



Vlaams Indicatorenboek 2021

WETENSCHAP – TECHNOLOGIE – INNOVATIE



Overzicht van de gemaakte selectie

Het Vlaams Indicatorenboek bevat een portfolio aan beleidsindicatoren die de ontwikkeling van het Vlaams potentieel inzake wetenschap, technologie en innovatie in kaart brengen.

Sinds 1999 wordt het boek om de twee jaar uitgegeven en vanaf 2017 wordt het Indicatorenboek een virtueel boek met een eigen website: <http://vlaamsindicatorenboek.be>. Het boek dat u nu in handen hebt is een selectie van hoofdstukken uit dit boek. Voor de volledige versie verwijzen we u graag naar de website.

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Wij wensen u alvast een informatieve zoektocht door het Vlaamse innovatielandschap!

Dankwoord

Wetenschap, technologie en innovatie zijn onmiskenbaar essentiële hefboomen tot welvaart en welzijn in onze maatschappij. De Vlaamse overheid heeft daarom veelzijdig en veelzijdig aandacht besteed aan de ontwikkeling van de kwaliteit en de slagkracht van het Vlaamse Wetenschaps-, Technologie- en Innovatiesysteem. Het brede spectrum van wetenschappelijk en technologisch onderzoek aan de Vlaamse kennisinstellingen is daarbij vervolledigd met maatregelen en instrumenten om het innovatievermogen van de in Vlaanderen opererende ondernemingen te verhogen, en daarbij ook de kleine en middelgrote ondernemingen steeds meer, gerichte innovatiekansen te bieden.

Het is dan ook nuttig en wenselijk om het geheel aan acties, en hun meetbare resultaten, in een coherent, regelmatig te verschijnen Indicatorenboek te bundelen. Het vernieuwde Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie, dat de tijdsreeksen uit de vorige Indicatorenboeken actualiseert en uitbreidt, draagt daartoe bij. Zo is het mogelijk een robuust en internationaal vergelijkbaar overzicht te geven van de situatie in Vlaanderen op het vlak van de bestedingen voor en de resultaten van onderzoek, ontwikkeling en innovatie.

Het Indicatorenboek 2021 wordt net als de vorige editie uitsluitend in een interactieve bevragingmode elektronisch aangeboden.

Uiteraard bouwt dergelijk Indicatorenboek op de inspanningen van veel enthousiaste medewerkers. De redactie en het schrijven van dit boek kwamen dan ook tot stand onder impuls van een redactiegroep van experts behorend tot de verschillende beleidsactoren uit het Vlaams Innovatiesysteem, die de staf van het Expertisecentrum O&O-monitoring (ECOOM) van de Vlaamse overheid bijstonden in de opdracht dit Indicatorenboek te ontwikkelen. Elk van hen droeg bij tot de conceptie van dit werk. We willen hen dan ook van harte danken voor de constructieve samenwerking om onder de gebruikelijke tijdsdruk dit document af te werken:

De Heer Paul De Hondt van het Kabinet van de Vlaamse Minister voor Economie, Wetenschap en Innovatie en tevens voorzitter van het Beheersorgaan van het Expertisecentrum O&O-Monitoring,

Mevrouw Linda De Kock van de Administratie Hoger Onderwijs,

De Heer Peter Viaene en Mevrouw Monica Van Langehove van het Departement Economie, Wetenschap en Innovatie (EWI),

De Heren Eric Sleenckx en Maarten Sileghem van het Vlaams Agentschap Innoveren en Ondernemen (VLAIO),

Mevrouw Danielle Gilliot van de Vlaamse Interuniversitaire Raad (VLIR),

Mevrouw Daniëlle Raspoet en Mevrouw Kristien Vercoetere en Mevrouw Annelies Wastyn van de Vlaamse Raad voor Innoveren en Ondernemen (VARIO),

De Heer Hans Willems van het FWO,

De collega's Tim Engels, Raf Guns, (ECOOM-Antwerpen), Katia Levecque en Noëmi Debacker (ECOOM-Gent), en Wolfgang Glänzel, Bart Thijs, Machteld Hoskens, Wytse Joosten, Laura Verheyden, Julie Callaert, Sarah Heeffe, Veronique Adriaenssens en Mariëtte Du Plessis (ECOOM-Leuven), en het ganse ECOOM-Leuven team dat de realisatie van deze digitale versie in goede banen heeft geleid,

die samen de nodige expert-inzichten en inbreng geleverd hebben bij het tot stand komen van de Vlaamse O&O gegevens.

Daarnaast danken we tevens van harte alle auteurs die op basis van de inbreng van de redactiegroep, de verschillende hoofdstukken en dossiers hebben uitgewerkt, geschreven en gedocumenteerd met relevant en betrouwbaar cijfermateriaal.

Zonder hun gezamenlijke inspanning was dit tiende Vlaams Indicatorenboek WTI nooit tot stand kunnen komen!

Van harte dank!

Prof. Koenraad Debackere en Prof. Reinhilde Veugeliers
Redacteurs Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie
Leuven, september 2021

Woord van de ministers

Na een moeilijke periode die getekend werd door de coronacrisis toont Vlaanderen veel veerkracht.

De pandemie heeft ons dynamische wetenschapslandschap niet kunnen temmen. Anders dan aanvankelijk werd gevreesd, is de innovatie in het bedrijfsleven niet teruggeduikt, en ook de kmo's worden steeds meer betrokken bij de noodzakelijke innovatie. De samenwerking tussen bedrijfsleven en kennisinstellingen, onder meer via de speerpuntclusters, verloopt nog steeds uitstekend en ook het fundamenteel onderzoek ondersteund door het FWO bleef productief.

De relance na de coronacrisis kan steunen op een heel stevige basis. Voor het eerst heeft Vlaanderen de norm van 3% van het bbp aan onderzoek en ontwikkeling doorbroken. In 2019 hebben alle bedrijven, overheden en kennisinstellingen in Vlaanderen samen 3,35% van het bbp geïnvesteerd in onderzoek en ontwikkeling, zo bleek uit de 3% nota 2021 van ECOOM. Dat is een belangrijke mijlpaal. Uit andere internationale rapporten komende nog positieve elementen naar voor. Zowel België als land, als Vlaanderen als regio, komen voor het eerst in de kopgroep van 'innovatieleiders' in Europa op een respectievelijke 4de (European Innovation Scoreboard) en 27e plaats (Regional Innovation Scoreboard).

Zoals blijkt uit de tiende editie van het indicatorenboek zet Vlaanderen met succes in op de ontwikkeling van haar talentbasis via hoger onderwijs en toenemende mobiliteit van studenten en onderzoekers binnen Vlaanderen maar ook internationaal, op de sterke aanwezigheid in Europese onderzoeks- en innovatieprogramma's, en op de ontwikkeling van significante posities inzake intellectuele eigendom zowel bij het bedrijfsleven als bij de kennisinstellingen. Ook de institutionele versterking van het innovatieweefsel met een portfolio van complementaire kennisinstellingen trekt investeringen in het Vlaamse WTI-weefsel aan.

Ook de toekomst ziet er goed uit. De Vlaamse Regering maakte 4,3 miljard vrij voor haar relanceplan, het plan dat de Vlaamse welvaart en het welzijn van de Vlamingen moet helpen versterken na corona.

In ons onderwijs wordt steeds meer de nadruk gelegd op STEM-richtingen. We zetten met de Digisprong ook een ambitieuze digitaliseringsoperatie van het hele onderwijs op de rails. Specifiek voor het hoger onderwijs is er in de nasleep van de coronacrisis een Voorsprongfonds van 60 miljoen euro gelanceerd, dat onze hogescholen en universiteiten nog toekomstgerichter en digitaler zal maken.

Het beleidsdomein EWI kan vanuit het Relanceplan Vlaamse Veerkracht 631 miljoen euro investeren. Hiervan wordt 87% uitgetrokken voor onderzoek en innovatie (waterstofonderzoek, bio-economie, digitalisering en duurzaamheid, O&O bedrijven, O&O onderzoeksinfrastructuur, ...) en 13% voor productieve, economische investeringen.

De komende jaren zal innovatie nog belangrijker worden, zeker in het kader van de uitdagingen rond duurzaamheid en zorg. We plannen deze legislatuur 250 miljoen euro voor onderzoek & ontwikkeling en daarbovenop nog eens 195 miljoen euro extra voor onderzoeksinfrastructuur.

Door innovatie als prioriteit van het beleid te blijven zien, willen we ook de komende jaren boven die 3% blijven en de plaats van Vlaanderen in de groep van innovatieleiders verder versterken. Kortom we willen Vlaanderen op het vlak van technologie, wetenschap en innovatie in de Europese cockpit plaatsen.

Het blijft essentieel voor het beleid om alles internationaal nauwgezet op te volgen en hierin speelt het Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie (de tiende editie ondertussen!) een belangrijke rol. Dit geldt zowel op het vlak van de bestedingen voor O&O en innovatie als voor de resultaten van het onderzoek uit het hoger onderwijs, onderzoek, ontwikkeling en innovatie.

Het Vlaams Indicatorenboek is dan ook uitgegroeid tot een belangrijk evaluatie-instrument voor het beleid.

Wij willen in naam van de Vlaamse regering ECOOM en iedereen die eraan meewerkte dan ook uitdrukkelijk bedanken.

Hilde Crevits

Viceminister-president van de Vlaamse Regering en Vlaams minister van Economie, Innovatie, Werk, Sociale economie en

Ben Weyts

Viceminister-president bevoegd voor Onderwijs, Sport, Dierenwelzijn en Vlaamse Rand

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In addition to the recurrent chapters, each edition of the Flemish Indicator Book also offers a number of specific dossiers that provide a summary of relevant figures and recent research into relevant themes. In this edition there are six different files that deal with very different topics.

7.3 Towards the top of knowledge and innovation regions in 2030

By Elie Ratinckx & Danielle Raspoet, Flemish Advisory Council for Innovation & Entrepreneurship (VARIO^[1]).

A top position in research, innovation and entrepreneurship contributes to long-term economic competitiveness as well as to better adaptations to changing global value chains, higher shock resistance and resilience towards climate change, health crises, drought crises... Despite its high R&D expenditure (3.35% of GDP^[2]), however, Flanders currently ranks 27th in the newest Regional Innovation Scoreboard (RIS-2021^[3]), belonging to the group of Innovation Leader-. The group of Innovation Leaders includes 38 regions and consists of three subcategories: Innovation Leader+ (above 144.8% above EU average), Innovation Leader (between 134.9% and 144.8% above EU average) and the bottom sub-group Innovation Leader- (between 125% and 134.9% of EU average). In the previous version of RIS (2019), Flanders ranked in a 40th position, belonging to the group of Strong Innovators+, the group just below the group of Innovation Leaders. However, it is not clear whether this new position is due to the new methodology of RIS-2021, due to real progress or both. The weak links in the Flemish innovation system, however, remain (cf. infra).

In its advisory report^[4] *'To the top of knowledge and innovation regions in 2030*, VARIO (2020) proposes an integral strategy to make a robust jump towards Innovation Leadership+ by 2030, joining the current select group of top regions in Switzerland, Sweden, Finland, Denmark and Germany. VARIO focuses on seven weak links in the Flemish innovation system that should be given absolute priority in the next ten years, in order to take the entire innovation system to a higher level:

- (1) The shortages in STEM^[5]
- (2) Lifelong learning
- (3) Ambitious entrepreneurship
- (4) An integrated vision on innovation
- (5) Impact of public R&D investment
- (6) High-tech export
- (7) An efficient and effective innovation policy

Additionally, VARIO selected (8) Knowledge-intensive services as an important lever for future growth. VARIO emphasizes that reaching the top of innovative regions requires not only an efficient R&D&I system, but also a transformation of the entire society and politics^[6]. This also includes a dynamic labor market, a strong future-proof education system and an efficient and effective government.

Minister-President of the Government of Flanders Jan Jambon and Flemish Minister for Economy and Innovation Hilde Crevits asked VARIO, the Flemish Advisory Council for Innovation and Entrepreneurship, for advice on how to connect with the top innovative regions in Europe. We refer to Advice 10 *'Innovative benchmark countries and regions for Flanders'*^[7] and Advice 11 *'A high-quality set of indicators for science and innovation'* in response to the first phase of the request for advice.

This text focuses on the second phase to formulate more concrete recommendations for an integrated strategy to make a robust jump to Innovation Leader+ by 2030.

VARIO highlights the strengths and assets of the Flemish R&D&I-system, also made possible by the sustained (financial) efforts of the successive Flemish Governments. Our strengths must absolutely be maintained and therefore closely monitored; VARIO refers to the high private and public investments in R&D, the scientific excellence of our knowledge institutions, innovative SMEs that enter into many partnerships.

Considering the economic crisis resulting from COVID-19 and the consequences it will have in the medium term, VARIO also puts forward measures for innovation policy for the short-term. (See 7.3.9)

In order to ensure effective progress of the strategy, VARIO asks to evaluate and to report using interim milestones on the road to 2030, at the end of the legislature of this Flemish Government in 2024.

^[1] The Flemish Advisory Council for Innovation and Entrepreneurship (Vlaamse Adviesraad voor Innoveren en Ondernemen, corresponding with VARIO) advises the Flemish Government and the Flemish Parliament on its science, technology, innovation, industry and entrepreneurship policy. VARIO works independently from the Flemish Government and the Flemish stakeholders in the field of science, innovation, industry and enterprise. <https://www.vario.be/en>

^[2] 3%-nota 2021: <https://www.ecoom.be/nl/3-procent-nota>

^[3] https://ec.europa.eu/growth/industry/policy/innovation/regional_en

^[4] VARIO (2020). Towards the top of knowledge and innovation regions in 2030. Advisory report 14. <https://www.vario.be/en/publications/advisory-report-14-towards-top-knowledge-and-innovation-regions-2030>

^[5] STEM corresponds to Science Technology Engineering & Mathematics

^[6] R. Unger (2019). The knowledge economy. Verso books. <https://www.versobooks.com/books/2928-the-knowledge-economy>

^[7] <https://www.vario.be/en/node/2280>

7.3.1 RECOMMENDATION 1: TACKLING SHORTAGES IN STEM

The shortages in STEM remain large. The percentage of STEM diplomas should be increased from 18.6% (2017) to 30% by 2030^[1], VARIO puts forward seven action points:

1. The ambition in the new STEM Action Plan^[2] should be raised: 30% STEM diplomas by 2030;
2. Stronger focus on impact: on increasing the share of graduates from STEM education;
3. Actively attracting foreign STEM profiles: we refer to VARIO Advice 1 '*Attracting and retaining top international talent*'^[3];
4. Stronger focus on STEM profiles with the largest mismatch: both academically, in the private sector and in education. In education, we refer to the shortages for subject teachers in mathematics, physics and chemistry;
5. Stronger focus on STEAM: STEAM, in which A stands for Arts, is the combination of creativity and innovation with the more scientific and technical skills in STEM. In policy and in the professional field, the A in STEAM is still undervalued. However, these profiles form the innovation leaders and entrepreneurs of the economy in the 21st century. At the same time, in non-STEM education, including the social sciences and the humanities, adequate attention should be paid to technical skills and knowledge;
6. A strong focus on STEM diversity and inclusion: policy must find more appropriate tools and instruments to increase the untapped potential of girls and young people with a migrant background for STEM careers;
7. Focus on digital skills: the digital world will continue to offer opportunities and challenges for the competitiveness of our economy, the transformation of society over the next ten years. The focus on digital skills must start early enough from primary school.

^[1] VARIO Memorandum 2019-2024: <https://www.vario.be/en/publications/vario-memorandum-2019-2024>

^[2] In June 2021, the new action plan, STEM Agenda 2030, has been published, see <https://beslissingenvlaamsereregering.vlaanderen.be/?search=STEM-Agenda%202030> However, no concrete targets, i.e. 30% STEM diplomas by 2030, were included. VARIO hopes this will happen in the near future

^[3] There is an English abstract available on: <https://www.vario.be/en/publications/advisory-report-1-attracting-and-retaining-top-international-talent>

7.3.2 RECOMMENDATION 2: A BREAKTHROUGH IN LIFELONG LEARNING

Eagerness to learn, acquiring knowledge, learning new (digital) competences... are key to innovation in a knowledge economy, for a more shockproof society... VARIO cannot emphasize enough that Flanders needs a new mindset, a stronger culture for lifelong learning, for upskilling and reskilling...

Given the potentially high macroeconomic impact of lifelong learning, breakthroughs are imperative in the next decade. The aim should be to triple the number of lifelong learners in Flanders relatively quickly by the end of this Flemish legislature in 2024^[1]. The Lifelong Learning Platform announced in the Coalition Agreement, must be set up quickly. Its priority must be to develop an evidence-informed overarching strategy with concrete measures for a learning society as soon as possible.

^[1] VARIO Memorandum 2019-2024: <https://www.vario.be/en/publications/vario-memorandum-2019-2024>

7.3.3 RECOMMENDATION 3: STRENGTHENING AMBITIOUS ENTREPRENEURSHIP

The importance of startups and scale-ups (and other innovative SMEs) for our innovative strength, dynamism and competitiveness cannot be underestimated. However, despite the progress made, entrepreneurial dynamism remains relatively low and ambitious entrepreneurship is not yet sufficiently established in Flanders. There is also need for better balance between early exits on the one hand and good anchoring of top tech companies with decision centers, R&D, production & distribution in Flanders on the other hand (see also Recommendation 6 on High-tech export).

VARIO stresses the importance of innovation ecosystems. Economic competitiveness is shifting progressively from the individual company level to competitiveness at the level of ecosystems. The large Flagship companies can take the lead in an ecosystem to drive innovation and growth, together with ambitious startups and scale-ups. Smaller companies, niche players, also have proven to be able to take on a leading role. An important lesson is that the ecosystem leader does not become too dominant so that partners in the ecosystem remain motivated to work quickly, to innovate and to grow the ecosystem.^[1]

VARIO proposes a three-track policy to maximize the chances of successful young innovative companies. We also refer to VARIO Advisory Report 4 '*Innovative High Growth Companies with Impact*':

1. Increasing the number of ambitious entrepreneurs in the long term: we should strengthen ambitious entrepreneurship at all levels of education as an explicit task of VLAIO^[2] and its partnerships. More needs to be done with hands-on learning processes (from an early age) in which entrepreneurship in practice is more strongly stimulated such as for creating a business plan with a real budget, customer experience.
2. In the shorter term, we should stimulate more foreign top talent for ambitious entrepreneurship: Flanders Investment & Trade (FIT)^[3] can play an important role together with VLAIO and our knowledge institutions. We refer to Advisory Report 4 '*Innovative High Growth Firms with Impact*'^[4] in which VARIO asks to provide startup and scale-up visas in order to attract foreign entrepreneurs more easily.
3. Strengthening the quality of the macroeconomic context: more attention should be paid to the gaps or bottlenecks in the local macroeconomic context in which ambitious entrepreneurs operate. VARIO points to a recent analysis of the macroeconomic context by Leendertse, Schrijvers, & Stam (2020)^[5] which also includes the macroeconomic context for each of the Belgian provinces. Is there enough talent available locally? Is there enough venture capital available?... This analysis is an important diagnostic tool for the local stakeholders, urban and provincial governments (sector federations, POMs^[6], SALK Turbo^[7]...) to work on a high-quality macroeconomic context in synergy with the more central Flemish (and Belgian) governments.

^[1] De Meyer & Williamson (2020). Ecosystems edge. Sustaining competitiveness in the face of disruption. Stanford Business Books. <https://www.sup.org/books/title/?id=31495>

^[2] VLAIO is the Flemish Agency for Innovation and Entrepreneurship: <https://www.vlaio.be/nl/andere-doelgroepen/flanders-innovation-entrepreneurship>

^[3] Flanders Investment & Trade: <https://www.flandersinvestmentandtrade.com/language-selection?destination=%3Cfront%3E>

^[4] English abstract available on: <https://www.vario.be/en/publications/advisory-report-4-innovative-high-growth-firms-impact-0>

^[5] https://www.uu.nl/sites/default/files/REBO_USE_WP_2020_01%20update%20May%202020.pdf

^[6] POM corresponds to Provincial (Economic) Development Agency

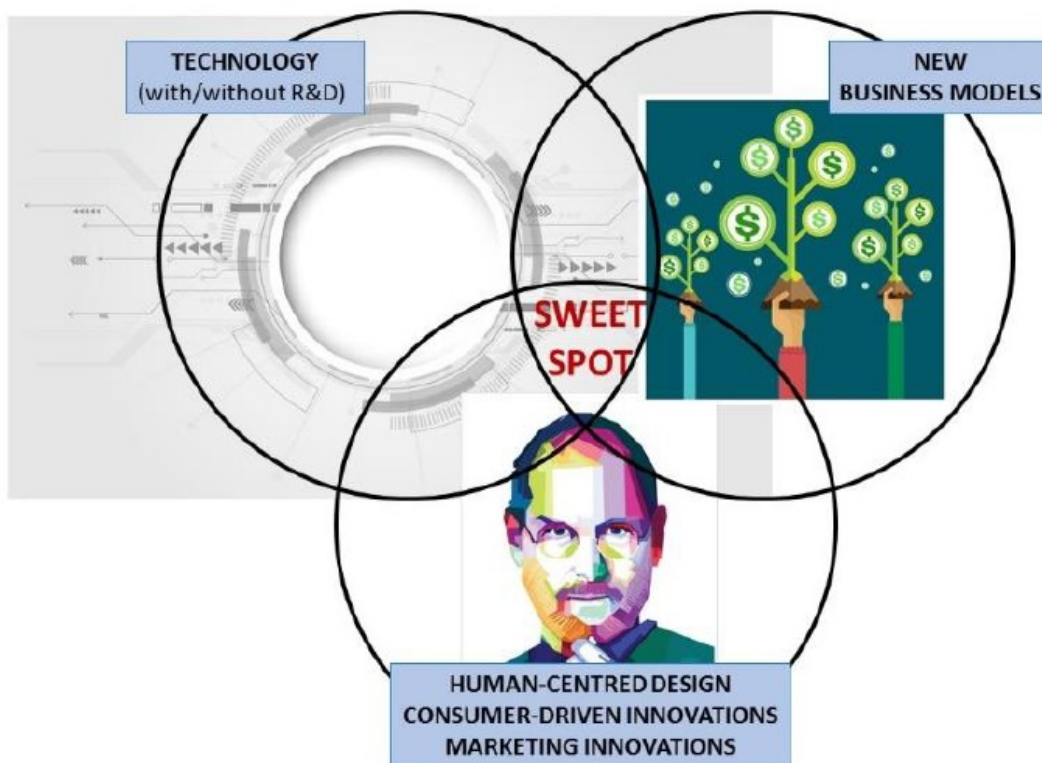
^[7] SALK Turbo is a new action plan to strengthen and to accelerate the economy in the Belgian province of Limburg: <https://www.salkturbo.be/over-salk-turbo/>

7.3.4 RECOMMENDATION 4: DEVELOPING AN INTEGRATED VISION ON INNOVATION

In top regions innovation is part of the entire economic system, not only in specific high-tech sectors such as biotechnology or ICT. Indeed, innovation is broader than innovations based on the traditional R&D in sciences, the hard innovation factors such as patents. A company can bring a new product or a variant of an existing product (product differentiation) to the market without having conducted R&D. It can also entail purchasing innovative knowledge, technologies, equipment, software and licenses that companies have not developed themselves, but can provide an important boost to their competitiveness.

VARIO refers to the broad, integrated vision on innovation in Figure 1, in which combinations of technical innovations (with or without R&D), business model innovations, human-centered design, marketing innovations, consumer-driven innovations, etc. play an important role. In Flanders we need to think much more commercially; consumer-driven innovations and societal challenges such as ageing, climate change... play an increasingly important role. For example, we refer to the Netherlands which jumped on the e-commerce cart much faster than Flanders and is now economically more resilient in response to COVID-19.

FIGURE 1: AN INTEGRATED MODEL FOR INNOVATION



Source: shutterstock, own editing

In Flanders, non-R&D-related expenditures on innovation are still too limited. An important role and redefinition of that role should be addressed by VLAIO and its partners, including the sector federations, VLAIO's Team Bedrijfstrajecten^[1], the Universities of Applied Sciences (Blikopener^[2]), other knowledge institutions... VARIO asks the Flemish Minister of Economy and Innovation to commission VLAIO to develop a proposal to better integrate the holistic vision in innovation policy and its instruments.

^[1] Business processes; VLAIO's Team Bedrijfstrajecten is a fusion of the former regional innovation centers at the provincial level.

^[2] The Flemish Universities of Applied Sciences provide innovative practical knowledge to companies, not-for-profit organizations... through the Blikopener project.

<https://www.blikopener.vlaanderen/>

7.3.5 RECOMMENDATION 5: INCREASING REGIONAL IMPACT OF PUBLIC R&D INVESTMENTS

Top innovations should also be translated in economic and societal success, both in Flanders (at the regional level and in all provinces) and internationally. However, the regional and international impact of R&D is unbalanced. A better balance is needed with more attention to the impact of public R&D investments in Flanders also taking into account regional economic strengths. However, achieving regional impact of innovations based on R&D is more than a financing problem, achieving a 3% R&D norm... Despite several success stories, we have not yet sufficiently found the mechanism or mechanisms to realize regional impact of research in Flanders. In Flanders we are not yet sufficiently successful in commercializing innovations based on public R&D. VARIO puts forward six working points to increase the impact of research in Flanders:

1. Making use of the dynamics of regional knowledge and business ecosystems: international economic competitiveness is increasingly shifting from the individual company level to competitiveness based on ecosystems or networks. VARIO asks to monitor the dynamics of new, emerging knowledge and business ecosystems in Flanders by means of advanced data analysis. This information can be used by VLAIO and its partners, vzw Team Bedrijfstrajecten and in tandem with FIT to increase the growth of emerging ecosystems and the new players involved in them; to connect new emerging ecosystems with other (international or cross-border) knowledge and innovation partners, to show the way to international markets...;
2. Making innovation instruments ecosystem-proof: in order to prevent fragmentation of resources and to make innovation instruments more ecosystem-proof, a screening and impact analysis of the instruments must be carried out (including the R&D business projects); learn from this and better attune it to the reality and dynamics of local ecosystems in Flanders. In tandem with VLAIO, FIT should also play an important role in ensuring the international impact of innovations from local ecosystems;
3. To better align public strategic research resources with strengths in local innovation ecosystems: we need to further improve regional absorptive capacity^[1] by better aligning strategic public R&D resources with local economic strengths in Flanders... VARIO asks to explore how financial resources can be shifted to better match public strategic research investments with regional economic strengths;
4. Stimulating demand-driven innovations: VARIO asks to focus more strongly on demand-driven innovations based on social and/or economic demands: strategic innovative procurement and mission-oriented R&D policies. VARIO refers to the Dutch Top Sector Policy^[2] and the German High-tech Strategy 2025^[3] which have been oriented to missions as well as the European agenda (e.g. Horizon Europe, the Green Deal...);
5. Entrepreneurial universities of the 21st century: in addition to education and research, universities also contribute to society (3rd mission of universities). If we want to increase the impact of R&D investments in Flanders, universities (and other knowledge institutions) absolutely need to pay lot more attention to the 3rd mission (societal service), with enough attention to the impact of research in Flanders itself. VARIO formulates four action points:
 - Especially in research projects of strategic importance (SBO^[4]), a societal impact implementation plan should be built in that is just as important as the more technical research part and is evaluated as such post hoc;
 - VARIO urges to make the TTOs^[5] (1) more accessible to the demand-side, based on so-called Flipped TTOs in which ambitious entrepreneurs play a central role, (2) creating a stronger 'Yes We Can' mentality for academic entrepreneurship (in order to create more spinoffs with stronger growth ambitions) and (3) achieving more critical mass by means of stronger cooperation between individual TTOs (in a learning network)...;
 - The importance of innovation and the impact of research on the world outside university is not yet sufficiently captured by most academic researchers. It should be investigated to what extent innovation KPIs can play a role in academic practice and how research funding could be more attuned to impact and innovation efforts;
 - A stronger focus on circular mobility of highly educated domestic and international talent between knowledge institutions

and the local economy in Flanders^[6]. Regarding international talent, we refer to VARIO's Advice 1 '*Attracting and retaining international top talent*'^[7] and the joint research project of VARIO and VLUHR^[8] '*Economic effects of international student mobility*'.

6. Promoting Flanders as an attractive, international high-tech hotspot: VARIO puts forward two action points:

- > Abroad, we should promote Flanders in a more coherent and stronger way as an international innovative high-tech hub. FIT should play an important role together with the local innovation partners (Strategic Research Centers, spearhead clusters, Universities and Universities of Applied Sciences...), (local) governments... The quality of our knowledge workers, the excellence of our research, the tax support measures for researchers... are important assets;
- > We undoubtedly need to improve our reputation abroad on several other indicators in the areas of innovation, competitiveness, quality of government, a more attractive business environment... Some of these bottlenecks are also situated at the federal level.

^[1] VARIO notes that also other factors such as the number of STEM graduates determine the absorption capacity of (public) R&D investments. For example, China invests a great deal in R&D, likewise they also have the human capital (many engineers) to absorb these resources.

^[2] <https://www.topsectoren.nl/missiesvoordetoekomst>

^[3] <https://www.bmbf.de/en/high-tech-strategy-2025.html>

^[4] <https://www.fwo.be/en/fellowships-funding/research-projects/sbo-projects/>

^[5] TTO corresponds to Technology Transfer Office

^[6] See also open letter to policy makers in De Tijd, 4th of July 2020 <https://www.antwerpmanagementschool.be/nl/nieuws/its-the-knowledge-and-talent-stupid>

^[7] <https://www.vario.be/en/publications/advisory-report-1-attracting-and-retaining-top-international-talent>

^[8] VLUHR is the Flemish umbrella organization of universities and the universities of applied sciences (UAS):

7.3.6 RECOMMENDATION 6: STRENGTHENING HIGH-TECH EXPORT

The importance of high-tech products and the related knowledge-intensive services for international business is high. If we want to further develop the knowledge economy in Flanders, we need to focus more on economic impact: more (export of) high-tech products and the related knowledge-intensive services.

VARIO proposes a three-track policy to strengthen high-tech export, in which our knowledge institutions together with the government, VLAIO and FIT etc. have an important role to play:

1. Cherishing larger R&D companies in Flanders: we need a more proactive government that, together with the larger R&D companies and knowledge partners (in Triple-helix), tackles bottlenecks and develops roadmaps to strengthen competitiveness, to reduce costs, to make R&D&I, production and distribution, infrastructure etc. futureproof;
2. Sustained focus on the growth of tech startups and scale-ups: for the purely tech startups we need a better balance between too early exits (through foreign takeovers) on the one hand and the growth and anchoring of these firms in Flanders on the other hand. Although we also observe success stories from foreign acquisitions that provide extra recruitment and extra production capacity (internally and from suppliers), we only have very few successes from our own growth companies. However, they are desperately needed. A sufficient number of head offices (as strategic decision-making centers) remaining in Flanders increase the chance of anchoring R&D&I, production and distribution. This theme will also gain importance internationally;
3. Attracting R&D centers and high-tech production facilities: we should not only focus on attracting foreign R&D centers from large multinationals, but also foreign multinationals that are developing new state-of-the-art high-tech production facilities in Flanders, new distribution hubs and offices.

7.3.7 RECOMMENDATION 7: AN EFFICIENT AND EFFECTIVE INNOVATION POLICY

We need a competent, efficient and effective government with institutional leadership and unity of command... The Sustainable Governance Indicators (2019) point to the problem of the (Belgian) public debt, which results in public investments in public infrastructure and Higher Education that have fallen below a healthy level. VARIO puts forward five focus areas:

1. An evidence-informed innovation policy as spearhead: Flanders must make from evidence-informed policy an absolute spearhead in the next ten years, also in innovation policy. We need to engineer^u innovation policy in a more rigid way based on scientific knowledge and analysis and from different perspectives of all stakeholders in the working field;

2. A proactive, future-proof innovation policy: governing means looking ahead; a proactive government is essential to be strategically well prepared in a complex and rapidly changing world, to major societal challenges... We need a greater policy capacity for foresight. VARIO asks for a new foresight study in order to get a better understanding of the societal and economic challenges ahead..., the technological developments and opportunities in the next 10 years (2030). We refer to the former VRWB Clusters 2015^[2] and the VRWI Foresight Study 2025.^[3]

3. A coordinated, multilevel regional innovation policy with bottom-up focus: from the analyses accompanying this advisory report, we observe that compared to the highly urbanized Flemish Diamond^[4], the peripheral provinces (West Flanders and Limburg) lag in terms of innovation and competitiveness. In order to strengthen innovation and competitiveness in the Flemish peripheral provinces, without losing critical mass, efficiency and effectiveness, VARIO advises to make use of agglomeration benefits of local, urban areas from a bottom-up focus, as much as possible and in a more coordinated way. VARIO puts forward 3 working points:

a. Strengthening cooperation between governments: in innovation policy VARIO asks to pay more attention to cooperation between local, urban authorities on the one hand and the more central government in Flanders (Flemish government), Belgium (Federal Government) and the European level on the other hand. Bottlenecks arise in regional hotspots because different levels of policy sometimes conflict or duplicate each other;

b. Stimulating links between the peripheral provinces and the Flemish Diamond: missing resources or 'holes' in ecosystems in the peripheral provinces should be compensated as much as possible by stimulating stronger links between the Flemish diamond and the peripheral provinces;

c. Stimulating cross-regional cooperation in Eurometropolises: further effort should be made to cross-regional cooperation in innovation policy to increase the local market, as a lever for internationalization of SMEs in the slipstream of larger companies. Opportunities lie within stronger links between the urbanized EU region of Maas-Rhine with urban areas in Limburg on the one hand; and the urbanized EU region of Kortrijk-Lille-Tournai with West Flanders on the other. VLAIO may be asked to experiment with new, low-threshold innovation instruments in these regions together with fellow agencies in our neighboring countries and regions. The cooperation between VLAIO, ICON^[5] and INNOVIRIS (the innovation agency in Brussels) for cross-border regional cooperation can be inspirational.

4. Public investments in infrastructure and higher education must absolutely be increased: VARIO asks to invest in strategic investments in large (innovation) infrastructure, such as green energy, CO₂ reduction, mobility, ICT infrastructure, health infrastructure... and in Higher Education which is underfunded. Investments in large infrastructure are important not only in terms of the economic recovery (COVID-19), but also in the medium to long term on the road to 2030. VARIO therefore asks the competent authorities, together with private partners, to prioritize and accelerate the roll-out of the 5G network;

5. Stronger diplomatic representation and information flow at the European level: in order to participate in European decision-making, the Flemish Government must develop a better governance framework with an efficient decision-making path, maximum use of existing consultation channels and structures in and between the regional, community and federal levels, maximum use of Flemish representatives in European forums; and better information flow.^[6]

[1] Henri Ghesquire (2006). Singapore's success: Engineering economic growth. Gale Asia. <https://www.amazon.com/Singapores-Success-Engineering-Economic-Growth/dp/9814195286>

[2] <https://www.vlaanderen.be/publicaties/zes-clusters-en-hun-speerpunten>

[3] <https://www.vlaanderen.be/publicaties/vrwi-toekomstverkenningen-2025>

[4] https://en.wikipedia.org/wiki/Flemish_Diamond

[5] The imec:icon research program is a formula for demand-driven, cooperative research. See <https://www.imec-int.com/nl/imec:icon>

[6] VARIO Memorandum 2019-2024: <https://www.vario.be/en/publications/vario-memorandum-2019-2024>

7.3.8 RECOMMENDATION 8: KNOWLEDGE-INTENSIVE SERVICES

Taking into account the characteristics of the Flemish economy and its growth and innovation potential, VARIO selects knowledge-intensive services as a lever for future growth. Flanders is lagging in terms of the share of knowledge-intensive services in total exports, while trade in services is growing 60 percent faster than that in goods. We refer to the financial and business services, maritime services, (service) design, research, technical services (IT, Telecommunications...)... partly based on their contribution to the competitiveness of other sectors, such as in high-tech (see above). A number of these services are also internationally scalable as a result of digitization (including AI, digital services related to data...) and potentially have a great deal of economic added value. We need to gain better understanding of the current needs, opportunities and growth areas of this group of companies, including many SMEs, to further stimulate the knowledge-intensive service sectors to innovate and internationalize (analogous to the industrial sectors). Here too VLAIO and FIT have a role to play.

7.3.9 RECOMMENDATION 9: POLICY MEASURES FOR SHORT-TERM ECONOMIC RECOVERY

Measures to slow down the spread of COVID-19 have largely halted the global economy. However, innovative companies usually seem to get through crises better.^[1] During the 2008/2009 economic and financial crisis, innovative companies lost considerably fewer jobs than other companies^[2]. In the context of the economic recovery following COVID-19 and a possible hard Brexit in the near future that could even exacerbate the crisis, VARIO advocates in the short term for:

1. An ambitious innovation policy that ensures that companies don't interrupt their innovation activities during the crisis. Direct and indirect financial policy instruments can help overcome liquidity problems for innovation projects. This is especially true for small and medium-sized enterprises; larger companies often have more internal financial resources and better access to credit markets^[3];

2. In line with the resolution of the Flemish Parliament (9 June 2020^[4]) to support entrepreneurship and entrepreneurial spirit, with special focus on (early) startups and scale-ups to boost entrepreneurial confidence;

3. As Flanders is very export-sensitive, strengthening (high-tech) exports, including knowledge-intensive services should be a priority in the recovery of the Flemish economy;

4. Strategic innovative procurement and investments in large (innovation) infrastructure, such as green energy, CO₂ reduction, mobility, ICT infrastructure, Health infrastructure.... to stimulate demand as soon as possible^[5]. Although it is currently almost impossible to predict which innovations COVID-19 will produce, digital technologies will in many cases play an important role^[6]. VARIO therefore asks the competent authorities, together with private partners, to prioritize and accelerate the roll-out of the 5G network;

5. In line with the resolution of the Flemish Parliament (9 June 2020^[7]), VARIO asked to accelerate efforts to sharpen digital skills in the labor force. In addition - obviously taking into account possible (international) flare-ups of COVID-19 - a boost should be given to programs such as Erasmus+ to study abroad as well as internships in business for those who graduate during the period of COVID-19 and do not find a suitable job quickly enough due to the economic crisis.

[1] Santiago, Dachs & Peters (2020). Foster recovery from COVID-19 through science, technology and innovation. <https://iap.unido.org/articles/foster-recovery-covid-19-through-science-technology-and-innovation>

[2] Dachs & Peters (2014). Innovation, employment, growth, and foreign ownership of firms. *Research Policy* 43(1), 214-232.

[3] Santiago, Dachs & Peters (2020). Foster recovery from COVID-19 through science, technology and innovation. <https://iap.unido.org/articles/foster-recovery-covid-19-through-science-technology-and-innovation>

[4] <https://www.vlaamsparlement.be/parlementaire-documenten/parlementaire-initiatieven/139773>

[5] Santiago, Dachs & Peters (2020). Foster recovery from COVID-19 through science, technology and innovation. <https://iap.unido.org/articles/foster-recovery-covid-19-through-science-technology-and-innovation>

[6] <https://www.en24news/2020/06/covid-19-and-rd-in-companies-experiences-from-previous-crises.html>

[7] <https://www.vlaamsparlement.be/parlementaire-documenten/parlementaire-initiatieven/139773>