would allow for a more systematic, data-driven approach in allocating public resources from the EC, promotional banks and innovation agencies. Additional transparency on this approach and the outcome of the assessment would create greater transparency for private investors, thereby maximising the "signalling value" and ultimately the credibility of public sector support. Moreover, such a data platform could be linked up with already

existing central platforms such as the European Investment Project Portal (registering KETs companies could automatically opt in to be included in the KETs database).

We therefore suggest improving transparency in two ways:

1. First, the creation of a KETs database that centralises already available information about public support for KETs companies, and in another step can provide lenders and investors with more transparency, and thus a better understanding of the economics and financials of KETs companies;
2. In the medium to longer term, the development of a technology credit assessment approach that would enable public authorities at the EU, national and local level to take more data-driven decisions with regard to the allocation of public resources, based on economic, financial, behavioural and technological criteria.

4.1.1. KETs information sharing platform

The EC, innovation agencies and national promotional banks already hold a wealth of information and different types of data on the KETs sector and KETs projects. For instance, the EC's KETs Observatory gathers comprehensive information on the situation of the KETs sector in Europe and there is information about c. 31 000 projects, some of which are KETs that have applied for the SME Instrument; there is publicly available information of KETs companies that have registered their projects with the European Investment Project Portal (EIPP); the EIB holds public and private information about which KETs companies have received direct or indirect EIB funding including detailed due diligence materials; there are various other data files stored in different EC DGs that contain information on KETs projects and research (not to mention information at a national/regional level). However, this data is typically either macro (i.e. not at the level of entities but aggregated across whole industries and company sizes) or more technology-focused (i.e. does not include sufficient information on the economic and financial situation of KETs companies to support lending or investment decisions). Such databases could, however, in a relatively straightforward manner be enriched with more financial data over time, especially regarding the receipt of public funds (grants, equity or debt) or any form of technical assistance/advisory. In particular, the additional data included in the databases should aim at providing information that is reflective of KETs companies at a more granular level, i.e. it can be sliced and diced by company size, sector, type of product, financing tools.

To develop such information sharing platform, we recommend a phased approach in which the EC catalyses the progress by initially pulling together in a central IT infrastructure all the data the different EC Services and outposts/agencies already hold on European KETs companies. As a next step and building on this good example the EC could, in conjunction with an inter-agency working group, draw in national innovation agencies and promotional banks to enhance the quality and breadth of information. For greater precision, the EC could in a first step bring together its in-house information on KETs companies, researched and/or funded by the EC, in a common, state-of-the-art IT platform.

A separate and more continuous exercise would have to ensure the standardisation of such data, where possible, and the definition of future common standards once non-EC, national or regional public authorities are being drawn in; furthermore, it is important to gather data that follows the performance of the company over time and enables the evolution of highly dynamic projects to be assessed. Over a number of years, collecting the same data across companies, it could become possible to leverage the database and build a technology credit assessment that combines

assessments of creditworthiness and technology and could become an additional factor to enhance the public funding allocation of agencies across all levels. Assuming the assessment approach will be sufficiently effective (especially given the size and scope of the database it would be based on), national authorities might progressively join to use the tool and thus contribute to the database.

There are a number of implementation options to be considered subsequently: the procedures to define a common set of data standards; choice of underlying technology platform and analytics as well as sourcing of an external project manager to implement this recommendation; data security and privacy considerations (which for already public information about e.g. types of funding received from the EIB, such as collected in the first step of the platform, should not be a major hurdle); data collection processes including consent of national and regional agencies/promotional banks/innovation agencies; standardisation of expert input (with regard to technology assessment later on), time and cost of implementation including external support; and a continuing learning approach to ensuring high data quality.

For practical implementation purposes, one approach would be to use a hub-and-spoke model where the EC could become the clearing house of information and data by aggregating data from existing decentralised databases (at the national and EU level) and bringing them together in a European information platform on the basis of an information sharing agreement between EU and national level institutions.

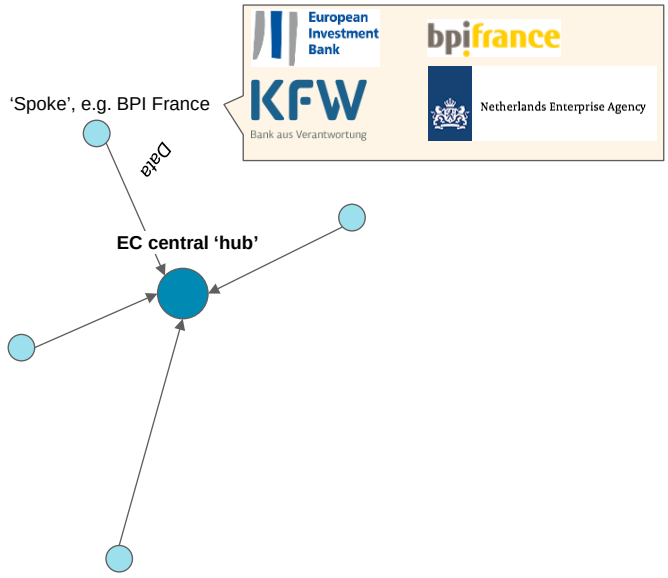
Under this approach, national innovation agencies and NPBs would agree to relay certain types of information, to be mutually agreed on, to the central hub. In particular, this information platform would include: (1) non-financial information about KETs such as the type of public support received plus associated information (year, volume, people to contact etc.), and some basic company details e.g. industry, type of technology/KETs, top management and shareholders (publicly available information); (2) publicly available historical financials as filed with commercial registers, over time permitting an ongoing view and analysis about financial performance as the company grows. In such format, the database would initially be confidential and limited to the subscribed public authorities. At the same time, the centrally managed hub would ensure adequate reporting, standardisation/uniformity, and timely delivery. This would provide all stakeholders (at EU, national and regional levels) with more transparency on KETs companies, their location, evolution and funding options following earlier public financing, as well as access to more comprehensive assessment tools.

Data that could be shared across public innovation agents in Europe include:

- Public funds received: type (grant, equity, debt), volume, date, purpose, institution;
- Other type of public support received (e.g. technical assistance);
- Contact person representing the assessment or deal team at the public body to get in touch with if necessary;
- Company consent (case by case or general waiver): exchange of assessment/due diligence materials with other public bodies;
- Public company information such as historical financials filed with commercial registers, management and shareholders;

- Sectoral studies conducted by the public institutions active in the network/hub-and-spoke model, e.g. on access to finance or latest technological developments;
- Cluster information involving RTOs and larger corporate partners collected by public institutions;
- Further types of information that could be shared pending a hub-and-spoke agreement.

Figure 41: Schematic representation of the hub-and-spoke approach



Spokes can include: (i) national promotional banks; (ii) national innovation agencies; (iii) EIB Group (EIB and EIF); (iv) EC and all its services as well as associated agencies and platforms, such as the JRC, EIT, KETs Observatory and EIPP; (v) other national ministries/agencies working on KETs, e.g. ministries of research, economics, digitalisation; (vi) regional public initiatives, e.g. Silicon Saxony.

The outlined approach has the benefit of creating a common information platform that facilitates the exchange of data and information from the national to the EU level whilst maintaining the ownership of a decentralised database with each institution that will participate in the development of such and an information clearing house.

The suggested information platform has the potential to build over time a comprehensive and standardised information base enabling early predictors of future company success to be determined. Whilst initially this information platform and underlying dataset would be purely a tool for public institutions and policy-makers, open to them and only to them, depending on the success of the tool this platform could become a reliable go-to source of information for private-sector providers of follow-on capital and the public at large.

For instance, KETs companies would be able to agree to share their information on this database with potential investors as is currently the case with credit scores established by rating agencies; in fact much of the information to be centralised is already publicly available to investors, e.g. which

KETs projects received funding from a national or EU-level promotional bank (except that at present this information is stored within individual institutions' websites and is hard to find or search for).

4.1.2. Technology credit assessment

In addition to a central KETs database, the EC, NPBs and innovation agencies could work together to further structure and take a data-driven approach in allocating public resources. In particular, the development of a "technology credit assessment" (i.e. credit assessment approach combining management, financial, technology and business components) could support the allocation of public resources (see recommendation 3 for potential use with contingent grants). As more data becomes available, the approach could become increasingly data-driven and, if proven to be sufficiently predictive, be made available to potential lenders and investors (either through reports or database access). As mentioned in the previous section, Korea's KOTEC has gathered such extensive data on thousands of innovative companies and developed a "technology credit rating tool" used to standardise its allocation of financing instruments (e.g. guarantees).

To demonstrate the power of such a data-driven approach, the EC, NPBs and innovation agencies should guide their existing grant and innovation loan schemes towards KETs companies based on their technology credit assessment. Inclusion of data related to public sector support of individual KETs in the database will also send an important market signal and provide a focal point for subsequent private sector capital.

Our proposed approach to technology credit assessment would be comprehensive, assessing industry, financial, behavioural and technology factors. As shown in

In the establishment of such database and technology & market assessment, Europe's Research & Technology Organisations hold the potential to play an important role. For one, RTOs have intrinsic knowledge and are used in the regular application of the TRL scale that the High Level Group on KETs proposed to the European Commission to use as a tool for assessing KETs and related projects: *"[…] The TRL scale can be used to assess the eligibility of innovation projects based on their maturity, assuming the scales are adapted to the specific context in which they are used."* Furthermore, RTOs have ready access to experts in Key Enabling Technologies that are researching at the frontiers of their field and can provide an assessment of technological, but also to some extent commercial prospects of particular KETs projects.

Table 10, the criteria used could include information about

- The country of operation of the company (e.g. economic, institutional);
- An assessment of the trends of the industry of the KETs company as well as its competitive positioning within that industry (e.g. from economic/market analyses, expert analyses, experts at large companies);
- Financial elements such as key cash flow elements, balance sheet position and profitability ratios;
- Behavioural information around management (e.g. number of years in an industry), past economic behaviour (e.g. debt repayment) and potentially Big Data (e.g. social media, news on the company or brand);

Information about the technology, including its level of readiness (e.g. TRL scale), number of patents held by the company or other IP, its commercial/economic potential and its expected impact on the European economy.

Figure 42 illustrates what such a credit assessment approach could look like for a KETs company and how it could guide decision-making.

It is important to note that, while this wide range of data could be used for a variety of types of decisions, the weights allocated to each criterion may differ depending on the purpose of the decision. For instance, a fundamental research grant would weigh mostly on the technology and its impact on the economy, while contingent grants and innovation loans would balance more the technology elements (i.e. social benefits from innovation) with the financial elements (i.e. economic cost of not recovering the grant or loan).

This database could be supported by a "tech credit rating assessment" to facilitate decision-making and allocation of public resources (e.g. by complementing the evaluation of proposals).

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Table 10: Mapping of factors typically used in technology and credit assessments

Factors	Dimensions	Traditional credit scoring		Innovative credit rating (e.g. Big data)	Public scoring authorities		Proposed approach
		Banks	Credit rating agencies		Promotional banks	Innovation agencies	
Country	Economic	✓	✓	✓	~		✓
	Institutional & governance	✓	✓	✓	~		✓
	Legal	✓	✓	✓	~		✓
	Financial system	✓	✓	✓	~		✓
Industry & competitive positioning	Industry risk (e.g. growth trends, market structure, cyclicality)	✓	✓	✓	✓		✓
	Competitive position	✓	✓	✓	✓		✓
Financial	Cash flows and leverage	✓	✓	✓	✓		✓
	Profitability	✓	✓	✓	✓		✓
Behavioural	Management quality, leadership & strategy	✓	✓	✓	✓	~	✓
	Past behaviour (e.g. account)	✓	✓	✓	~		~
	Big data (e.g. social media)			✓			~
Technology	Technology readiness					✓	✓
	Market potential					✓	✓
	Potential impact on overall innovation					✓	✓

[116] EARTO, The TRL scale as a Research & Innovation Policy Tool, EARTO recommendations.

Figure 42: Example of technology credit assessment approach

Factors	Metric	Score		Metrics scoring	Avg. score	Weighted score
		T	T-1			
Financial					4	20%
Cash flow statement → *assess profitability and liquidity position*	Turnover/EBITDA/net revenues (EUR m)	4	3	3		
	Cash available (EUR m)	0.5	1.5	4		
	...	...	...	...		
Financial ratios → *ability to repay debt/grant, distribute dividend & withstand shock*	Capital structure (equity cushion)	0.7	0.7	4		
	Debt/EBITDA and DSCR	7.3x	6.5x	5		
	...	...	...	...		
Behavioural					1.75	20%
Quality of management & strategy → *ability to deliver strategy*	Founders' experience	3 yrs	2 yrs			2
	Founders' previous successful companies	2	2			
	...	...	...			
Past behaviour → Previous use of accounts	Management credit score	Good	Good			2
	Company delays in payments	Good	Good			2
	...	...	...			
Industry					2	20%
→ *assess overall industry situation and company-specific competitive positioning*	Industry growth	10%	10%	1		
	Market/commercial feasibility	Average	Average	2		
	Expected timing of take-off	2025	2023	3		
Technology					1.67	40%
→ *assess technological prospects & potential to transform into a solid commercial product*	Technology readiness	TRL9	TRL8	1		
	Market potential	Very good	Good	1		
	Potential impact on innovation	Unclear	Unclear	3		
Overall score						2.2

4.1.3. Points for consideration

It is important to highlight that developing such a hub-and-spoke model around a central database would involve organisational and operational costs: for the underlying IT infrastructure; the project management and set-up costs; costs over time to ensure continued harmonisation and alignment across the various spokes (e.g. IT, processes, and training); a permanent working group led by a central EU institution such as the EC to align with the spokes, harmonise, share, upgrade etc. Therefore a gradual ramp-up is recommended, starting with the attempt to centralise and make easily accessible the relevant data that exists in EU institutions/bodies such as the EC, the EIB, JRT, EIT, EASME, etc. and selected platforms such as the KETs Observatory, the Innovation Radar, the EIPP, etc.

- Further considerations include, amongst others (not exhaustive): **Data confidentiality, availability and timeliness** – special attention will have to be paid to questions of data protection and confidentiality where non-public company or expert information is involved. Sharing such information will require the explicit consent of the concerned company or service provider. For projects already funded this would have to be ex ante; however going forward, each company receiving public funding can be automatically requested to provide (or not) the consent to share, similar to the requirement for disclosure of EU funding. While the data needs to be available in a timely manner, it will be important to consider the impact on confidentiality and privacy that such a database could provide. In addition, some member states may have stricter laws limiting the availability and ability to share information on the KETs companies. The possibility and ways of opting out for KETs companies will need to be reviewed;

- **Coordination and project management** to build the IT platform but also apply a more strategic focus, managing together with the EC a working group to set up such database; e.g. identify available data across levels, map these data, provide common standards and oversee the design and implementation of an adequate IT platform;
- A **strong IT platform and algorithm** will be necessary to manage the analysis involving certain costs to build and maintain it.

4.1.4. Implementation

The implementation of a shared information platform about KETs companies and the public support received, as well as ultimately of a technology credit assessment tool based on this centralised database, can be performed in three steps as outlined below.

All steps require a tightly coordinated working group. The EC due to its European mandate, public sector focus and wealth of available data about funded companies, is in a particularly good position to coordinate such a working group. The group needs to involve representatives of all DGs that possess information about KETs; relevant EC-linked agencies (EIT, JRC, EASME) and platforms (KETs Observatory, Innovation Radar, EIPP, etc.) that can provide input; and the relevant spokes as listed before at national/regional level including the EIB Group. Since one key element for making the existing data easy to access, search and filter is the development of a physical IT infrastructure, it is recommended to have an external project manager with deep IT and PM experience to lead this part of the work.

As to the phased-in approach of rolling out the KETs information platform, the following steps are suggested:

- First, the KETs information platform could be built **based on existing data** held by the EC, its services and related agencies, as well as the EIB Group: e.g. from the SME Instrument, from the KETs Observatory, Innovation Radar and EIPP, from EIB/EIF loans and facilities etc. Given these are all EU institutions/bodies, establishing a working group and agreement on the outlines of this project should be facilitated. Secondly, public national innovation agencies and promotional banks can be drawn in to share information about publication and grants to KETs. This would need to be explored if the data can be structured in a useful way and some of the data collection processes can be repurposed and extended, e.g. adding elements on technology and extending the data collection over time so that it follows the company through its life cycle. Once the collaboration is established, this may require some significant changes to processes (e.g. monitoring the company over a longer time period on the basis of mutually agreed standards) and the addition of new processes (e.g. standardised technology assessment).
- **The EC and EIB could over time leverage this growing information base to develop a technology credit assessment approach**. The technology assessment can combine technology, financial and behavioural factors, and support decision-making for public authorities. For instance, a balance of financial and technology factors could support the decision to grant a forgivable loan, while grants would typically be more weighted towards technological factors. The EIB's Memorandum of Understanding signed with KOTEC in 2017 and the associated retroactive pilot to test KOTEC's rating methodology on EIB-funded projects can provide a useful pointer in that direction.
- **Finally, as the technology credit assessment approach matures and becomes more widely used at the EU level, it would be possible for national authorities (e.g. innovation agencies,**

promotional banks) to join and use it to also support their decision-making process. These bodies would then over time also start to contribute to the database and help to make it more comprehensive. Eventually, if the tool is effective (i.e. predictive and cost-efficient), its use may be opened to private-sector investors to support their analyses. Indeed, already today EIB-intermediated banks have expressed a general interest in learning about the outcome of the aforementioned pilot between the EIB and KOTEC and seeing what lessons and guidelines can be drawn for the commercial lending business from applying this proven technology assessment methodology in a European context.

Recommendation B - Refine existing financial instruments

As described in previous sections, KETs companies need to draw in significant private capital given their high capital expenditure needs and long pilot lines, especially during the earlier stages of financing. However, the risk-return profile of KETs companies is currently unattractive for private-sector investors with the current suite of products.

We believe this is a challenge for repurposing and focusing existing schemes, rather than creating additional financial capacity. In particular, we recommend focusing on the following four products.

Table 11: Products to make further use of

Product category	Recommendation
Forgivable grants (or conditional grants) and blended grants	• Promotional banks (e.g. EIB, NPBs, regional promotional banks) and innovation agencies (EC, national and regional agencies, universities, etc.) could consider transforming part of the existing grant programmes into forgivable loans and/or contingent grants • Blending grants with automatic or conditional follow-on, return-generating types of finance (debt or equity, public or private) • In order to maximise the signalling power of these grants, these would be integrated in the enhanced KETs database (as per recommendation 1 above)
Hybrid instruments	• NPBs and EIF could deepen the potential market for venture debt in two ways – Co-investments in venture debt funds – Provision of first or second loss guarantees to venture debt vehicles
Equity funding	• Co-investments with asymmetric returns profiles will enhance the attractiveness of such returns • They could be used with various types of customers, potentially tweaking the risk-return profile depending on their risk appetite – Corporate venture capital – Traditional venture capital funds • This will provide further benefits from the signalling value of participation from promotional banks
Supply chain finance	• We recommend that the EIB/EIF and NPBs work with commercial banks to develop facilities to support large companies' use of supply chain financing for KETs companies • This form of financing is particularly valuable to KETs companies when they develop cash flows and client relationships, but before they reach profitability, in order to be able to afford term loans – as well as to more mature KETs companies

In addition, it is critical to regularly assess the comprehensiveness and adequateness of the availability of financing instruments throughout the life cycle of KETs companies. For instance, Sweden recently decided to supplement its already extensive suite of products with the introduction of Saminvest, a state-owned investment fund investing in privately-managed private equity funds.

It is clear that the recommendations will require a large group of stakeholders to coordinate their actions to maximise the impact of public-private participation. We recommend the creation of an ad-hoc "KETs strategy implementation group" tasked with developing a master implementation plan, assigning implementation accountabilities, coordinating key stakeholders and reporting on progress.

4.1.5. Financial instruments to fine-tune and re-target towards KETs and deep tech projects

4.1.5.1. Develop "forgivable debt" facilities and boost blended grants

Innovation agencies and/or promotional banks (EC, EIB, national and regional agencies, universities, etc.) should transform part of the existing grant programmes into contingent grants that are repaid like a loan if a KETs company/project is successful (and not repaid if the KETs company is unsuccessful), thus increasing the capacity of the schemes as repaid grants are made available for new grants (as Israel's IIA has been doing for decades). The "success" of a KETs company/project will need to be defined clearly and ahead of time based on easy-to-measure metrics (e.g. a pre-defined level of revenue or technology performance).

This could also be achieved through "forgivable debt" products which may be easier to accommodate within accounting frameworks. In order to maximise the signalling power of these grants or forgivable debts, these would be integrated within the enhanced KETs database (as per recommendation 1 above).

Another way to transform existing grant schemes and leverage their signalling power is by blending them explicitly with follow-on finance, be that equity or debt (depending on the stage of the company's life cycle) and be that public or private. This can happen simultaneously or sequentially, and ultimately consists in conditioning the grant upon the raising of some form of return-generating capital (of private or public sources). The reason why this blended form of finance is particularly interesting for deep tech companies such as KETs companies is that due to their capital and research intensity as well as long demonstration and piloting times, they need to survive for a longer period of time on grants and equity before being able to access fixed-income instruments. Especially in the latest TRL levels, grant money can effectively be linked to private venture capital pending successful completion of the piloting milestones. The EC together with select public promotional bank partners, be that at EU and/or national level, can test the impact of such blended finance initially in a series of financing pilots with a select range of KETs companies.

4.1.5.2. Equity financing

While the EIF and NPBs already invest significantly in venture capital, they typically only increase the size of the funds but do not adjust the risk profile to attract the right investors. Co-investing in funds with asymmetric return profiles could support the involvement of additional private-sector investors and may be done at a limited cost.

"Asymmetric return profiles" refers to investors having different return profiles (e.g. one having higher risk but higher return than another) while typically, investors in a VC fund share the same risks and potential returns.

The use of such structures can help take advantage of the varying risk appetites of investors and thereby introduce a way to significantly expand the overall amount of venture capital available. Financial investors are typically less risk averse and seek high returns while corporate investors want

to limit the downside risk. Promotional banks could help shift risk across investors and adjust the risk profile. This could be done via various investment structures, from traditional venture capital funds to corporate venture capital firms.

Such structures have successfully developed vibrant VC environments such as are present today in the US and Israel. Through its SBIC programme, the SBA essentially leverages smaller VC funds, thereby taking less risk (as it is paid back first) but enhancing the returns for investors (see case study on page 78). Similarly, the Yozma programme was launched in Israel in 1992 – the funds were co-invested by public and private sector actors but private investors had the option to buy back the government's investment after five years at a pre-defined cost, thus increasing the potential return of the investor while limiting its downside. In Europe, Sweden is exploring this option with the creation of Saminvest.

The features of the products offered may therefore differ depending on the sector and company size targeted, the typical investors involved and the risk appetite and tolerance of the promotional bank.

In addition, the structure of such a product would need to take into account a number of factors: potential cost or risk for the government entity financing it, potential moral hazard for private-sector investors, etc. To ensure that the additional capital does flow into deep tech as opposed to ICT/digital and software projects, one selection criterion for public debt or equity co-investment could be the sectoral focus of the fund and whether its managers show a successful track record of prior investments into the KETs domain.

Nonetheless, such co-investments, especially if on a debt basis and providing asymmetric returns to public/private investors, have the potential to significantly increase the overall availability of venture capital for deep tech funds.

4.1.5.3. Hybrid instruments

Venture debt is a form of debt lending that combines characteristics of traditional debt (e.g. interest rates and principal) and equity (e.g. stake in the upside of the company). While it is complementary with other sources of financing (especially VC equity), its use remains limited in Europe (estimated at 5% of VC-backed firms vs. 15-20% in the USA). However, scale-up capital without dilutive effects on the shares of the initial risk-takers – both entrepreneur(s) and initial investors – is critical towards growing a business from first commercial successes towards profitability, both operative and ultimately bottom-line.

Co-investments in venture debt funds and the provision of first or second loss guarantees to venture debt vehicles would significantly deepen the potential market for venture debt, and could complement the sources of financing for KETs companies, especially at a growth stage.

NPBs and EIF could deepen the potential market for venture debt in two ways. First, the EIF and NPBs could co-invest in venture debt funds as they already do in private equity funds (i.e. *pari passu*), thus strengthening the EIF's existing programme. Furthermore there could be dedicated investments under an "asymmetric returns" structure (as suggested for equity funds below). Both would increase the scale and capacity of the fund while the "asymmetric returns" would increase the attractiveness of the asset class for private investors. In addition, the EIF and NPBs would consider offering guarantees to venture debt vehicles (either funds or within banks). Guarantees could help in reducing total losses (e.g. *pari passu* coverage using products such as InnovFin) or limiting the downside risk (e.g. 2nd loss guarantee such as ENABLE offered by the UK's BBB). While SPRING's VDP focused on offering a *pari passu* guarantee, the BBB's Help to Grow programme offers a combination

of both co-investments (asymmetric returns) and guarantees which makes the risk-return more attractive for private-sector investors.

4.1.5.4. Supply chain finance

Supply chain finance is particularly valuable when KETs companies develop first income and client relationships, but before they reach profitability that would allow them to afford term loans; it is also valuable for more mature KETs companies that do not yet have a very long track record and depend on a few strategic relationships with large corporates. Supply chain finance is already intermediated today through the EIB, however there is no direct SCF product targeting KETs companies or corporates working with them specifically. Similarly, at NPB level few banks offer a direct, targeted SCF product.

We therefore recommend that the EIB and NPBs increase their work with commercial banks to develop facilities that support large companies' use of supply chain financing for innovative, deep tech SMEs such as many KETs companies. Here, the EIB and NPBs already work with but can enhance efforts towards commercial banks and SCF specialists to develop facilities to support large companies' use of supply chain financing for KETs companies. Notably, they could explore SCF and reverse factoring products that are not in sufficient supply today. The EIB could also explore a direct SCF facility targeted specifically at large corporates that seek to employ key enabling technologies developed by young, innovative companies.

To achieve that goal, the EIB and NPBs could collaborate with private sector actors (e.g. large corporates, logistics companies, supply chain finance specialists, banks) to identify specific technologies, industry sectors and geographic regions where their actions could be most impactful. Some possibilities include supporting the discounting/factoring of purchase orders (e.g. the promotional bank could take some of the additional "delivery risk") or supporting extended, more connected reverse factoring platforms.

Such an initiative could leverage the EC's collaboration with industry partners under the PPP programme, and take the work and results of that collaboration into consideration.

4.1.6. Points for consideration

The main point of consideration is whether existing instruments need to be expanded by dedicated KETs or deep tech angles/sub-initiatives, or whether rather a holistic approach should be pursued that would amend existing eligibility criteria and credit risk policy guidelines so as to widen the general application of those instruments to encompass the special risk and return characteristics of KETs companies (in particular scale-ups that are the focus of this study).

Indeed these risk/return characteristics make it difficult to employ the same kind of instruments as for companies exhibiting lower technology, market and/or execution risk than many KETs scale-ups. However, as the limited success of prior targeted facilities has shown, a thematic instrument needs to be designed with great care. For instance, the eligibility criteria need to be able to be applied so flexibly that unforeseen applications or forms of a particular KET can still be covered.

It is therefore recommendable to pilot-test the envisaged instrument with a few select KETs companies before rolling it out in a more formal way and on a larger scale.

Furthermore, a thorough mapping of existing products and programmes already being deployed at KETs is required. The development and launch of adjusted or new products and programmes requires a number of points to be considered, including:

- Existing programmes at the EIB/EIF, national and regional promotional banks, and innovation agencies
- Alignment of internal organisation and processes to reflect the new nature of products
- Re-allocation of financial resources to support the creation of new products
- Alignment of the new products with the risk appetite of the public authorities.

4.1.7. Implementation

We expect all the products to follow the following high-level implementation steps:

- Definition of product
- Mapping of existing products offered at EU, national and regional level
- Identify long-list of potential options (e.g. product features, distribution)
- Assessment of options against constraints (e.g. operational, financial, risk appetite)
- Agreement on selected option
- Feedback from relevant market participants active in that particular segment of finance
- Development of product
- Alignment of internal processes
- Contracts with private institutions
- Pilot-testing with a select number of relevant companies
- Launch of product.

We would expect that some products and programmes could be reviewed earlier than others. In particular, venture debt and equity products could be developed faster, building on the EIB/EIF's and EC's existing product offering and infrastructure. The development of contingent grants may require new processes (e.g. technology credit assessment) and a change in the design of the next Framework Programme. The development of a supply chain finance offering in principle can also build on existing due diligence and appraisal processes, albeit a more KETs targeting facility would have to be developed in partnership with large corporates (e.g. auto Tier 1 and 2 suppliers). Furthermore, workshops and studies can identify particular sub-technological and geographical areas where the national promotional banks and EU level banks would have the most significant impact in deploying a supply chain financing facility.

Recommendation C – Provide targeted support and advice to KETs companies

Our third recommendation is to strengthen local or regional joined-up innovation ecosystems, enabling in particular SMEs and innovative, R&D-intensive companies to benefit from substantial positive externalities resulting from the geographic proximity of public support institutions (i.e. promotional banks), Research and Technology Organizations (RTOs), research institutes, large corporate and private-sector investors in a given region.

The objective is to leverage specific EU and national initiatives to strengthen local or regional clusters, promoting the smart specialisation of regions focusing on specific sub-sectors of KETs competencies (i.e. semi-conductor or photonics industries). At the same time, it is recommended to enhance the linkages between deep technology companies and traditional industries within local ecosystems in order to facilitate the integration of KETs technologies within other industries, such as automotive or energy. Furthermore, the study recommends strengthening inter-regional cooperation between different regional ecosystems within Europe to support a process of open innovation that enables innovative KETs companies to collaborate closer with key stakeholders from industry, research, public institutions and investors from other regions.

These joined-up innovation ecosystems represent an important factor for a positive enabling environment that supports the development and growth of KETs companies. They provide vital opportunities for (i) improved access and exchange of knowledge; (ii) strengthening networks between researchers, innovators and large corporates; and (iii) facilitating industry networks in order to connect KETs companies with potential R&I with business partners and investors, including larger corporates as potential customers, suppliers, universities and technology research centres.

Innovation ecosystems can be important catalysts for a step-change in the quality and coordination of business and enhanced operational and financial support to KETs companies as they evolve through their life cycle. A key aspect existing cluster/innovation ecosystems frequently do not yet fully incorporate is the provision of advisory services to innovative companies related to (i) general business advice (e.g. strategy, investor/financer readiness) and (ii) enhancing access to finance for early stage and scale-up companies. The scope of advice should include general business advice (e.g. business planning, technology development, governance and organisation) as well as investment advice (e.g. capital structure, funding strategy, investors approach). Such advice can aim to facilitate industry networking in order to connect KETs companies with larger enterprises as potential customers as well as suppliers. This coordinated approach also holds the potential to complete the available chain of financing by coordinating the use of financing instruments at European, national and regional levels, and by catalysing the adequate sources of private capital.

The main vehicles for such advice can be the EIB (through the InnovFin Advisory team and European Investment Advisory Hub) at the EU level as well as promotional banks, innovation agencies and government (e.g. Ministries of Commerce) at the national and regional levels. The scope of advice should include general business advice (e.g. strategy, investor/financier readiness, technology development). In addition, such advice can aim to facilitate industry networking in order to connect KETs companies with larger enterprises as potential customers, suppliers, universities and research centres. This coordinated approach has the potential to deliver a complete chain of financing by coordinating the use of financing instruments at European, national and regional levels, and by catalysing the right sources of private capital.

A particular role in the build-up of robust ecosystems for KETs companies finally falls onto RTOs that hold the potential to act as a local aggregator of technology know-how, business advice and as a bridge to the financial community investing in those technologies.

4.1.8. Recommendation and potential impact

4.1.8.1. Recommendation

KETs companies will benefit from a step change in the quality and coordination of business and operational support as they evolve throughout their life cycle.

The EIB (through its Advisory Service team), NPBs and local innovation agencies may consider focusing on two points: first, to provide essential business advice such as business strategy, investor/financier readiness, investor presentations, technology development, etc.; and second, to proactively facilitate industry networking in order to connect small KETs companies with enterprises critical to their development such as potential customers, suppliers, universities and research centres, etc.

This coordinated approach has the potential to complete the chain of financing by coordinating the use of financing instruments at EU, national and local levels, and to catalyse the right sources of private capital.

4.1.8.2. Potential impact on clusters and smart specialisation

This mechanism also has the potential to facilitate the development of local or virtual clusters of specialisation that may emerge in specific sub-sectors of KETs or competencies, and will require coordination with various EU bodies that facilitate public-private partnerships, develop local regional specialisation and drive allocation of EU grants.

The Free State of Saxony is a successful example of this approach in the EU. Silicon Saxony is the originator of every second microchip produced in Europe and supports 2 100 enterprises and 51 000 employees in these innovative sectors. Such an ecosystem is complemented by a strong research landscape composed of nine universities with approximately 45 000 students in fields relevant to micro- and nano-electronics. The State's Ministry of Finance implemented a "smart specialisation" strategy that leveraged local public authorities (e.g. SAB, the local development bank, to provide financial advice as well as financial products) in partnership with private sector actors.

4.1.9. Points for consideration

The aforementioned proposal needs to consider a number of points, including:

- Existing local initiatives, at both national and regional level – it will be critical to take into account national and regional initiatives (such as in Saxony) in order to coordinate and identify the best ways for such an approach to add value;
- Coordination with local authorities – insofar as national and regional authorities already play a key role and are already present in the areas targeted, it will be key to coordinate with them and ensure that the approach is complementary to an EU-level perspective;
- Variety of existing programmes across member states – there is no "one-size-fits-all" approach for this programme and it will need to take into account the variety of programmes across member states and be tailored to the various environments and existing programmes.

4.1.10. Implementation

The implementation of such a programme would be performed in a four-step approach:

First, existing programmes need to be reviewed. This includes the activity to gather detailed information on available programmes at EU, national and regional levels (e.g. programme features, pros and cons, KPIs). Successful initiatives should be identified and studied and transversal lessons derived for inspiration of any new initiative.

Second, the responsible working group must decide on a range of implementation options and their priorities. Key features of selected services should be agreed upon.

Following the identification of priorities, an action plan and detailed implementation plan must be developed, including detailed products/services features, a high-level roadmap and action plan, detailed action charters and timelines. Responsibilities must be clearly allocated to both a PMO team and individual stakeholders that need to be able to draw on dedicated resources across institutions.

Finally, in the implementation phase legal and financial features of the new cluster initiative need to be outlined and agreed amongst stakeholders. Organisation and processes should be aligned in keeping with requirements, and advisory capabilities launched.

Appendix A. Interviews

A.1. Interview questionnaires

A.1.1. Private lenders

Table 12: Interview approach – Private lenders

Topic		Commentary/Questions
Preamble		• General background on previous and current study of financing of KETs with EC and EIB (including definition of KETs sector) • Focus on banks given key role in financing in Europe and findings of previous study
Strategy and risk appetite	Current situation	• What are the volumes and share of lending to KETs companies (rough estimate)? Especially for RDI projects
	Strategy	• Is the approach for supporting and managing KETs clients different from other clients (e.g. products, RMs/specialisation) or other sectors (e.g. deep tech, digital)?
	Risk appetite	• What role do RDI play in current strategy and risk appetite? • Do you have exposure limits for RDI overall or for specific sub-sectors? What are they? • Are there criteria (e.g. loan size, minimum turnover/profit) that may limit the ability to finance RDIs?
Lending process	Origination/ distribution	• Do you have specialist RM, generalist RM or some other coverage model? • What level of pre-screening is used in theory and in practice? How is this managed/controlled? Do you use pre-screening to actively filter out lending requests that are unlikely to meet lending criteria? Are KETs/RDI companies more or less likely to be screened out than non-KETs companies? • How are RMs trained and incentivised to provide such loans? – Are RMs trained and incentivised to originate loans for KETs/RDI companies with <€50m turnover? With <€5m turnover?
	Credit analysis and financial DD	• What is the key information required and investment criteria used for financial and technical due diligence? • What factors do you consider in a DD, in particular

Topic		Commentary/Questions
		– Financial criteria (e.g. minimum level of revenue, profit, etc.) – Technological criteria (e.g. technological readiness, patents) • Rejection rate – What is the rejection rate (among those that apply)? – What is the rate of KETs companies that you think are discouraged at the bank (i.e. before applying)? Estimate • Collateral – Do you always require collateral? If not, what are the conditions to not require collateral? – How do you deal with IP (e.g. as collateral)? • Technological assessment – How much relative weight do you accord to the risk of the client's core technology and understanding it? If you could attain a good understanding of the technology, how much would it influence your lending decision-making? – Do you use technological assessments to evaluate technological readiness? If so, how do you do it (e.g. outsourced, internal specialist team)? Are they focused on sectors or specific companies? – Are government agency grants and/or loans extended to innovative companies used as a signal/information in the DD process to suggest they have an advanced level of technological readiness? – What criteria must a tech assessment address in order to encourage a positive credit recommendation? • In your experience, what are the main challenges that KETs/RDI companies face during the DD process?
Lending process	Approval	• Is the approval conducted by a generalist or specialist credit underwriting team? • What kind of automation processes do you use? e.g. – Scorecards and models – Auto-decisioning • What are the delegation levels and procedures for KETs companies?
Involvement of public sector	Involvement of national entities (e.g. NPBs)	• Do you use NPB products and/or government schemes? • Are there schemes/programmes in place to address these challenges? • Do you leverage information received from government entities?

Topic		Commentary/Questions
	Use of EIB/EC products and services	• EIB products/services – Are you aware of EIB products dedicated to such companies (e.g. InnovFin, EDP)? Do you use them? – How complementary do you find them with your own products and with NPB products? • Do you use any European Commission services/solutions (e.g. for information)? • What are the key obstacles for you to co-finance R&D-intensive, high-risk companies together with the EIB or national promotional banks? Would you be favourable to co-investing with the EIB on high-risk projects?
Potential solutions	Technological assessment	• Is understanding the development and maturity of the technology an obstacle to assessing and lending to KETs companies? How big an obstacle? • Is understanding the market potential of the technology an obstacle? How big an obstacle? • What information would you require to overcome these obstacles? – Technical maturity assessment? Market potential? Other? • Where would you look for such information? For instance (options not mutually exclusive) – Internal specialist team? – Independent expertise (e.g. consultancy)? – Public sector-supported assessments? – Other? • How much of a difference would these potential solutions make in your lending decisions? • What should a technological assessment focus on to be complementary to your analyses?
	Other solutions	• What could the public sector bring to you that would help you serve these sectors? – Bespoke market and/or technical consulting/assessment support? – Public studies and research reports? – Operational support? • Who would be best positioned to provide such products and/or services? – Pan-European agencies? Local public-private organisations?

A.1.2. VC and PE firms

Table 13: Interview approach – VC/PE

Topic		Questions
Preamble		• General background on previous and current study of financing of KETs with EC and EIB • Point of view of VC/PE firms primarily for portfolio companies
Current situation		• In terms of investment focus, what types of KETs companies do you typically invest in? • In how many KETs companies have you invested and for what amount? How many do you currently have in your portfolio?
Investment process	Market screening	• How do you approach market screening (i.e. identification of potential investments)? • Is your approach more strategic (e.g. focus on nanotechnologies) or opportunistic (e.g. meeting with an innovator)? • How is the strategy elaborated? What drives the "focus"?
	Due diligence (financial and technological)	• What is the key information required and investment criteria used for financial and technical due diligence? • How do you assess technological capabilities/readiness? – Do you use technology/market potential assessments? – If so, do you have a specialised team? And if so, how is it structured/organised (e.g. by sector)? – Do you use external experts to conduct assessments? – Do you sometimes use public sector assessments (e.g. reports, awards, grants) as a signal for technology readiness?
	Investment decision	• Based on which key criteria do you make your decision? Especially regarding technology/market potential assessment? • What criteria typically are "deal breakers" for investing in such businesses?
	Support to exit	• What are the typical exits for KETs companies?

Topic		Questions
Access to finance for portfolio companies	Use of bank loans	• Do your portfolio companies seek and obtain lending from banks? • What is in general the rate of rejection in response to loan applications for your KETs companies? • How much of their capital structure does bank lending account for? • What challenges do they face when seeking bank loans? What are the main reasons mentioned for rejection? • In your opinion, what are the most important challenges to lending to KETs companies for banks? • Do you think a better understanding of the underlying technology and market potential for KETs companies would help mobilise bank debt financing?
	Use of alternative financing products	• Has one of your portfolio companies ever sought/obtained – Venture debt – IP financing – Other forms of hybrid instruments and/or specialist financing products • If so, how much of their capital structure and/or lending does it account for? • What are the challenges your portfolio companies face to use/obtain such type of financing?
Involvement of public sector products (e.g. national promotional bank, EIB, EC)		• Do you use NPB, EIB or EC products and/or government schemes? • Do you leverage information received from government entities? Market studies? Technology assessments? • What are the key obstacles for you to co-finance R&D-intensive, high-risk companies together with the EIB or national promotional banks? Would you be favourable to co-investing with the EIB on high-risk projects?
Conclusion		• What could the public sector bring to you that would help you serve these sectors and/or help them being served by banks?

A.1.3. Asset managers/owners

Table 14: Interview approach – Asset managers/owners

Topic		Questions
Preamble		• General background on previous and current study of financing of KETs with EC and EIB (including definition of KET) • Interest to have the views of asset managers /owners as potential investors
Current situation with KETs and interest in KETs		• Current position – Do you have a particular focus on such sectors? – What products/vehicles do you use to invest (e.g. equity, debt, securitisation, crowdfunding platforms)? – What volumes/share of your investments do they account for? • Strategy – What position do KETs (or deep tech sectors) currently have in your strategy and risk appetite? – If not, why do you not invest in such sectors? What are the challenges to making such investments? – Would you consider expanding into such a sector?
Investment process	Investment approach/process	• [Depending on products/vehicles used to invest] could you please describe your investment process? • In the case of securitised loans and/or crowdfunding, how would you consider standardising/automating the decision-making?
	Technological assessment	• How do you assess the technological potential of the companies you invest in? • Do you have a dedicated, specialised team? • Do you use external advice (e.g. experts, government)?
Involvement of public sector products (e.g. national promotional bank, EIB, EC)		• Do you use NPB products and/or government schemes (e.g. equity co-investments or FoF)? • Are there schemes/programmes in place to address these challenges? • Do you leverage information received from government entities (e.g. reports, awards, grants)?

Topic	Questions
Conclusion	• What could the public sector bring to you that would help you invest more in these sectors? • Who would be best positioned to provide such products and/or services?

A.2. Summary of responses

Table 15: Interviews – Preliminary findings

Sector	Initial findings	Quotes
Private lenders	• Banks' strategic focus and risk appetite for KETs is limited given the risk they represent; most banks will not lend without existing cash flows • The lending process for traditional term loans is the same as for all SMEs and therefore not adapted to the specificities of young, high-growth companies – Distribution and relationship managed by a generalist relationship manager – Due diligence and credit analysis primarily based on past financial data (balance sheet, income statement, cash flows), current business data (e.g. invoices, contracts) and some forward looking business/financial data (e.g. business plan) • Limited use of technology assessment – Most banks do not use in-house experts; however, those that do usually have innovation and/or sector specialists that contribute to the analysis of the market potential and business plan (instead of credit scoring)	• *"We are interested in financing innovative companies. […] We don't have problems with pre-seed companies and large companies but the challenge is with scale-ups which have high investment needs for a long duration but do not have cash flows or collateral. It is equity risk as there are no cash flows to rely on."* • *"KETs companies are not mentioned in our risk appetite and strategy" (Bank)* • *"For large loans to early-stage companies, we often request additional equity, e.g. €5m more for a €25m loan."* • *"A good advisor costs €10-20k which is too high for an SME loan"* • *"We would use additional information from public entities such as studies on the technology and its business potential and risk, especially if there is a lot of data on KETs sectors. It is important, however, to make sure it connects both technology and finance – that's really the challenge."* • *"In theory we could use IP as collateral but in reality, if the company goes bust what would we do with IP? We do not have the resources*

Sector	Initial findings	Quotes
	– External experts are generally deemed too expensive – The lack of historical cash flows can be a limiting factor even in the presence of a tech assessment • No bank (of the ones interviewed to date) uses IP as collateral as it is deemed to have no value until it starts generating revenue, it is difficult to resell and valuation is expensive • While banks use national and EU financial schemes and overall are satisfied with them, it does not replace the need for existing cash flows	*or the expertise to resell it."* • *"Lending against a security or a guarantee without looking at its ability to pay is not something we do. […] Security, guarantee, etc. become very secondary."* • *"Capital, pricing, etc. is secondary. At the end of the day, the cash flows need to be there." (Bank)* • *"In terms of guarantees, we are pretty well covered <€50m."* • *"The chain of financing is very important and needs to take into account the complementarity of products"*
VC/PE firms	• VC/PE firms assess their investment (technology and market potential) with both in-house and external experts – Some of the VC/PE funds had extensive in-house specialisation in KETs sectors – However, a number of VC/PE firms interviewed did not have the full depth on the technology and usually resorted to external experts at some point of the due diligence • Fragmentation of the availability of equity capital across stages of the life cycle and countries in Europe is a key issue • Some VC/PE firms (depending on their stage in the life cycle) see venture debt as a potentially useful complement to their role	• "*When it comes to KETs companies, we often need some external help because it is a more complex business*" • "*The availability of capital is fragmented in Europe across regions and the life cycle of the companies*" • "*You need capital at every stage of the company to support companies with the proper level*" • *"Venture debt is missing in Europe while it is abundant in the US"* • "*The InnovFin guarantee is very powerful – it is a complete game changer*"
Asset managers/ owners	• *"In asset management, we hear about FinTech only in two areas – online advisory and lending platforms for SMEs"* • *"SME platforms are predominantly focused on retail and specific regions but they are building out to the rest of the EU"* • *"Our appetite is primarily for more traditional SMEs with stable earnings and cash flows. Not to say that in the future we will not be interested in more equity-esque/venture type of investments. But at the moment we are building our capacity in SME debt and our strategic focus is on more stable SMEs."* • *"Venture markets in the Nordics are well funded. There is a lot of capital at the seed stage and early stage. It is just a matter of finding it"*	

A.3. Detailed responses

A.3.1. Private lenders

Table 16: Findings from interviews with private lenders

Topic		Key points	Quotes
Strategy and risk appetite	**Current situation**	• Bank lending to RDI companies estimated at ~10% of SME lending • Alternative lenders do not differentiate based on level of innovation	• *"We are interested in financing innovative companies. […] We don't have problems with pre-seed companies and large companies but the challenge is with scale-ups which have high investment needs for a long duration but do not have cash flows or collateral. It is equity risk as there are no cash flows to rely on."* (Bank) • *"Traditional banks are typically impossible to get a loan from. Most people don't bother asking."* (VC/PE firm) • *"KETs companies are not mentioned in our risk appetite and strategy" (*Bank) • *"We do not have a strategy towards KETs companies. However, we do have a strategy oriented towards growth companies" (Bank)* • "*We have a lending policy based on the financials, the projections and the securities provided" (*Bank) • "*Banks are conservative. They need to see cash flows and collateral to lend*." (VC/PE firm) • *"For early-stage companies, grants and soft loans account for 20-25% of funding. The rest is generally split between the founders and the VC firms, in a split that varies depending on the sector of the company (e.g. low for life sciences)."* (VC/PE firm)
	Strategy	• None of the banks covered have a dedicated lending strategy for KETs • One bank had a clear strategy through the life cycle where the involvement was limited to relationship building, account opening and credit card lending for the first couple of stages; term lending and asset-based lending only come in in the second half of the life cycle • However, we observed that some banks aim to differentiate themselves and target innovative companies, with a primary focus on FinTech and ICT companies – A few of the banks have set up a specialised team for innovative companies, but primarily focused on digital/ICT companies [one bank] – Some banks have started setting up venture debt funds [one at €120m] – One bank has created an incubator with seed funding primarily focused on FinTech start-ups [one with seed funding of up to €50k]	

Topic		Key points	Quotes
	Risk appetite	• Banks will not lend to SMEs if they do not have revenues and cash flows • This means that they do not lend to KETs • An exception is for banks that have set up a venture debt fund, in which case they would have a higher risk appetite (and potential reward) for those specific investments • Alternative lenders lend to SMEs as soon as they have revenue as long as it is backed by invoices from creditworthy buyers; however these loans can only finance working capital, not capex investments	• *"We like to see a proven track record in terms of generating cash. Preferably, the company would also have assets that we can go after if they are unable to generate enough cash"* (Bank) • *"We can lend as soon as SMEs have revenues and invoices from creditworthy buyers. It can, however, only finance working capital as it is based on invoices."* (Alternative lender) • *"We do not have upside so we are not as interested in looking at the long-term potential. This is an asymmetric return – we only have the downside risk, not the upside return "* (Bank) • *"This is an age-old risk-return problem. Given the levels of technology risk, size risk and cash flow risk inherent in such companies, an adequate level of return is needed." (*Bank) • *"The risk is too high. It doesn't make sense for a bank to lend money to something which will fail with a high probability. Your IRR would have to be in the range of 40%" (*VC/PE Fund)
Lending process	**Origination/ distribution**	• Relationship primarily with SME generalist relationship manager	• *"We would like to have advisors but the size of the projects is not big enough to be able to involve external advisors. […] A good advisor costs €10-20k, which is too high for an SME loan." (Bank)* • *"We are pretty comfortable with our resource capabilities at this point in time. Our expert team has bridged the gap between the technology and the credit team."* (Bank) • *"The issue is not with senior debt or venture debt but with the lack of equity/seed funding and subordinated debt "* (Bank) • *"For large loans to early-stage companies, we often request additional equity, e.g. €5m more for a €25m loan."* (Bank)
	Credit analysis and financial DD	• Data collected by relationship manager • Due diligence and credit analysis primarily based on past financial data (balance sheet, income statement, cash flows), current business data (e.g. invoices, contracts) and forward looking financial data (e.g. business plan, forecasts) • While most banks do not seem to use either in-house or external technology experts, some have created specific teams – A couple of banks have a person in charge of "innovation"	

Topic	Key points	Quotes
	(generally more focused on FinTech, e.g. blockchains) – Some banks have sector specialists, but they are generally aligned with the high-growth sector in the region they cover (especially ICT) • Banks with venture debt funds may, however, use in-house or external experts – Review by in-house experts (e.g. one bank had 15 innovation specialists with backgrounds combining engineering and finance) – Based on the analysis performed by the VC firm invested in the start-up – Technology assessment is supported by external advisors – One player had developed a new rating model that is not based on the balance sheet • The lack of equity is a key issue as well as the lack of junior debt (i.e. junior to traditional bank loans) • Collateral is generally required, especially when the SME has a limited track record – Collateral generally includes tangible assets (e.g. equipment) or invoices (i.e. requires revenue) and leasing can be used to finance equipment – IP is generally included as part of the assets of the SME to be shared in the event of liquidation; however, IP is never used as collateral for younger, high-growth ventures (and if it were, it would be significantly discounted) as it is - Considered as not having value until it generates revenue - Complex and expensive to value (i.e. requires experts)	• "*Venture debt is a great idea but it is difficult to implement for banks as it is costly with Basel III"* (Bank) • *"In theory we could use IP as collateral but in reality, if the company goes bust what would we do with IP? We do not have the resources or the expertise to resell it."* (Bank) • *"IP has no value until it generates revenue"* (Bank) • *"We do not use IP as collateral because you would need an institution to value it. Valuation is difficult. […] It is better to collateralise against equity of the company"* (Bank) • *"Regarding IP, we do not have the competencies to hire new management to proceed with the idea or a liquid market to sell it to"* (Bank) • "*We are a bank and our expertise is not in reselling IP, it is in assessing companies' ability to repay funds and in financing companies*" (Bank) • *"Where I have used IP as collateral was for venture debt because they have a level of specialisation that traditional lenders lack."* (VC/PE firm) • *"For very new and innovative IP such as biotech, the valuation of IP by valuers could result in a wide range of values."* (Expert)

Topic		Key points	Quotes
		- Difficult to resell (no market for IP, no clear value)	
	Approval	• Approval generally based on credit risk rating, with possibility to override by relationship manager	
Involvement of public sector		• Banks generally use InnovFin or COSME in combination with other national guarantee schemes (or national guarantee schemes leveraging InnovFin or COSME) • Grants are widely used and are an important signalling factor reflecting the readiness and/or market potential of technology • Lack of transparency of grant decisions and access to grant information was mentioned as a challenge	• *"We request security and guarantee but not with the idea of using it. Lending against a security or a guarantee without looking at its ability to pay is not something we do. […] Security, guarantee, etc. become very secondary." (Bank)* • *"We do not use guarantees from EIB/EIF (COSME, InnovFin) or [NPB]." (Bank)* • *"In terms of guarantees, we are pretty well covered below €50m." (Bank)* • *"We definitely use national guarantee schemes but they are insufficient to enable us to lend to scale-ups given the long duration of the loan." (Bank)* • *"Capital, pricing, etc. is secondary. At the end of the day, the cash flows need to be there." (Bank)*
Potential solutions		• Most banks believe that additional data or financial support would not make a significant difference as it is essential that they have a clear track record of financials and cash flows • Some banks considered that additional data could be helpful, especially if it – Provides new data on the risk and financial aspects of the new technology – Links technology with finance	• *"Some additional qualitative information on the sector or technology would be helpful." (Bank)* • *"We would use additional information from public entities such as studies on the technology and its business potential and risk, especially if there is a lot of data on KETs sectors. It is important, however, to make sure it connects both technology and finance – that's really the challenge." (Bank)* • *"No external view would impact our department." (Bank)* • *"You would imagine that, with all the discussions on capital requirements, banks would all run for our financial products that reduce capital needs [guarantees] but that's not the case." (NPB)*

Topic	Key points	Quotes
		• *"The solution is not in one single government financial product but about their combination and the impact they have on the combination of equity and debt for SMEs. The chain of financing is very important and needs to take into account the complementarity of products." (Bank)* • *"I don't think banks are the right hammer for this nail." (NPB)* • *"I don't think banks are the right hammer for this nail. […] you just can't get a bank to take on this level of risk using their traditional lending model." (NPB/Expert)* • *"The real key is structured products – addressing information asymmetries only gets you so far along the way" (NPB/Expert)*

A.3.2. VC and PE firms

Table 17: Interview findings – VC and PE firms

Topic		Key points	Quotes
Current situation		• Amount of KETs varies depending on firm (25-100% of fund) • While there is significant capital available at the buy-out stage, new funds are being created in small-caps given opportunities	• *"Everything below €50m has to be done by us because there is a market failure. That said, there are a lot of initiatives to solve this." (VC/PE firm)* • *"Early-stage financing in Europe is weaker than in the US. For later stage companies (less than €15-20m in revenue), there are more financing options such as venture debt." (*Corporate)
Investment process	**Market screening**	• Market screening is done internally based on networking and management of databases to follow	• *"When it comes to KETs companies, we often need some external help because it is a more complex*

Topic		Key points	Quotes
		potential targets	*business." (VC/PE firm)*
	Due diligence (financial and technological)	• Due diligence is generally driven by an internal team but often involves experts (either in-house or from network) • External experts typically have various backgrounds, including – Academics (especially for technology readiness/ assessment) – Strategy/management consultants (for business plan) – Auditors and lawyers for accounting and legal aspects	• *"The availability of capital in Europe is very fragmented on a geographical level. The UK and Nordics are well developed compared to the other regions. This may be driven by different tax regimes." (VC/PE firm)* • *"Our expected default rate is 20-30%" (VD fund)* • *"The growth capital market is key. It is the main exit of venture players." (VC/PE firm)* • *"You need capital at every stage of the company to support companies with the proper level, e.g. you need teams with different expertise, etc. In the US it is seamless and abundant while we have potholes in Europe. For instance, the potholes we have in growth capital result in low returns in VC because they have to go directly to IPO or sell to Asian/US companies" (VC/PE firm)* • *"The majority of the businesses we provided venture loans to were loss-making, but this is because they were investing in their future" (VD provider)* • *"There are no good networks regarding exit opportunities" (VC/PE firm)*
	Investment decision	• Key criteria are the exit opportunities and expected valuation at exit • This depends on a variety of factors, including – Technology readiness and potential (signals include patents, grants, competitions, awards, etc.) – Scalability of the business model – Expected future revenues, profits and cash flows – Exit opportunities (which depend on the sector, availability of capital at later stages, capital markets)	
	Support to exit	• Lack of available capital at some stages and/or geographies creates a vicious circle of lack of investment – Capital is insufficient at certain stages of the life	

Topic		Key points	Quotes
		cycle and/or geographies – This results in difficulties to exit (e.g. for VC firms if there is insufficient growth capital) – When exits happen, they may happen at a discount, resulting in lower returns • Conversely, this means that funds at a later stage may lack investment opportunities (e.g. buy-out funds may have fewer investment opportunities if growth funds invest in few companies)	
Access to finance for portfolio companies	**Use of bank loans**	• Use of bank lending is low or inexistent at the earlier stages but becomes very high at the later stages of the life cycle – Pre-revenue companies (generally financed by seed capital, i.e. friends and family, or business angels) do not have access to bank lending (besides personal loans or credit card lending as well as grants) – VC-backed companies do not have access (nor try to access) bank lending – PE-backed companies are often leveraged as they have a more stable, more predictable risk profile	• *"Venture debt is missing in Europe while it is abundant in the US. […] The picture with mezzanine is fairly similar." (VC/PE firm)* • *"SME lending will not come back due to regulations so alternative sources of funding need to be used." (VC/PE firm)* • *"I have seen some venture debt but, at the early stage, it remains dominated by equity" (VC/PE firm)* • *"With a double-digit growth company, we had tremendous difficulties in accessing debt. To be fair, I didn't even think of seeking debt. A typical bank wouldn't do it given the risk profile" (Corporate)* • *"Small companies often have a lot of intangible assets, but banks don't really understand the value in fully-developed IP "(VC/PE firm)* • *"The issue with IP is how do you make this collateral tangible" (VC/PE firm)* • *"We do not value the IP – we have tried it and*
	Use of alternative financing products	• While venture debt was not used by interviewed firms and rarely seen, it is considered as a potentially very useful source of funding • Mezzanine debt is also very useful, however at a later stage – no massive shortage of it though • Using FinTech platforms to enable institutional investors to lend to a pool of SMEs is considered as	

Topic	Key points	Quotes
	an opportunity but it is unlikely to target young, higher-risk SMEs (e.g. young, high-growth KETs) as they present a higher fundamental investment risk that warrants a more bespoke due diligence approach than such platforms typically provide for	*dismissed it as the valuation is too difficult and inaccurate. We would treat any valuations with a high degree of scepticism" (VD provider)* • *"I have seen IP taken as collateral only in rare cases of private debt funds" (VC/PE firm)*
Involvement of public sector products (e.g. national promotional bank, EIB, EC)	• EIF fund-of-fund investments and co-investments considered as very useful in the early stages of the life cycle • Interviewees however highlighted the importance of ensuring that capital is available across all the stages of the life cycle and regions to ensure the continuity of financing	• *"The amounts provided by the EIB programmes are not sufficient for companies with €10-20m revenue. They also lack the knowledge to understand why there is no EBITDA" (VC/PE firm)* • *"The EIF is, however, supporting our efforts quite significantly" (VC/PE firm)* • *"Grants are definitely a good signal, both with respect to assessing the company and putting the financials together." (VC/PE firm)* • *"There are some good initiatives at earlier stages such as the European Angel Fund which is a good initiative to pick some angels. There are also a lot of initiatives in seed venture at the regional, national, EU level which helps us because we get good source" (VC/PE firm)* • *"Navigating through the various aspects of support by the government is very time-consuming and difficult" (VD provider)* • *"The InnovFin guarantee is very powerful – it is a complete game changer" (VD Fund)* • *"Grants are an important tool to finance very early-stage companies, especially in some high-investment, high-risk sectors such as advanced materials. I see significant differences across Europe." (Corporate)*

Topic	Key points	Quotes
Conclusions	• Legal and regulatory fragmentation is a major issue in Europe – no homogeneous approach in Europe • While some countries have put in place useful tax incentives, most countries still lack the right incentives	• *"I would not use an EC tech assessment without them funding it (e.g. through grants). You put your money where your mouth is." (VC/PE firm)* • *"It is important to focus on KETs but also on gearing up the whole supply chain, both downstream and upstream" (VC/PE firm)* • *"The key issue for VC/PE is the legal and tax fragmentation across Europe" (VC/PE firm)* • *"There is a big financing toolbox available and it is important to use the right tool at the right stage." (Corporate)*

A.3.3. Asset managers/owners

Table 18: Interview approach – Asset managers/owners

Topic		Key points	Quotes
Current situation with KETs and interest in KETs			• *"Our appetite is primarily for more traditional SMEs with stable earnings and cash flows. Not to say that in the future we will not be interested in more equity-esque/venture type of investments. But at the moment we are building our capacity in SME debt and our strategic focus is on more stable SMEs."*
Investment process	Investment approach/process		• *"In asset management, we hear about FinTech only in two areas – online advisory and lending platforms for SMEs"* • *"SME platforms are predominantly focused on retail and specific regions but they are building out to the rest of the EU"* • *"Regarding corporate venture capital, corporates haven't made up their minds whether it's a strategic investment, a financial investment, or ways of innovating their business model"*
	Technological assessment		
Conclusion			• *"Venture markets in the Nordics are well funded. There is a lot of capital at the seed stage and early stage. It is just a matter of finding it"* • *"We cannot see a massive amount being invested in venture debt by asset managers – it would be a very specialist investment. This could, however, be done by pension funds investing directly in funds"*

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Appendix B. Glossary

Acronym	Definition
CVC	Corporate venture capital
Deep Tech	Unique, differentiating, hard to reproduce, technological or scientific advances that require a thorough understanding of the technology and market to understand their potential
EAD	Exposure at default
EC	European Commission
EIB	European Investment Bank
EIF	European Investment Fund
EU 13	13 newest members: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia
EVA	Economic value added
IFA	InnovFin Advisory
IRB	Internal Ratings Based approach to credit risk (Basel II)
IP	Intellectual property
KETs	Key Enabling Technologies: Nanotechnology, Advanced manufacturing and processing, Biotechnology, Advanced materials, Micro- and nano-electronics and Photonics
KETs companies	In the context of this study, "KETs companies" refers primarily to smaller KETs companies/projects, i.e. with revenue <€50m, and in particular below €10m (as identified as key gaps in the 2016 InnovFin Advisory study)
LGD	Loss given default
NPBs	National promotional banks
PD	Probability of default
RAROC	Risk-adjusted return on capital
RDI	Research, development and innovation
RoE	Return on equity
SMEs	Small and medium-sized enterprises
TRL	Technology Readiness Level – indicators of the maturity level of particular technologies, ranked from TRL 1 (lowest) to TRL 9 (highest)
PE	Private equity
VC	Venture capital

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