BiGGAR Economics

Economic Impact of 4TU

Final Report
9th November 2022

4TU.Federation

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

TU Delft

UNIVERSITY OF TWENTE.

WAGENINGEN UNIVERSITY & RESEARCH

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BiGGAR Economics

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1. Executive Summary

The total annual economic impact of the 4TU universities is estimated at €12.7 billion. This is created by learning, research, and valorisation impacts and by economic benefits created by the universities' direct operations. For every €1 of public investment[1], 4TU universities create €9 of GVA[2] impact. They are the motor of the Dutch economy.

This study was commissioned by 4TU to highlight the impact its members had throughout the economy in 2021. The members of 4TU are:

- Delft University of Technology (TU Delft);
- Eindhoven University of Technology (TU/e);
- University of Twente (UT);
- Wageningen University & Research (WUR).

Learning Impacts

4TU members create learning impacts through earnings premium realised by graduates, lifelong learning provision and from student internships.

The 4TU universities work to shape their students into "T-shaped professionals", who can intermix concepts and shape innovative systems and ideas, they are expert problem solvers. T-shaped engineers and technologists are an essential ingredient for interdisciplinary innovation. This makes 4TU graduates particularly productive.

There are two aspects to the graduate premium: one that accrues to each graduate personally and one that accrues to the companies they work for whose profitability is improved by using the graduate's skills. It is not possible to accurately calculate the benefits to individual company profitability and national productivity from employing graduates, therefore the method used in this analysis reflects only the personal benefit to graduates from studying at university. As a result, it is an underestimate of the total economic impact associated with increased graduate productivity.

It was estimated that the impact of the lifetime earnings premium associated with an annual cohort of graduates from the 4TU members is almost €2.0 billion GVA in the

[1] Public investment includes direct government funding ("first stream funding"), and research funding from the Dutch Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW) ("second stream funding").

[2] GVA (Gross Value Added) is a measure of economic output. It refers to the monetary value that an organisation, company or industry adds to the economy through its operations. In the case of the Universities this is estimated by subtracting the non-staff operational expenditure (mainly represented by expenditure on goods and services) from the total income of the Universities.

Netherlands. This impact is a productivity gain measured in terms of GVA, consequently it does not have an associated employment impact.

Lifelong learning is an important objective of 4TU member universities which recognises the changes required in workplaces as technological innovation reaches into the economy. It is designed to help working people develop new skills or update the existing skills they use. **It is estimated that the lifelong learning delivered by 4TU contributes €38 million GVA to the national economy and supports 30 jobs each year.**

Internships are of great benefit to students, to the business or organisation they are placed with and also to the host university by encouraging wider engagement with employers. **Student internships organised by the 4TU universities contribute an estimated €25 million GVA to the national economy and support 260 jobs each year.**

Valorisation Impacts

Valorisation draws the benefits of 4TU's research and teaching expertise into society, fostering economic growth. Each of the 4TU members has a keen focus on valorisation, with significant investment in people, structures and activities that are targeted at creating societal impact. Valorisation outcomes are supported by highly experienced technology transfer staff and facilities. Much of the impact of the Universities' research work is reflected in its valorisation impacts.

The 4TU universities have supported the development of 380 start-up and spin-out companies that continue to be active and for which data is available. They employed 33,040 staff and their combined annual turnover is estimated at € 2.9 billion. **It is estimated that spin-out and start-up companies associated with the 4TU universities generate €320 million GVA and support 2,360 jobs in the Netherlands each year.**

The 4TU universities facilitate knowledge transfer through their interactions with businesses. This includes: consultancy work; commissioned research; and access to facilities and equipment. **It is estimated that the 4TU universities generate €2.5 billion GVA and support 3,840 jobs in the Netherlands each year by providing research and consultancy services to businesses and public organisations.**

The 4TU universities support a range of science parks, business incubators, accelerators, and field labs/experimental farms. These have a variety of legal structures, operational models, and physical forms. All are embedded in regional partnerships and drive ecosystems. **It is estimated that the involvement of the 4TU universities in science parks and incubators generates €1.5 billion GVA and supports 15,660 jobs in the Netherlands each year.**

One of the ways in which the 4TU universities' research can be translated into economic activity is through licensing agreements with industry. **It is estimated that the 4TU members generate €57 million GVA and support 590 jobs in the Netherlands each year through their licencing activities.**

These estimates of the value of valorisation are likely to underestimate the true economic impact, because each 4TU member is focused on societal impact, rather than financial return. In part, the economic impact calculations are based upon financial returns to the universities, so do not capture the more creative and non-cash generating opportunities pursued by 4TU members to see their intellectual property reach the market.

Operational Impacts

As large employers with extensive supply chains, a significant number of students, and a large research operation, the 4TU universities have a sizeable economic footprint within the Netherlands and their regions.

As part of their core activities, the 4TU members generate economic activity through: direct impact – the income they receive and the staff they employ; supply chain impact – through expenditure on goods and services; staff spending impact – from salaries being spent in the economy; and capital expenditure impact – from investment in capital infrastructure. **It is estimated that this core activity supports €4.9 billion GVA and 59,140 jobs in the Netherlands each year.**

Impacts from the day-to-day spending and working habits of 4TU's 2021 cohort of 67,370 students are estimated to contribute **€1.3 billion GVA and support 20,640 jobs in the Netherlands each year.**

The 4TU universities have an impact on tourism through hosting graduations and organising open days for prospective students, driving friends and family visits to staff and students, and hosting conferences and events. **The economic impact associated with tourism-related activities stimulated by the 4TU universities support €16 million GVA and 210 jobs across the Netherlands each year.**

The quantifiable impacts can be thought of in two categories: **purposeful impacts,** which are the result of the nature of the work being done (the learning and research valorisation impacts), and **operational impacts** which will arise from any large organisation, regardless of the nature of its business (core, student and tourism-linked employment). In the case of 4TU, 51% of its GVA impact and 22% of its employment impact can be thought of as purposeful. The remaining 49% of its GVA impact and 78% of its employment impact can be thought of as operational.

Quantitative Impact Summary

GVA, € million	Netherlands
Purposeful Impact	
Learning Impact	2,030
Valorisation Impact	4,414
Sub-total (Purposeful)	**6,444**
Operational Impact	
Core Impact	4,907
Student Impact	1,335
Tourism Impact	16
Sub-total (Operational)	**6,258**
Total	**12,702**
Employment	
Purposeful Impact	
Learning Impact	290
Valorisation Impact	22,450
Sub-total (Purposeful)	**22,740**
Operational Impact	
Core Impact	59,140
Student Impact	20,640
Tourism Impact	210
Sub-total (Operational)	**79,990**
Total	**102,740**

Source: BiGGAR Economics Analysis (Note: Figures may not sum due to rounding.)

Societal Impacts

The benefits created by the 4TU universities are far wider in scope than can be measured through GVA and jobs. They supply skills and knowledge required to solve huge societal challenges, valorising these so that solutions reach society. The economic development they pursue is sustainable and can be transformational, with the UN Sustainable Development Goals a focus for much of their activity. The economic benefits described in this study are a small part of the overall societal impacts they deliver.

The universities provide a key mechanism in ensuring economic resilience in these challenging times, and also act as regional anchor institutions, becoming defining parts of the places to which they belong. Much of their impact accrues to the regions in which each university sits.

While the 4TU universities are undoubtedly an economic powerhouse at the heart of each of these regions, the part they play is much wider. Each institution uses its assets to create a wide array of economic and social value. There are deep connections into local communities, businesses, schools, colleges, the health system, local authorities and other public bodies.

4TU Innovation Systems

The Netherlands performs well as an environment where ecosystems can thrive and as world leaders in several technology domains, the 4TU universities are the driving force behind these. Each 4TU university is an innovation system in its own right.

Within the Netherlands, the 4TU members are at the heart of important, global systems, stimulating the development of clusters and ensuring critical success factors for competitiveness are in place. They contribute strongly to the overall global performance of the Netherlands as a home for innovation systems and to their own thriving regional systems. These are complex systems, with nuanced features that underpin their success – entrepreneurial mindsets, long term personal and professional relationships, culture, and history.

Conclusions

The 4TU universities are innovators in education, producing rounded professionals who are the engineers and technologists of the future. The lifetime earnings premium is significant. We anticipate this increasing in future, with an increasing focus on pedagogy and challenge-based learning that will enhance the productivity of future 4TU graduates.

Each of the 4TU universities has a laser focus on valorisation. While this report has considered economic impact, there is a broad scope of wider benefits created for society. It is remarkable that they achieve this without core strategic funding of valorisation activity, provided to universities in much of the rest of Europe. Lack of core funding means that facilities, teams and infrastructure are reliant on project subsidies. From an innovation systems perspective, this is less than optimal, because a systems approach requires concerted planning and action over the long term. Given the strategic focus of the 4TU institutions, their world leading science, and remarkable ability to drive scientific outcomes into society, there are opportunities to increase their valorisation impacts. An increase in valorisation impacts from the 4TU universities of 2-6 percentage points, an uplift associated with public support for valorisation funding elsewhere in Europe, could provide additional annual economic benefits to the Netherlands of €58 to €174 million from the 4TU universities alone.

While the scale of 4TU's economic impact is very significant, it is important to understand 4TU's contribution to the Netherlands goes far beyond what can be measured in GVA and jobs statistics alone. Without the underpinning mechanisms provided by the 4TU universities, the Dutch economy would be smaller and less resilient. Each 4TU university underpins its regional innovation system, and as a Federation working together 4TU provides the glue for a national system and connects it to wider global systems, acting as the motor of the Dutch economy.

2. Introduction

This study was commissioned by 4TU to highlight the impact its members have throughout the economy.

2.1 Background

The 4TU.Federation is an alliance of the four universities of technology in the Netherlands which aims to boost and pool technical expertise to address global societal challenges. As a group, they make a crucial contribution towards engineering and innovation power in the Netherlands. In 2021, the 4TU members had a combined income of €2.5 billion, a full-time student population of 67,370 people and 27,890 members of staff.

The four members are:

- Delft University of Technology (TU Delft);
- Eindhoven University of Technology (TU/e);
- University of Twente (UT);
- Wageningen University & Research (WUR).

4TU's core values are to connect, represent and innovate in the areas of education, research and valorisation

It is a very diverse, yet complementary, group with different research strengths and range of activities. The scale, scope and key features of each member organisation is described in Appendix A.

2.2 Objective, Scope and Method

This study was commissioned by 4TU to highlight the impact its members have throughout the economy, by educating engineers of the future, delivering fundamental and applied research and valorising research to help solve global societal challenges.

The economic impacts described in this report have been calculated for the Netherlands as a whole. Separate summary reports have been prepared for each 4TU member which set out their individual impacts.

The economic value generated by the 4TU members is expressed using two widely accepted measures of economic impact:

- Gross Value Added (GVA) is a measure of economic output. It refers to the montetary value that an organisation adds to the economy through its operations. A detailed explanation of GVA is provided in Appendix D; and
- Employment (jobs) is measured in terms of headcount jobs supported unless stated otherwise.

The analysis is based on data collected from the 4TU members for the 2021 calendar year. The economic impacts have been quantified based on this data provided by the 4TU members and where data was only available for some members, estimates for other 4TU members were not imputed[3]. Taking this conservative approach means that although the economic impacts are likely to have been underestimated in some areas, there can be a high degree of confidence in the results.

The Dutch Input-Output Tables for 2018 (2021 edition) have also been used, where appropriate, to estimate the multiplier effects throughout the economy. Appendix B explains the technical methodology, sources and assumptions used.

To understand the wider impacts the universities create, a series of consultations were held in Summer 2022 with education, research and valorisation leaders at each 4TU member university. A full list of consultees is given in Appendix C.

2.2.1 Timescales of Impacts

The analysis measures the impact created by the 4TU members over a single year. It provides a snapshot in time, in line with the conventionally accepted approach taken in our economic impact assessments of universities across Europe.

However in designing this approach, it is recognised that some of the activities of the 4TU members generate economic impact immediately, for example, staff and student spending. For most activities though the economic impacts will occur over a longer time frame, such as, valorisation of research and the earnings premium of graduates.

The report therefore makes the simplifying assumption that activity in 2021 generates impact in 2021. The rationale for this is that although the impact of some activity that occurs in 2021 will not occur until a later date, some of the impact that was realised in 2021 will have been generated by historic activity and no attempt is made to quantify the impact of this.

[3] The only exception to this is student volunteering, where the proportion of students undertaking volunteering was provided by one 4TU member and it was assumed that a similar level of volunteering takes place at the other universities. The rationale for this is that volunteering data is not always gathered by universities and the figure provided by the 4TU member is broadly in line with national statistics (CBS) on the proportion of 15-24 year olds that volunteer.

Each impact presented in the report should therefore be read as an annual impact and the graduate premium in particular should be understood as reflecting the lifetime earnings premium for an annual cohort of graduates (who graduated in 2021).

2.3 Report Structure

The remainder of this report is structured as follows:

- Chapter 3 describes **learning impacts** created by 4TU members through additional earnings premium realised by their graduates, and the lifelong learning they deliver to professionals throughout their careers;
- Chapter 4 describes **valorisation Impacts** created through research and knowledge exchange activity which deliver benefits for industry, create spin-outs and start-up companies and support science parks and incubator facilities. The impact of licensed intellectual property is also estimated. Much of the research work from the Universities is reflected in its valorisation impacts;
- Chapter 5 presents **operational impacts** created by 4TU members which reflect their scale as employers, their supply chain impact and the impact of capital expenditure on buildings and facilities, as well as the collective impact generated by students during their studies;
- Chapter 6 **summarises these quantitative impacts** providing the total economic impact of the 4TU members for the Netherlands as a whole;
- Chapter 7 introduces the **societal impacts** created through the 4TU members and their role as **anchor institutions** in their communities;
- Chapter 8 describes the **systems approach** of 4TU universities ensuring critical success factors for competitiveness are in place;
- Chapter 9 presents the **conclusions** of our analysis;
- Appendix A describes each of the **4TU members**;
- Appendix B contains our **methodology** for calculating impact;
- Appendix C presents a list of **consultees** for the study; and
- Appendix D contains a list of **abbreviations and terms** used in the report.

3. Learning Impacts

4TU members create learning impacts through earnings premium realised by graduates, lifelong learning provision and from student internships.

3.1 Graduate Premium

The 4TU universities work to shape their students into “T-shaped professionals” who are ready for employment and have the ability to thrive in a modern workplace. The notion of the T-shaped professional is increasingly accepted as a necessity. The stem of the T is based on the idea that the student will be well versed in their area of study. The top of the T, or the horizontal branch, represents the student’s ability to share and collaborate with others. A T-shaped individual can intermix concepts and shape innovative systems and ideas, and they are expert problem solvers. T-shaped engineers are an essential ingredient for interdisciplinary innovation. This section considers graduates contribution to economic activity.

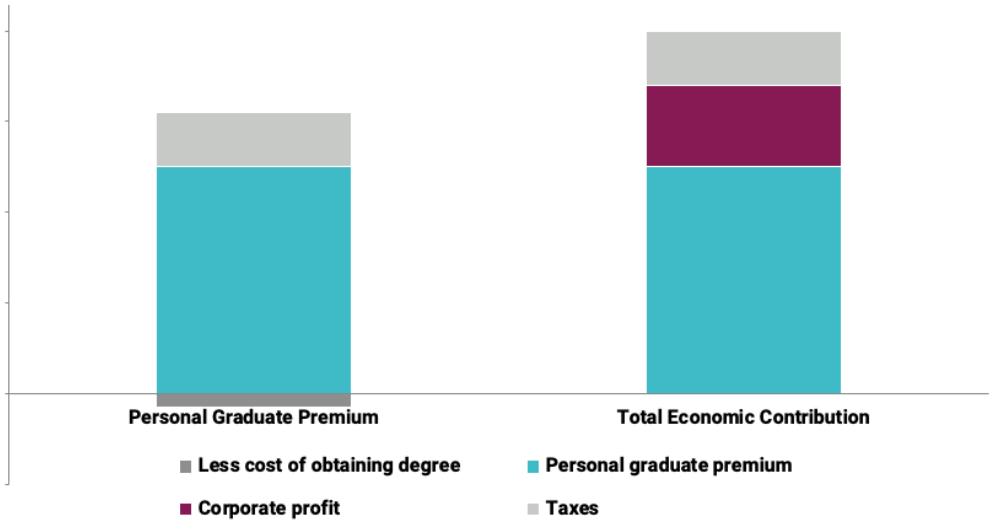
3.1.1 The Economic Contribution of Graduates

By completing studies at university, graduates acquire skills which make them more productive than they would otherwise have been. In line with common practice across similar assessments, the full value of university education is captured by looking at the difference between someone who attended university and someone whose highest qualification is upper secondary education.

There are two elements to the premium university education creates: one that accrues to each graduate personally (the ‘personal graduate premium’) and one that accrues to the companies they work for whose profitability is improved by using the graduate’s skills.

The ‘personal graduate premium’ includes any additional lifetime earnings achieved through university education minus the costs of obtaining a degree and any taxes paid on the extra earnings. The total economic contribution of graduates is the sum of their tax contribution, their additional earnings and corporate profits. The difference between the personal graduate premium and the total economic contribution of graduates is illustrated in Figure 3-1.

Figure 3-1 Personal Graduate Premium Vs Total Economic Contribution



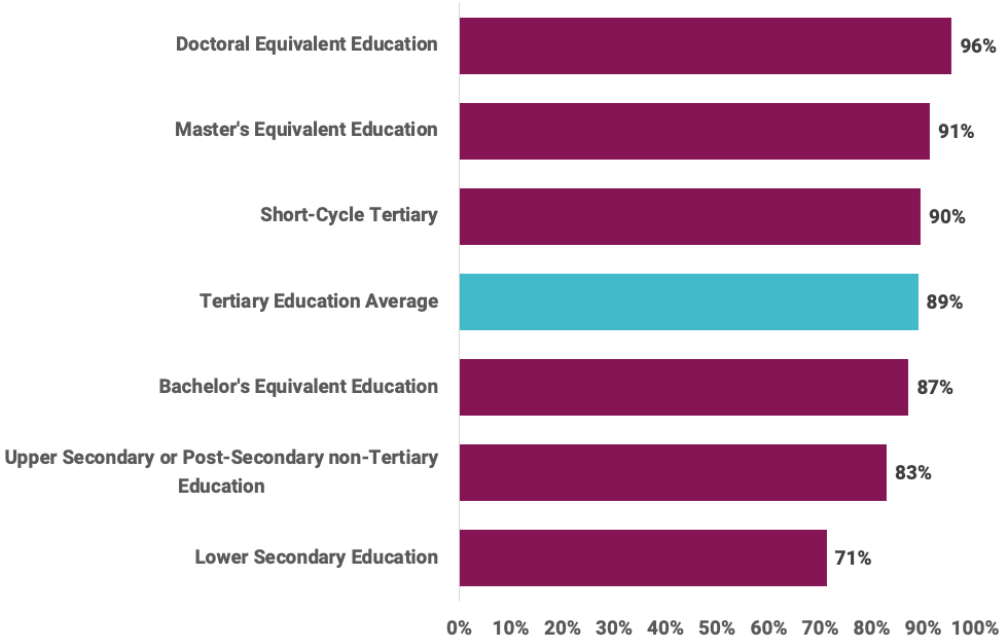
Source: BiGGAR Economics

Since it is not possible to accurately calculate the benefits to individual company profitability and national productivity from employing graduates, the method used here reflects only the personal benefit to graduates from studying at university. As a result, it is a conservative underestimate of the total economic impact associated with increased graduate productivity.

Over their lifetimes, graduates are also more likely to be employed than those without a university education[4]. As shown in Figure 3-2, the employment rate within the working age population (16-64 years of age) is larger across those with tertiary education (89%) than those with upper secondary education (83%). The effect is even more marked when considering those holding a master's or doctorate qualification.

[4] OECD (2022), Netherlands: Overview of the Education System (EAG 2022).

Figure 3-2 Employment Rate by Educational Attainment (16-64 Years Old)



Source: OECD (2022), Educational Attainment and Labour Force Status, Netherlands.

Therefore, the decision to go to university not only means that graduates are more productive when they are employed, but they are also more likely to be in employment than individuals who chose not to go to university. Although not quantified in this section, the increase in labour market participation by graduates is also a benefit to the economy.

The graduate premium captures the long-term contribution to economic activity made by those who graduated from the 4TU universities in 2021. As such, it should be understood as reflecting the lifetime earnings premium for an annual cohort of graduates (who graduated in 2021).

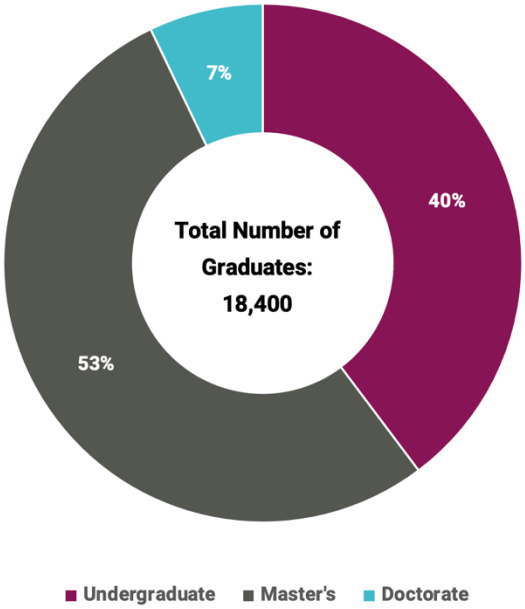
3.1.2 Estimating the Graduate Premium of 4TU Graduates

To estimate the graduate premium from 4TU graduates, it was necessary to gather data on two dimensions:

- the number of graduates by degree type and subject area; and
- the returns to different qualification levels across different study areas.

Based on data from the 4TU universities, around 18,400 students graduated from 4TU in 2021. The majority graduate with Master's degrees, which account for 53% of graduates, while Bachelor's degrees account for 40% and Doctorates account for the remaining 7%.

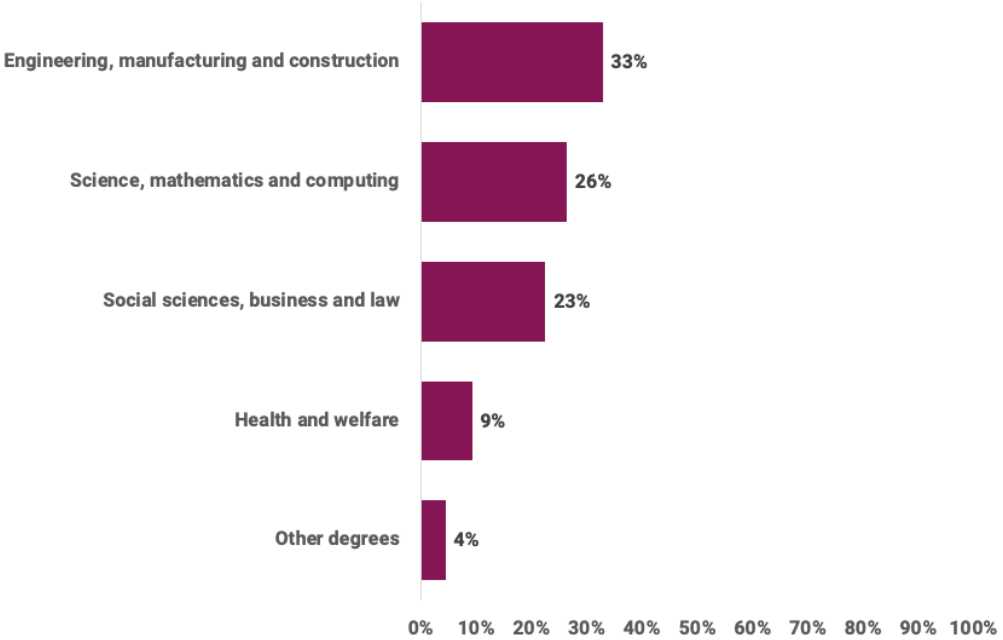
Figure 3-3 4TU Graduates by Degree Type



Source: BiGGAR Economics Analysis

Around 59% of graduates studied a degree in engineering, computing, mathematics, and science. The remainder of 4TU graduates mostly studied business-related subjects (23%), as shown in Figure 3-4.

Figure 3-4 Graduates by Subject Area, 4TU Universities



Source: BiGGAR Economics Analysis

The graduate premium is a well-researched subject. Information on graduate earnings is available from the OECD's Education at a Glance[5] data for 2019 and this can be used as a measure of the additional contribution graduates make to the Dutch economy each year, taking account of their degree subject.

Based on the OECD data, it was estimated that the net financial returns (private benefits minus private costs) from tertiary education in the Netherlands are €196,000. Adjustments were then made to account for the benefits arising from different levels of tertiary education (e.g., bachelor's, master's, or doctoral degrees). As earnings vary across professions, the returns to different degree types were estimated with reference to the mean monthly earnings of tertiary-educated adults, by field of education studied[6]. More details on the approach followed are set out in Appendix B.

Table 3-1: Graduate Premium by Award Type

	Earnings Premium at Bachelor Level (€)	Earnings Premium at Masters Level (€)	Earnings Premium at a Doctorate Level (€)
Teacher Training and Education Science	117,000	80,000	10,000
Humanities, Languages and Arts	114,000	78,000	10,000
Social Sciences, Business and Law	147,000	101,000	12,000
Science, Mathematics and Computing	147,000	101,000	12,000
Engineering, Manufacturing and Construction	155,000	107,000	13,000
Health and Welfare	120,000	82,000	10,000
All fields/mean	138,000	95,000	12,000

Source: BiGGAR Economics Analysis of OECD's "Education at a Glance"

As shown in Table 3-1 above, graduates from the 4TU universities are likely to have a higher earnings premium than those at other institutions. This is because graduates of the 4TU universities tend to have studied courses associated with relatively higher lifetime earnings (e.g. engineering, manufacturing and construction; and science, mathematics and computing).

To estimate the graduate premium, the number of students achieving each degree (by level) was multiplied by that subject's graduate premium (by level). The

[5] OECD (2019), Education at a Glance 2019

[6] Source: OECD (2020) Educational Attainment and Labour Market Outcomes by Skills.

proportions of graduates who leave the Netherlands on completion of their studies were then removed from the total.

In this way, it was estimated that the lifetime earnings premium associated with an annual cohort of graduates from the 4TU members is almost €2.0 billion GVA in the Netherlands. This impact is a productivity gain measured in terms of GVA, consequently it does not have an associated employment impact.

Table 3-2: 4TU Members Graduate Premium

GVA (€ million)	
	Netherlands
GVA (€ million)	1,967

Source: BiGGAR Economics Analysis

3.1.3 Challenge-Based Learning

Challenge-based learning is increasingly recognised as a way of increasing the impact graduates can make on society and the economy. It provides participants with an opportunity to work on important societal problems in multidisciplinary teams, together with companies and other organisations, such as hospitals and civic administrations. This connection between knowledge and its application to solve a problem is the essence of engineering. All of the 4TU members offer challenge-based learning for their students and the group has created a webinar series on the subject to share each other's best practice. Examples are given in Box 1.

Box 1: Challenge-Based Learning

At **TUDelft**, the 'Delft engineer' approach allows for more interdisciplinary group work, professional development, and the integration of new content on large societal challenges.

At **TU/e**, Innovation Space was founded almost ten years ago to develop knowledge and practice around challenge-based learning and the university is in the process of re-designing its bachelor curriculum to embed this as a curricula concept for all third-year students from 2023.

At **UT,** there is a challenge-based learning framework to guide staff in developing their curriculum and to guide students in defining their goals, investigate challenges and implement solutions with an authentic audience.

At **WUR**, students are offered extra-curricular challenges, such as the ReThink Protein and Urban Greenhouse Challenge, both of which have created important valorisation impacts in addition to learning benefits.

For illustrative purposes, a series of assumptions were made to estimate the potential productivity benefits from an increase in the number of graduates having undergone a challenge-based learning education. To ensure the robustness of this illustrative example, the analysis relies on conservative assumptions on both the number of students involved in challenge-based learning and the premium from similar courses compared to current provision.

The challenge-based learning approach is an important element of the provision across all four universities, especially at TU/e where the entire curriculum is going to be redesigned around this education format. Based on information from consultations with stakeholders, there are around 2,800 students per year in CBL at TU/e, equivalent to 26% of students. This same share was applied at the 4TU level, based on a future expansion in provision across all universities allowing for at least one in four 4TU students to experience challenge-based learning during their studies. On this basis it was assumed that 26% of future graduates (4,880) at the 4TU members will participate in challenge-based learning during their studies.

Participation in this type of challenge-based learning reduces the time graduates require to become fully proficient in their jobs. In this way, it has an impact on their productivity and earnings by shortening the time it takes for them to operate at a higher level of responsibility. For instance, evidence from consultations suggests that by teaching how to work in a project-based environment, challenge-based learning can lead to a shortening of the time it takes for a system engineer to become fully proficient in its work from 15 to 10 years. This has an impact on earnings' progression, with higher pay levels reached earlier in a graduate's career.

Based on this evidence, it was assumed for illustrative purposes that reducing the time it takes for graduates to be fully proficient in their jobs may lead to a 10% increase in their lifetime earnings. This may be a conservative assumption, as assessments of life-time earnings tend to discount benefits realised later in life more than those occurring earlier.

Multiplying the additional graduate premium by the number of graduates that may be involved in challenge-based learning, it was estimated that this could result in an additional €58 million in graduate premium compared to the current baseline. The benefit to the Dutch economy will be even greater as businesses and organisations will also benefit from the higher productivity of their graduate employees who undertook challenge-based learning.

3.2 Lifelong Learning

Lifelong learning is an important objective of the 4TU universities which recognises the changes required in workplaces as technological innovation reaches into the economy. There is a growing need for new knowledge and skills across all sectors of the Dutch economy to help it adapt to major social and economic issues like the energy transition and digitalisation, among others. For this reason, there is a growing need for education throughout people's careers.

Each university has its own approach to addressing this challenge, working with their regional partners to create solutions tailored to their local labour market conditions. All 4TU members have a commitment to lifelong learning. For example, UT's regional economy is characterised by large numbers of small and medium sized enterprises (SMEs). SMEs are recognised as having difficulties in accessing university services. In 2021 a design team at UT developed a roadmap for lifelong learning, seeing its approach as central in its commitment to pursue societal impact.

"Having societal impact means being able to reskill and upskill our alumni and other professionals to improve the economy and social wellbeing[7]"

3.2.1 Economic Impact from Lifelong Learning

Lifelong learning courses are designed to help working people develop new skills or update the existing skills they use. In 2021, the 4TU universities received an income of €5 million from delivering lifelong learning. The income received as a result of this provision was the starting point in estimating benefits from lifelong learning,

Businesses and organisations invest in lifelong learning because they expect it to generate positive returns. In the UK, a study for the government considered the impact of Regional Development Agency spending on businesses. One aspect considered was the GVA returns to business development and competitiveness interventions between 2002 and 2007. It found that interventions in science, research and development and innovation infrastructure had achieved a cumulative GVA impact equivalent to 340% of the cost of the projects. This increased to 870% when long-term benefits were considered.

This means that every €1 spent on lifelong learning would generate €3.40 GVA in direct economic benefit to businesses. Although the source relates to a UK study, the nature of this type of support is considered to be equally relevant to the Netherlands, therefore, it is appropriate to use the same multiplier in this situation.

Applying this rate of return to the total income received by 4TU members and taking account of appropriate multipliers to capture the effect of subsequent spending rounds, it is estimated that the lifelong learning delivered by 4TU contributes €38 million GVA to the national economy and supports 40 jobs each year. As the impact of lifelong learning comes from an increase in the productivity of course participants, increases in GVA associated with this activity do not directly translate to increases in employment. The only effects on employment relate to the additional spending of businesses where lifelong learners work, due to increased production and any benefits from lifelong learners' additional spending in the economy.

[7] University of Twente: A Roadmap Towards a coherent UT Outlook on Lifelong Learning (Titel (utwente.nl)

Table 3-3: 4TU Lifelong Learning Impact

GVA (€ million)	
	Netherlands
GVA (€ million)	38
Employment	
Jobs	40

Source: BiGGAR Economics Analysis

In addition, over 2021 the 4TU universities had a total 440,000 participants enrolled in Massive Open Online Courses (MOOCs). This form of education supports distance learning and the development of skills beyond the Netherlands. In this way, it contributes to the international standing of the 4TU universities.

3.3 Student Internships

Internships are of great benefit to students, to the business or organisation they are placed with and to the host university by encouraging wider engagement with employers. Students often enhance their employability through internships and they can lead to more permanent employment opportunities on completion of studies. They also create an impact on the economy through the contribution they make to the organisations they are placed with.

Over the course of 2021, 1,540 internships took place for students at the 4TU universities. This was considerably less than in a 'normal' year, as internships were affected by restrictions associated with the Covid-19 pandemic, which made it more complex for students to be placed within companies.

In addition to benefitting the interns and their universities, businesses benefit through:

- the work interns undertake which helps businesses to implement new procedures or carry out specific projects;
- having preferential access to new potential employees, facilitating the recruitment process and securing talent;
- the fresh perspective students bring which can stimulate organisations to work in a different way, creating changes which may be difficult to achieve otherwise;
- the new experiences and skills the interns introduce to existing staff; and
- the deeper relationships they facilitate between the host organisations and the academic sector.

The value of an internship depends on several factors including its duration, the skills of the intern and the nature of the work. In this case, the value has been estimated based on the amount of time the students spend with the business or host organisation. Although the duration varies by university and by course, for this analysis, only internships of 12 weeks or longer were considered. Placements lasting

less than 12 weeks were assumed to be observational in nature and would not lead to a change in the hosts' capacity to deliver its goods or services.

Finally, it was assumed that internship students are less productive than full-time employees because they have less experience and require more supervision. Therefore, they are assumed to contribute one-half of the GVA achieved by an average worker in the same industry. Using these core assumptions and applying appropriate multipliers to capture the indirect effect, the student internships organised by the 4TU universities contribute an estimated €25 million GVA to the national economy and support 260 jobs.

3.4 Summary Learning Impacts

The learning impacts created by the 4TU members support €2.0 billion GVA and 300 jobs across the Netherlands each year. This includes the lifetime earnings premium received by the annual cohort of graduates, the lifelong learning the 4TU members deliver and the internships that take place.

Table 3-4: 4TU Members – Summary Learning Impact

GVA (€ million)	Netherlands
Graduate Premium	1,967
Lifelong Learning	38
Student Internships	25
Total	**2,030**
Employment	**Netherlands**
Student Internships	260
Lifelong Learning	40
Total	**300**

Source: BiGGAR Economics Analysis

4. Valorisation Impacts

Valorisation draws the benefits of 4TU's research and teaching expertise into society, fostering economic growth.

Research provides a pipeline of knowledge. Where this is disseminated into society to create value, academic research fuels innovation. Each of the 4TU members has a keen focus on valorisation, with significant investment in people, structures and activities that are targeted at creating societal impact. WUR's Corporate Value Creation team describes this process succinctly:

"By building bridges between knowledge, the business community and society and by applying the results of scientific research in products, technology and services, Wageningen University & Research (WUR) is able to create value far beyond the boundaries of science."

Source: WUR, Corporate Value Creation, 2021 in highlights

For each member of 4TU, valorisation outcomes are supported by highly experienced technology transfer staff and facilities. Research findings are translated into the economy through several routes, including research collaboration with private firms and public organisations, creating spin out businesses to commercialise research, providing services to businesses, science parks and incubators, and licensing intellectual property. Together these create benefits through increased productivity, employment, and societal impacts.

4.1 Research

The 4TU universities focus on key enabling technologies that are fundamental in tackling grand societal challenges. The resulting societal benefits, which include economic impacts, are built on the foundations of world-leading research. Each 4TU university is an academic powerhouse, without whose fundamental research strengths there simply would be no impact. Each has several faculties leading core areas of academic research as well as institutes focused around individual research strengths.

None of this research is undertaken in isolation. There are strong research relationships among the 4TU universities and also between them and academic,

commercial and civic partners in the Netherlands and around the world. This ensures academic research undertaken within the 4TU universities is connected throughout the system and forms a vital underpinning mechanism for the Dutch economy. The role of the 4TU universities in driving this systems approach to the economy is discussed in Chapter 8.

4.2 Spin-outs and Start-ups

Entrepreneurship is a strong theme running throughout each 4TU member. Entrepreneurship education and research ensures that thinking and acting as an entrepreneur is supported through modules and courses within undergraduate and post graduate curricula, as well as through research activity. Each university provides support for students and staff, whose start-ups and spin-outs are housed in incubators and accelerators, and nurtured by technology transfer staff with a wealth of experience and expertise.

In 2021, there were an estimated 380 spin-out and start-up companies from the 4TU members. Based on the data provided, they employed 33,040 staff and their combined annual turnover is estimated at € 2.9 billion.

Only those companies for which employment data was provided or could be sourced were included in the analysis. This figure is therefore likely to underestimate the extent of 4TU members' spin-out and start-up activity. All spin-off and start-up companies created in 2021 or earlier that continue to be active in 2021 have been included in this impact. This is because companies created prior to 2021 (regardless of how long ago they were created) are still generating turnover and employing staff in 2021.

The total GVA and employment impact spin-outs and start-ups create reflects their own employment and income, plus the impact of their staff spending and the impact they generate throughout their supply chains. This is calculated based on appropriate ratios and multipliers for the sectors in which they each operate. By applying these factors, it is estimated that spin-out and start-up companies associated with the 4TU universities generate €320 million GVA and support 2,360 jobs in the Netherlands.

Table 4-1: 4TU Universities – Impact from Spin-Outs and Start-Ups

GVA (€ million)	
	Netherlands
GVA (€ million)	320
Jobs	2,360

Source: BiGGAR Economics Analysis

4.3 Services to Businesses

The 4TU universities facilitate knowledge transfer through their interactions with businesses. This can take different forms across the 4TU members but broadly includes:

- €4.3 million income from consultancy work for businesses or public organisations;
- €293.8 million income from commissioned research[8]; and
- €1.9 million income from access to facilities and equipment at the universities.

During the course of a year, these services generate an income of €300 million for the 4TU universities. The 4TU members do not all provide these services and therefore only income from the services they do provide has been included here.

Businesses and public organisations expect this type of investment to generate positive returns, either by increasing staff productivity, by developing new products, services and processes or by improving existing products, services and processes.

Often, it can take several years to produce tangible results from academic engagement. For example, in 2012, Danish consultancy DAMVAD[9] conducted a study on the economic impact realised by companies collaborating with the University of Copenhagen and the results showed that impacts are realised gradually. Six years after the collaboration, companies which had engaged with the University on research and development projects were 15.8% more productive than those which had not.

The value organisations gain from research collaborations will vary between projects based on the type of work done, the stage in the development process the project relates to and the capacity of companies or organisations to absorb the results from the collaboration. Since detailed information on the returns achieved for individual projects is not available, it has been necessary to estimate what the value would be to a company or organisation based on typical returns from this type of academic interaction.

The 340% assumption used in section 3.2.1 for calculating the impact on business turnover from investing in lifelong learning can equally be applied in this case[10] since research and consultancy interactions with the 4TU universities are similar in nature to those measured by the DBERR study. This is a cautious approach and may well underestimate the real impact of these interactions.

[8] Commissioned research refers to any income to the 4TU members from work commissioned by third parties, including work commissioned by companies and other non-profit organisations. This is likely to take a collaborative form though the exact nature of this activity will differ from one member to another.
[9] DAMVAD (2012), Measuring the Economic Effects of Companies Collaborating with the University of Copenhagen.
[10] PriceWaterhouseCoopers, Impact of RDA spending – National report – Volume 1 – Main Report, March 2009, DBERR

The sectoral split of companies engaging with the 4TU universities was estimated based on data provided. These have been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects. In this way, it is estimated that the 4TU universities generate €2.5 billion GVA and support 3,840 jobs in the Netherlands by providing research and consultancy services to businesses and public organisations.

Table 4-2: 4TU Universities – Services to Businesses

GVA (€ million)	
	Netherlands
GVA (€ million)	2,516
Employment	
Jobs	3,840

Source: BiGGAR Economics Analysis

4.4 Science Parks and Incubators

The 4TU universities support a range of science parks, business incubators, accelerators, field labs, and experimental farms. These have a variety of legal structures, operational models, and physical forms. All are embedded in regional partnerships and drive ecosystems and they are described in more detail in Chapter 8. Together, they provide a significant economic asset for the Dutch economy.

An important part of the success of science parks and incubators is due to the academic partners involved. Without them, they would simply be a collection of businesses with little incentive or stimulus to collaborate. Science parks generate economic benefits by increasing the level of economic activity as well as attracting more companies to the area. For these reasons, it is appropriate to include their value within an assessment of university economic impact.

Data provided by 4TU members indicates there are 48,610 employees across the science parks and incubators supported by 4TU members. Unlike spin-off companies, most of the businesses employing these staff would exist in some form even if the science parks did not, meaning that it would not be appropriate to attribute all the economic impact of these businesses to the universities. If the science parks did not exist, some of the businesses may have chosen to locate elsewhere in the Netherlands or outwith the Netherlands. However, it is likely that colocation with a 4TU member has enabled many of these businesses to achieve higher levels of growth than would otherwise have been possible.

In assessing the economic contribution of science parks and incubators, it was necessary to consider both of these factors and come to a view about the extent to which this impact is additional. Further detail about the approach is provided in Appendix B. Having accounted for the additionality of this impact, it was estimated

there are 14,750 employees at the science park and incubator facilities associated with 4TU members that have not been considered elsewhere in this study.

The total GVA and employment impact they create reflects their own employment and income, plus the impact of their staff spending and the impact they generate throughout their supply chains. This is calculated based on the appropriate ratios and multipliers for the sectors they operate in. By applying these factors, it is estimated that the involvement of the 4TU universities in science parks and incubators generates €1.5 billion GVA and supports 15,660 jobs in the Netherlands.

Table 4-3: 4TU Universities – Science Parks and Incubators

GVA (€ million)	
	Netherlands
GVA (€ million)	1,521
Employment	
Jobs	15,660

Source: BiGGAR Economics Analysis

4.5 Licensing

One of the ways in which the 4TU universities' research can be translated into economic activity is through licensing agreements with industry. These give companies the legal right to use technology or intellectual property developed at the universities to generate additional sales, reduce costs or otherwise improve productivity. In return, companies pay royalties to the universities. Around €2 million is received by the 4TU members in royalties over the course of a year and 99% of the licence holders are based in the Netherlands.

Table 4-4: Licensing Income, 4TU Universities

	Value
Total licensing income in 2021, € million	2
% of income from clients based in the Netherlands	99%

Source: BiGGAR Economics Analysis

The relationship between the royalty paid for a technology and the turnover it generates for licensees depends on the details of individual licensing agreements, which can vary considerably. To agree on a licensing deal, negotiators form a view of how much the intellectual property is worth to the prospective licensee. This is often guided by the '25% rule' which is based on an empirical study by the late Robert Goldscheider, first undertaken in the 1950s and updated in 2002[11]. The study found

[11] R. Goldscheider et al, Use of the 25 Per Cent Rule in Valuing IP, December 2002

that royalty rates were typically around 25% of the licensee's profits which represent around 5% of total turnover generated by licensed technology.

By applying the 5% rate based on the Goldscheider analysis, it is possible to estimate the increased turnover the licensed technologies generate. This figure has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects.

In this way, it is estimated that the 4TU members generate €57 million GVA and support 590 jobs in the Netherlands through their licencing activities.

Table 4-5: 4TU Universities - Licensing Impact

GVA (€ million)	
	Netherlands
GVA (€ million)	57
Employment	
Jobs	590

Source: BiGGAR Economics Analysis

4.6 Summary of Valorisation Impacts

Taken together, the 4TU universities create a valorisation impact of €4.4 billion GVA and support 22,450 jobs in the Netherlands. This likely to underestimate the true economic impact, because each 4TU member is focused on societal impact, rather than financial return. This means they consider how intellectual property is most likely to generate solutions to societal challenges and seek opportunities to make those solutions a reality. Because our economic impact calculation is based in part upon financial returns to the universities, it does not capture the more creative and non-cash generating opportunities pursued by 4TU members to see their intellectual property reach the market.

Table 4-6: 4TU Universities – Summary Valorisation Impact

GVA (€ million)	Netherlands
Spin-Outs and Start-Ups	320
Services to Businesses	2,516
Science Parks and Incubators	1,521
Licensing	57
Total	**4,414**
Employment	**Netherlands**
Spin-Outs and Start-Ups	2,360
Services to Businesses	3,840
Science Parks and Incubators	15,660
Licensing	590
Total	**22,450**

Source: BiGGAR Economics Analysis

5. Operational Impacts

As large employers with extensive supply chains and a significant number of students, the 4TU universities have a sizeable economic footprint within the Netherlands.

5.1 Core Impacts

The 4TU members generate economic activity through:

- direct impact – the income they receive and the staff they employ;
- supply chain impact – through expenditure on goods and services;
- staff spending impact – from salaries being spent in the economy; and
- capital expenditure impact – from investment in capital infrastructure.

5.1.1 Direct Impact

The direct impact is the value an organisation adds to the economy through its own operations. In the context of universities, this can be estimated as the difference between total income and total supply spending.

In 2021, the 4TU members generated an annual income of €2.5 billion. Over the same period, they collectively spent €580 million on goods and services. This generated a direct impact of €1.9 billion GVA and 27,890 jobs.

5.1.2 Supply Chain Impact

As large and complex organisations, university supply chains have an impact on the wider economy by increasing turnover and supporting employment with their suppliers.

Over the course of 2021, the 4TU members spend around €580 million on goods and services. This expenditure excludes any spending on capital investments, as this is estimated separately in Section 5.1.4. An estimated 90% of supply chain expenditure went to suppliers located in the Netherlands based on data provided by the 4TU members. This has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects.

5.1.3 Staff Spending

Staff who work for the 4TU members have an impact on the wider economy by spending their wages and salaries in the areas where they live.

It is estimated that the 27,890 staff employed receive around €1.7 billion in salaries, wages and other staff costs each year. 97% of those working for the 4TU members live in the Netherlands. This has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects.

5.1.4 Capital Spending

Capital investments made by the 4TU members have an impact on the construction sector and others that supply capital equipment. As capital spending fluctuates from year to year, an average value was derived based on actual capital spending for the past five years (2017-2021) and forecast capital spending over the coming five years (2022-2026).

By this method it is estimated that, in an average year, the 4TU members invest around €259 million on capital projects, including buildings, machinery and IT infrastructure. This expenditure is in addition to the supply chain expenditure of 4TU members, discussed in Section 5.1.2. It was assumed that the share of capital spending benefiting businesses in the Netherlands was the same as spending on supplies. This has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects.

By this method, capital expenditure by the 4TU members is estimated to create an impact of €288 million GVA and support 2,740 jobs in the Netherlands each year.

5.1.5 Summary of Core Contributions

Summing up the economic impact generated by core activities, it is estimated that the 4TU universities support €4.9 billion GVA and 59,140 jobs in the Netherlands each year. A summary of annual impact by source is provided in Table 5-1.

Table 5-1: 4TU Members – Summary of Core Impacts

GVA (€ million)	Netherlands
Direct Impact	1,901
Supply Chain Impact	716
Staff Spending Impact	2,002
Capital Spending Impact	288
Total	**4,907**
Employment	**Netherlands**
Direct Impact	27,890
Supply Chain Impact	9,360
Staff Spending Impact	19,140
Capital Spending Impact	2,740
Total	**59,140**

Source: BiGGAR Economics Analysis. NOTE: Figures may not sum due to rounding.

5.2 Student Impacts

This section discusses the economic impact of the day-to-day spending and working habits of students attending courses at the 4TU universities. The focus is on full-time students, as the spending patterns and labour market contribution of part-time students is mostly driven by their work rather than their study.

5.2.1 Student Population

In 2021, there were 67,370 full-time students enrolled at the 4TU universities on all higher education courses. The breakdown of students between the level of courses they are enrolled on is shown in Table 5-2. Doctorate students have been considered as members of staff and their impact is included in the core contribution of the 4TU universities.

Table 5-2: 4TU Universities - Student Numbers

	Full-time Students
Bachelors	34,450
Masters	30,860
Other	1,960
Total	**67,370**

Source: BiGGAR Economics Analysis. NOTE: Figures may not sum due to rounding.

5.2.2 Student Spending Impact

The student spending is estimated based on:

- where they live – data from Eurostudent[12] suggests that around 57% of students live in rented accommodation either at the Universities or in the private sector. The remainder live with parents or guardians; and
- spending patterns – which are estimated with data from Eurostudent.[13]

[12] Eurostudent (2022), Students' Housing Situation 2018-2021 Aggregated data
[13] Eurostudent (2022), Student Spending Data 2018-2021

Table 5-3: Monthly Student Expenditure (€)

	Living with Parents	Not Living with Parents
Accommodation	112	478
Food	132	216
Transportation	49	60
Communication	33	34
Health	94	94
Childcare	0	4
Debt Payment	2	6
Social and Leisure Activities	102	112
Other Living Costs	96	93
Other Study Related Costs	77	53
Total	**696**	**1,149**

Source: Eurostudent (2022), Student Spending Data 2018-2021 NOTE: Figures may not sum due to rounding

Collectively, the annual expenditure on living costs and rent for all full-time students at the 4TU universities amounts to €701 million. This has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects. It is estimated that student expenditure supports €1.1 billion GVA and 10,780 across the Netherlands each year.

5.2.3 Student Part-time Working Impact

Students have an impact on the economy by working part-time to support their studies. Often these jobs are in the hospitality and retail sectors, providing the additional labour some businesses require to support their economic activity. Some 4TU universities provided estimates of the proportion of their students who worked part-time. Where no estimate was provided, an assumption of 47% was used based on data from Eurostudent.[14] Not all these jobs will be additional as some may displace employment from non-students and the rate of additionality has been adjusted according to the prevailing rate of youth unemployment in each area.

Based on data from Eurostudent,[15] it is further assumed that students in part-time jobs work for 15 hours per week on average. The impact of their collective working activity has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects. It is estimated that student part-time work supports €225 million GVA and 9,860 jobs across the Netherlands each year.

[14] Eurostudent (2022), Students' employment during the current lecture period, 2018-2021
[15] Eurostudent (2022), Time spent on Paid Jobs, 2019-2021 aggregated data

5.2.4 Student Volunteering

Students contribute to the output of voluntary and educational organisations by providing their time and skills for free, enabling charities and other third sector organisations to undertake activities they might not otherwise be able to do. Based on survey evidence provided by one of the Universities, it was estimated that 40% of students take part in volunteering. Evidence from CBS[16], indicates that volunteers spend around 3.7 hours volunteering. As with part-time work, it was assumed that students volunteered in the areas where they lived. This has been converted into GVA and employment impacts by applying appropriate ratios and calculating multiplier effects. It is estimated that student volunteering supports €46 million GVA across the Netherlands each year.

5.2.5 Summary Student Contribution

The student communities at the 4TU universities, are estimated to contribute €1.3 billion GVA and support 20,640 jobs in the Netherlands each year.

Table 5-4: 4TU Members – Summary of Student Impacts

GVA (€ million)	Netherlands
Student Spending Impact	1,064
Student Part-Time Working Impact	225
Student Volunteering	46
Total	**1,335**
Employment	**Netherlands**
Student Spending Impact	10,780
Student Part-Time Working Impact	9,860
Total	**20,640**

Source: BiGGAR Economics Analysis

5.3 Tourism Impacts

5.3.1 Visits to Graduations and Open Days

The 4TU universities have an impact on tourism through hosting graduations and organising open days for prospective students. This visitor expenditure is additional to the area and generates economic activity that would not have occurred otherwise.

5.3.2 Conferences and Events

Conferences, events and graduations hosted by the 4TU universities also generate short-term economic impacts by drawing visitors to the area. It is estimated that around 110,000 visitors attend conferences and events organised by the 4TU universities each year.

[16] CBS (2020), Fewer Young Volunteers in 2019

5.3.3 Visits to Staff and Students

Friends and relatives who visit staff and students at the universities make an economic contribution by going to areas they would not normally have visited. In this sense, their expenditure is additional to the area and would not have happened without the universities.

5.3.4 Summary Tourism Contribution

The economic impact associated with tourism-related activities stimulated by the 4TU universities support €16 million GVA and 210 jobs across the Netherlands each year.

5.4 Operational Impact Summary

The collective operational impact of the 4TU universities is summarised in Table 5-5. It is estimated that they generate €6.3 billion GVA and support 102,740 jobs in the Netherlands over the course of a year from operational activities.

Table 5-5: 4TU Universities – Summary Operational Impact

GVA (€ million)	Netherlands
Core Impact	4,907
Student Impact	1,335
Tourism Impacts	16
Total	**6,258**
Employment	
Core Impact	59,140
Student Impact	20,640
Tourism Impacts	210
Total	**102,740**

Source: BiGGAR Economics Analysis (Note: Figures may not sum due to rounding.)

6. Summary Quantitative Impacts

Collectively, the 4TU universities generate an economic contribution of €12.7 billion and support 102,740 jobs in the Netherlands.

6.1 Purposeful and Operational Impacts

The contributions associated with the 4TU members can be grouped into two main categories: purposeful impacts and operational impacts.

Purposeful impacts are associated with the nature of the activity undertaken by the Universities and reflect outcomes designed specifically to drive innovation and productivity growth within the economy. In a sense they measure the wider value the Universities bring beyond their impact as large employers with a significant supply chain. In this way, the following impacts can be thought of as purposeful:

- the learning impacts delivered by the Universities through their graduates who contribute to the productivity of the economy as a result of the skills and experience they gain during their time at university, from the internships they support and from the lifelong education and training they deliver; and
- valorisation of research by the 4TU members through conducting industrial research and development, by supporting innovation and businesses creation, by influencing the growth of science parks and by licensing their intellectual property.

For the 4TU universities, 51% of their GVA impact and 22% of their employment impact can be thought of as purposeful.

Operational impacts result from the existence of any large organisation with a significant staff complement, an extensive supply chain and a large consumer base. These types of impacts occur regardless of the nature of the business or organisation and for this reason are thought of as operational impacts. In the case of the 4TU universities these include:

- the core operational effects of the 4TU universities, including the people they employ, their expenditure and that of their employees on goods and services and their expenditure on physical capital and research infrastructure;
- the effects generated by students at the member organisations including the impact of student expenditure on the economy and the contribution that students make to the local economies in which they live by working or undertaking voluntary activity during the course of their studies; and

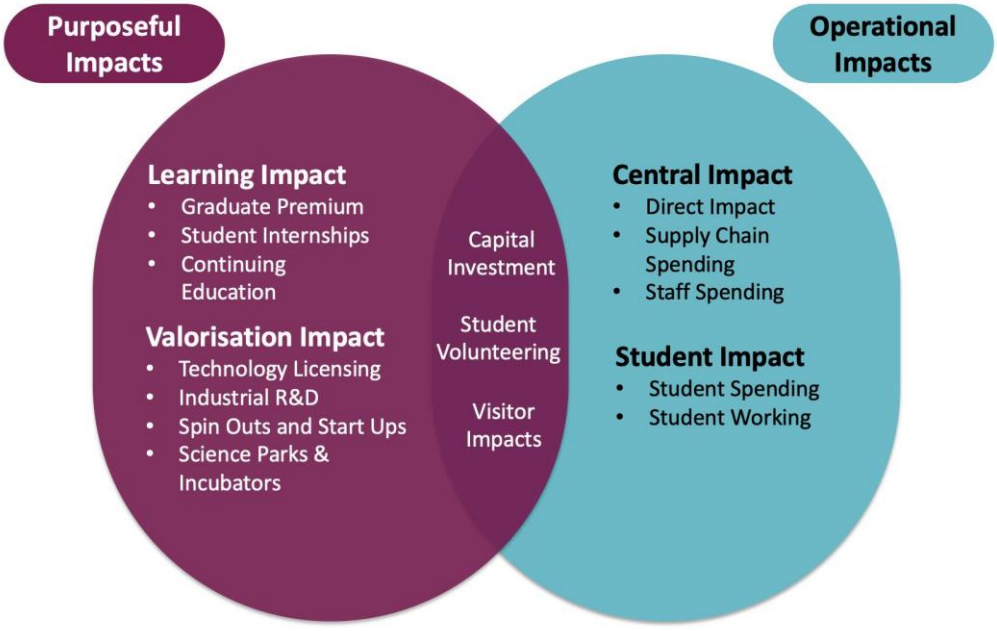
- the contribution to the tourism sector made by visitors to staff and students at the 4TU universities.

For the 4TU universities, 49% of their GVA impact and 78% of their employment impact can be thought of as operational.

The division between purposeful and operational impacts is illustrated in Figure 6-1 which shows the split is not always clear-cut. For example, some tourism impacts are associated with conferences and events which are directly related to core areas of research or knowledge exchange activity. Similarly, students who decide to volunteer often do so independently of the universities, but their ability to do so may rest on skills or knowledge gained during their work or studies. The impact of capital spending also creates a purposeful impact in creating new facilities, however it only happens to support the core activity.

In reality these crossover areas are relatively small impacts, representing only around 3% of the total impact generated by the Universities. They have been included in the totals for operational impacts throughout the report.

Figure 6-1: Purposeful and Operational Impacts



Source: BiGGAR Economics

The distinction between purposeful and operational impact is a useful framework for analysing the impacts to reflect more insightfully the true contribution of the Universities to economic development. It has been used throughout this and the individual member reports to summarise and describe the impacts they create.

Table 6-1: Total Economic Impact of 4TU Universities

GVA, € million	Netherlands
Purposeful Impact	
Learning Impact	2,030
Valorisation Impact	4,414
Sub-total (Purposeful)	**6,444**
Operational Impact	
Core Impact	4,907
Student Impact	1,335
Tourism Impact	16
Sub-total (Operational)	**6,258**
Total	**12,702**
Employment	
Purposeful Impact	
Learning Impact	290
Valorisation Impact	22,450
Sub-total (Purposeful)	**22,740**
Operational Impact	
Core Impact	59,140
Student Impact	20,640
Tourism Impact	210
Sub-total (Operational)	**79,990**
Total	**102,740**

Source: BiGGAR Economics Analysis (Note: Figures may not sum due to rounding.)

7. Societal Impacts

The 4TU universities pursue sustainable development, contribute to a resilient economy and act as regional anchor institutions.

The benefits created by the 4TU universities are far wider in scope than can be measured through the GVA and jobs impacts highlighted in the quantitative analysis presented above. They supply skills and knowledge required to solve huge societal challenges, valorising these so that solutions reach society. The economic development they pursue is sustainable, with the UN Sustainable Development Goals a focus for much of their activity. The universities provide a key mechanism in ensuring economic resilience in these challenging times, and also act as regional anchor institutions, becoming defining parts of the places to which they belong.

7.1 4TU and Sustainable Development

All 4TU members are guided by the UN's Sustainable Development Goals (SDGs) as a focus for their research activity. These are a shared blueprint for peace and prosperity for people and the planet and address the fundamental challenges of our time. Working towards them will protect the planet and improve society for current and future generations.

The role of technology in delivering the SDGs is fundamentally important. According to a study by the World Economic Forum, if technological innovation is employed, we could make progress with two-thirds of the 169 targets within the Sustainable Development Goals[17]. Each 4TU member publishes information about how their work makes a positive contribution towards the SDGs and while beyond the scope of this study, it should be noted that 4TU members tell important stories about how they contribute across SDG themes. The economic benefits described throughout this report are just a part of this overall impact.

7.2 Economic Resilience

The focus of this report is on the economic benefits created by the 4TU universities, one part of the overall societal impact they deliver. The role played by universities in driving economic development has long been recognised, and for decades economists have been evidencing the importance that high-level skills and innovation have in boosting economic competitiveness and addressing inequalities in society. In the 1950s, Robert Solow's work demonstrated that the long-run growth rate depended on increases in productivity. In the 1960s, Kenneth Arrow's research showed that almost all economic growth could be accounted for by innovation.

[17] World Economic Forum (2020) Unlocking Technology for the Global Goals, https://www.weforum.org/reports/unlocking-technology-for-the-global-goals

Building on this, Joseph Stiglitz, has shown that productivity is the result of learning and, so a focal point of policy should be to increase learning within the economy.

BiGGAR Economics conducted an analysis of international statistics published by the World Bank (2020)[18] and the OECD (2019)[19] to test the theory that investment in education results in better rates of economic growth[20]. Data were reviewed for a sample of economies in Europe, North America and Oceania. The analysis found that across 19 countries[21], investment in higher education is correlated with:

- higher levels of Gross Domestic Product (GDP) per capita;
- higher growth in GDP per capita over time;
- higher rates of labour force participation; and
- lower rates of youth unemployment.

Spending on higher education across advanced economies is positively associated with a country's economic performance

Universities support economic performance and they are fundamental to a country's economic resilience. The Covid-19 pandemic has delivered the greatest shock to the global economy in modern times and, in parallel, it has brought a rare opportunity to build back a better economic future. In this context, universities have a powerful, long-term role in strengthening economic resilience in a way which is sustainable, equitable and transformative. This view is supported by influential global policy makers who have identified investment in education and research as priorities for long-term fiscal recovery, which will also support the desired focus on a green transition that is a shared goal in most advanced economies[22]. The transformative role universities can play in this context include:

- securing and providing high quality employment;
- providing the human and intellectual capital necessary for both economic recovery and transformation;
- driving innovation for new and existing businesses and public sectors;
- reducing and avoiding youth unemployment;
- building the resilience of public services, including the health and care sectors;
- supporting the net zero challenge and the green recovery, helping to provide the intellectual and human capital on which it will be based;

[18] World Bank (2020), World Development Indicators
[19] OECD (2019) Education at a Glance
[20] BiGGAR Economics (2020), Universities in Advanced Economies: Recovery and Transformation, Productivity Growth and Fiscal Returns, for Universities Scotland
[21] USA, Canada, South Korea, Australia, United Kingdom, Finland, New Zealand, Austria, Netherlands, Norway, Sweden, France, Belgium, Japan, Portugal, Iceland, Spain, Germany and Italy.
[22] Hepburn, C., O'Callaghan, B., Stern, N., Stiglitz, J., and Zenghelis, D. (2020), 'Will Covid-19 fiscal recovery packages accelerate or retard progress on climate change?', Smith School Working Paper 20-02

- providing leadership in economies as well as in wider civic society; and
- rebuilding the tax base to help ensure a net positive fiscal return which will help to pay for the cost of government assistance.

Universities have a crucial role to play in any advanced economy and they are particularly important in a time of uncertainty and change, which is the nature of the current economic climate. To be sustainable and resilient, economic recovery and transformation needs to be based on human and intellectual capital, knowledge and innovation. The 4TU members have an especially important function in this respect, as they drive solutions to society's biggest technical challenges – including climate change, digitalisation, and the energy transition.

7.3 Regional Anchors

As large employers, the 4TU universities have an impact on and within their local areas because of the number of people they employ, their land and infrastructure assets, spending power, the nature of their services and the ways in which they interact with their communities. The notion of universities as anchor institutions is an accepted tenet of economic policy[23].

The 4TU universities have a sizeable economic footprint in their regions

The annual economic impact of the 4TU universities at a national level in 2021 was €12.9 billion GVA and over 107,000 jobs, and a great deal of this impact accrues to the regions in which each university sits.

Each 4TU university is an economic powerhouse at the heart of its region. However, the part played by each university in supporting its region goes beyond what can be expressed in terms of GVA and jobs alone. Each institution uses its assets to create a wide array of economic and social value. There are deep connections into local communities, businesses, schools, colleges, the health system, local authorities and other public bodies.

Collaboration is at the heart of each 4TU university's contribution to regional economic development. They have strong relationships with partners, working together to address priority needs in the economy and society, including raising productivity through innovation support, forming new businesses, and addressing skills needs. Fundamentally, they are ecosystem builders, a role which is described in the following chapter.

[23] Harris, M., Holley, K. (2016). Universities as Anchor Institutions: Economic and Social Potential for Urban Development. In: Paulsen, M. (eds) Higher Education: Handbook of Theory and Research. Higher Education: Handbook of Theory and Research, vol 31. Springer, Cham. https://doi.org/10.1007/978-3-319-26829-3_8

8. 4TU Innovation Systems

The Netherlands performs well as an environment where innovation ecosystems can thrive and the 4TU universities are the driving force behind these.

The Netherlands was ranked fourth in Europe and sixth globally (out of 132 countries) for its innovation ecosystems in the 2021 Global Innovation Index (GII) [24]. Among high income countries, its performance is above expectations for its level of development. One of the strengths cited is the Netherlands' knowledge and technology outputs, and there is little doubt of the importance of the 4TU universities in delivering these.

Each 4TU university is an innovation system in its own right. Systems thinking has its origins in biology and engineering a century ago and spread to many other areas of science. The innovation process takes place in a complex system in a state of constant change and so systems thinking is essential for understanding the innovation system and improving it to meet challenges and opportunities which are presented.

There are many definitions of innovation systems and innovation ecosystems, with the terms often used interchangeably. Some focus narrowly on businesses in a particular sector competing and collaborating whilst others are broader, also recognising the interdependence of innovation and skills development.

One of the most useful is the Systems of Innovation approach developed in Sweden by Professor Charles Edquist, which is influenced by the successful innovation systems in the Nordic countries in particular. Whilst taking a systemic approach it identifies the main determinants of innovation processes, that is the main parts of the system that need to interact and work together (Figure 8-1).

[24] World Intellectual Property Organisation, 2022, Global Innovation Index 2021, 14th Edition

Figure 8-1: Determinants of Innovation Processes

I. Provision of knowledge inputs to the innovation process
Provision of R&D and, thus, creation or recombination of new knowledge, primarily in engineering, computer sciences, medicine, life sciences and natural sciences.
Competence building, e.g. through individual learning (educating and training the labour force for innovation and R&D activities) and organisational learning.
II. Demand-side activities
Formation of new product markets.
Articulation of quality requirements emanating from the demand side with regard to new products.
III. Provision of constituents for Systems of Innovation (SIs)
Creating and changing organisations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms; and creating new research organisations, policy agencies, etc.
Networking through markets and other mechanisms, including interactive learning among different organisations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.
Creating and changing institutions e.g., patent laws, tax laws, environment and safety regulations, R&D investment routines, cultural norms, etc. – that influence innovating organisations and innovation processes by providing incentives for and removing obstacles to innovation.
IV. Support services for innovating firms
Incubation activities such as providing access to facilities and administrative support for innovating efforts.
Financing of innovation processes and other activities that may facilitate commercialisation of knowledge and its adoption.
Provision of consultancy services relevant for innovation processes, e.g., technology transfer, commercial information, and legal advice.

Source: Edquist (2011)[25]

[25] Adapted from various publications from Professor Charles Edquist, Ruben Rausing Chair in Innovation Research at Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, Sweden, including Edquist (November 2011) Design of innovation policy through diagnostic analysis: identification of systemic problems or failures, in Industrial and Corporate Change

Edquist[26] has identified six strengths of the systems of innovation approach, all of which are present within the 4TU approach. These:

- place innovation and learning processes at the centre of focus;
- adopt a holistic and interdisciplinary perspective;
- employ historical and evolutionary perspectives, which makes the notion of optimality irrelevant;
- emphasise interdependence and non-linearity (with innovation not taking place in isolation but collaboratively);
- encompass both product and process innovations, as well as subcategories of these types of innovation;
- emphasise the role of institutions.

Within the Netherlands, the 4TU members are at the heart of important, global systems, stimulating the development of clusters and ensuring critical success factors for competitiveness are in place. They contribute strongly to the overall global performance of the Netherlands as a home for innovation systems and to their own thriving regional systems. These are complex systems, with nuanced features that underpin their success – entrepreneurial mindsets, long term personal and professional relationships, culture, and history.

8.1 TU Delft System

TU Delft is the largest of the 4TU universities by employment and income and it is based in a region which is recognised as having a strong ecosystem for entrepreneurship[27]. It is placed among the top 10 engineering and technology universities in the world and it ranks among the top 10 most innovative universities in Europe[28].

The scale of the TU Delft Campus presents a key economic asset for the region – it hosts over 41,000 researchers, entrepreneurs and students and is home to around 275 companies; including a large number of start-ups and scale-ups, corporates, research institutes, colleges, and the TU Delft itself as the heart of the campus. Activity delivered at the TU Delft Campus is shaping the future of robotics, AI, quantum, medical technology, energy transition, aerospace among other important areas.

The TU Delft Campus also hosts several incubators of which YES!Delft is a well-known leading European incubator offering 360 degree support: custom start-up programs, full-lifecycle services, such as recruitment and funding, access to market and capital, and a community of experts, corporate partners and mentors. YES!Delft holds a steady top 5 position in the UBI Global ranking of the world's best university incubators. Following the success of YES!Delft, the university supports the Erasmus

[26] Charles Edquist (2006), Systems of Innovation: Perspectives and Challenges (in The Oxford Handbook of Innovation)
[27] Entrepreneurial Ecosystem Index 2022, Utrecht University and Birch Consultants
[28] Reuters

University and other organisations with their incubator activities, an example of which is YES! in Rotterdam.

Around 10,000 square meters of space and support for scale-ups and high growth companies is provided by NEXT Delft.

The Delft fieldlabs are physical centres with industrial-scale equipment that also support academic research, where technology can be scaled-up from 'academic size' to 'industrial size'. They host open innovation systems and assist in closing the gap between research and society, playing a crucial role in accelerating innovation processes, and collaboration between researchers, students, entrepreneurs, government, businesses and society at large. Actual industrial use-cases form the basis of these demonstrators, and fieldlab staff support both the industry partners with innovation and the university staff with academic research. There are several examples of success where TU Delft has pushed technology, industry has pulled technology and the fieldlab has scaled up the technology by combining science with engineering.

In general, fieldlabs do not have a prescribed legal form. Any place where industry, education and research are combined could qualify, and so some of the Netherlands fieldlabs are commercial in nature. However, fieldlabs on TU Delft Campus are "public fieldlabs", hosted by the university with the aim of developing and educating in future technology for society. These are registered as non-profits and are not exclusively linked to technology for commercial suppliers. Each fieldlab at TU Delft Campus has a different structure, and while they are closely linked and connected to TU Delft, they are housed under the Holding of TU Delft. They are not, therefore, officially within the scope of the economic impact of TU Delft as a university. For this reason, our quantitative analysis is likely to underestimate the economic impact of TU Delft's role in the TU Delft Campus.

The networks embedded within and beyond the people and facilities at TU Delft are far bigger than the location. There are several communities focused around technology areas or impact themes, with the campus organisation bringing these together to drive the economic benefits highlighted throughout this report.

8.2 TU/e System

TU/e has a large technology education campus, hosting the university, HBO, MBO and several companies, institutes, start-ups and spin-offs. It is at the heart of the internationally renowned Brainport Eindhoven Region, a technology-rich area in which companies, governments and educational institutions work together. The aim is to increase innovation power in the region, including through new patents and companies, and bigger consortia going faster to the market.

The university underpins the Brainport ecosystem. With education, research and valorisation functions intertwined throughout its operation, and a collaborative approach to delivery, there are several impact related entities at TU/e, including: Eindhoven AI Systems Institute; Eindhoven Institute for Renewable Energy System;

Eindhoven MedTech Innovation Centre; The Gate; Innovation Space; Eindhoven Engine; and more.

Eindhoven Engine is a public-private research facility located on the TU/e Campus, hosting teams of researchers from industry and knowledge institutes. It is a company with three shareholders: TU/e, TNO and Fontys University of Applied Sciences. Supported by regional funding to grow the economy, its role is to accelerate innovation, with a focus on solving societal challenges through a systems approach. This means working with large consortia and/or with whole supply chains, with companies located in the region, or whose engineers come from elsewhere to work at Eindhoven Engine on research and development projects.

Education and valorisation are closely tied together at TU/e. Innovation Space is a community and facility that supports interdisciplinary challenge-based learning. Another structural and innovation community asset, it offers large flexible space which hosts both education and valorisation outcomes.

An understanding of the success of the TU Eindhoven system requires an understanding of the culture of the place. Many people working within the system, at the university and elsewhere in the Brainport region, began their careers within Phillips, and the language and culture of the place reflects this history. Culture is one of the most persistent things in this ecosystem and its industrial history provides its "lingua franca".

8.3 UT System

UT markets itself as "Europe's most entrepreneurial university", highlighting the central importance of valorisation to its identity. Its flagship facilities are noted as its world-renowned NanoLab, newly formed DesignLab and a new TechMed Centre. The UT campus is part of Kennispark Twente, an innovation campus of research institutes, innovation centres and high tech companies.

Kennispark is home to Novel-T, an incubator and accelerator which is a partnership between Entrepreneurs, Educational Institutions and Government - UT, Saxion University of Applied Sciences, the province of Overijssel, Gemeente Enschede and Twente Board. Novel-T runs from several locations across the campus, including the student union. Enterprising people have access to support that can launch an idea right through to scale up.

There are particular industrial strengths in Overijssel , such as in medical technologies. The regional medtech innovation system has UT's Medtech centre at its heart, whose mission is to improve healthcare by personalised technology. Partners include research institutes, education, healthcare providers, and industry. While it provides important economic benefits, a clear focus is on health benefits, creating impact for patients.

The ecosystem relies on the strength of collaboration between UT, the regional cities of Twente, Saxion University and the province of Overijssel. It is a connected system

with all the founders sponsoring it and supporting its operation. This is true collaboration at a strategic, institutional and personal level.

8.4 WUR System

WUR works with academic partners, companies, government organisations and non-governmental organisations on global, regional and local challenges and transitions. The challenges identified in WUR's strategy include that humans are exhausting the planet's natural resources, malnutrition remains a global problem, cities are becoming overcrowded, and the climate is changing rapidly.

The role of WUR is focused on innovation, entrepreneurship, shared facilities and equipment and 'bustle' on the Wageningen Campus. The Campus consists of two locations: the WUR buildings themselves and the Business & Science Park Wageningen. The two locations host WUR, national and international R&D companies such as FrieslandCampina, Noldus, Yili, Kikkoman and Keygene, research institutes such as NIOO, educational institutes such as the Aeres University of Applied Sciences. It hosts over 200 companies, including 78 start-ups, 109 SMEs and 14 corporates. The science park is focussed on companies in life sciences, food and health.

StartHub is WUR's start-up incubator and StartLife is its agrifoodtech accelerator, delivered in partnership with Oost NL, FoodValley and several corporate partners. Both are situated on the Wageningen Campus, in the Plus Ultra II building, which opened in Autumn 2021. This building is home to several organisations, including OnePlanet, Foodvalley, StartHub, WUR-Student Challenges, StartLife, and businesses.

WUR is different from other 4TU universities because it has a different legal structure and is the only Dutch university reporting to another ministry. Its legal structure has an impact on how WUR collaborates with private parties and through industry sponsored research.

The distinctive approach taken by WUR can be seen in how it describes its partnership working. It is common for institutions to describe commercialisation, knowledge exchange or valorisation activities. The language used by WUR is quite different with an emphasis instead on 'value creation and cooperation'.

WUR's Corporate Value Creation approach supports, facilitates and catalyses value creation. It sees its role as building an innovation ecosystem in which organisations can optimally reinforce each other, which can be seen in its role in Foodvalley, the knowledge-intensive agrifood ecosystem of the Netherlands. Together the organisations that are part of this system work to turn scientific discoveries into value for people, the economy and for society.

9. Conclusions

The total annual economic impact of the 4TU universities has been estimated at €12.7 billion in 2021. This is created by learning, research, and valorisation impacts and by economic benefits created by the universities' direct operations.

For every €1 of public investment, the 4TU universities create €9 of GVA impact.

The 4TU universities are innovators in education, producing rounded professionals who are the engineers and technologists of the future. The lifetime earnings premium received by the annual cohort of graduates in 2021, lifelong learning the 4TU members deliver and internships is estimated at €2 billion. We anticipate this increasing in future, with an increasing focus on pedagogy and challenge-based learning that will enhance the productivity of 4TU graduates in the future, potentially by €58 million per year.

Each of the 4TU universities has a laser focus on valorisation, with an enviable level of success in ensuring scientific discovery leads to societal impact. While this report has considered economic impact, there is a broad scope of wider benefits created for society. In fact, 4TU members make significant contributions right across the UN Sustainable Goals. Success in valorisation is based on the strength of the 4TU systems-based approach to innovation. It is remarkable that they achieve this without core strategic funding of valorisation activity, provided to universities in much of the rest of Europe.

Lack of core funding means that facilities, teams and infrastructure are reliant on project subsidies. These are not focussed on strategic approaches to delivering impact, but are limited in scope and short term in nature. From an innovation systems perspective, this is less than optimal, because a systems approach requires concerted planning and action over the long term.

Early in 2022, BiGGAR Economics provided an analysis for Universiteiten van Nederland of the opportunities that could be realised with investment in valorisation in the Netherlands[29]. The purpose of the analysis was to inform policy decisions about the role of valorisation from the Dutch universities, university medical centres, and research institutes in driving economic and social recovery in the Netherlands.

[29] BiGGAR Economics, Investing in Valorisation: The Economic Opportunity, A report to Universiteiten van Nederland, January 2022

The study showed that for universities in the Netherlands, valorisation impacts (excluding science parks) represent 16% of total impacts, while the equivalent figures for comparators elsewhere in Europe range from 18% to 22%, representing a gap of 2-6 percentage points. The UNL study found that closing this gap could result in an additional economic impact from valorisation of €0.9-€2.5 billion from universities.

The 4TU universities are at the top of the comparator range, with 22% of their impact coming from (non-science park) valorisation activity. This is higher than the range for the Netherlands as a whole. However, given the strategic focus of the 4TU universities, their world leading science, and remarkable ability to drive scientific outcomes into society, there are opportunities to increase their valorisation impacts further. Closing the gap with a similar increase in valorisation impacts applied in the UNL study of 2-6 percentage points, associated with public support for valorisation activity, could provide additional economic benefits to the Netherlands of €58 to €174 million per year from the 4TU universities alone.

While the scale of 4TU's economic impact is very significant, it is important to understand 4TU's contribution to the Netherlands goes far beyond what can be measured in GVA and jobs statistics alone. Without the underpinning mechanisms provided by the 4TU universities, the Dutch economy would be smaller and less resilient. Each 4TU university underpins its regional innovation system, and as a Federation working together 4TU provides the glue for a national system and connects it to wider global systems, acting as the motor of the Dutch economy.

10. Appendix A: 4TU Members

Each 4TU member has distinctive strengths which help to build specialist ecosystems of global significance.

10.1 Delft University of Technology (TU Delft)

TU Delft Mission is to solve global challenges by training new generations of socially responsible engineers and expanding the frontiers of the engineering sciences

Established in 1842 in Zuid-Holland, Delft University of Technology is the oldest public technical university in the Netherlands with a tradition of more than 175 years in civil engineering and an offering that spans the entire range of engineering sciences. It is also one of the largest campuses in the world, extending to over 161 hectares. It regularly ranks among the top 100 universities in the World in most university ranking guides.

In 2021 it had 27,730 full-time students, 12,970 members of staff and an income of €825 million.

The University's research capacity has been organised into university-wide institutes which has raised its international profile in several areas. TU Delft also hosts 13 fieldlabs which are built around its research strengths. These are real life, public-private testing sites where various parties collaborate to test and develop new technologies for commercial application.

The TU Delft Campus ecosystem attracts large companies to locate on site and entrepreneurship is actively supported through YES!Delft, a leading European Tech Incubator. TU Delft's holding company, DelftEnterprises (DE), invests in start-up companies based on TU Delft knowledge in exchange for an equity interest. By late 2020 DE owned shares in 67 spin-out companies, many of which were on or near campus.

Regionally, TU Delft works in the LDE alliance with Leiden University and Erasmus University Rotterdam on specific areas of common objectives. Along with Erasmus MC and the Erasmus University Rotterdam it is also a member of the Convergence alliance which has been formed to address societal challenges around resilient data, health and technology, AI and data and digitalisation. It is also an active member of several European university networks which focus on engineering and technology.

10.2 Eindhoven University of Technology (TU/e)

The mission of Eindhoven University of Technology is to educate students and to advance knowledge in science & technology for the benefit of humanity

Established in 1956, Eindhoven University of Technology in Noord-Brabant is a public technical University founded by industry, local government and academia.

In 2021, it had 13,210 full-time students 3,970 staff members and an income of €450 million.

The University has four research institutes which all work closely with industry:

- Eindhoven Artificial Intelligence Systems Institute;
- Eindhoven Institute for Renewable Energy Systems;
- Institute for Complex Molecular Systems; and
- Eindhoven Henrik Casimir Institute

The TU/e Campus houses over 100 knowledge institutes and high tech companies, from multinationals to innovative SME's and start-ups.

TU/e is a major academic partner in Brainport Eindhoven, a technology region of global significance where companies, government and education work together and around a third of TU/e graduates find their first workplace.

Eindhoven Engine is a public-private partnership between TU/e, Fontys Hogescholen, TNO and industry which accelerates innovation in the Brainport region by facilitating challenge-based research at the TU/e Campus. The University has also set up TU/e Innovation Space, a centre for challenge-based learning and student entrepreneurship. In 2020, seven new companies were established based on TU/e's intellectual property. TU/e has a holding company, TU/e Participations, which manages its commercial activities.

Eindhoven is a highly collaborative university. It is part of a 4-year collaboration with Tilburg University/Jheronimus Academy of Data Science to become an internationally recognised institute in Data Science and Entrepreneurship. It belongs to the Utrecht-Wageningen-Eindhoven alliance which focuses on life sciences, AI, education, innovation and societal challenges and it is intensifying its cooperation with the Universities of Applied Sciences – Avans, Fontys as well as SUMMA College. It is also a member of EuroTech Universities Alliance.

10.3 University of Twente (UT)

The University of Twente's mission is to be the ultimate people-first university of technology, empowering society through sustainable solutions

The University of Twente was established as a public technical University in 1961 in Enschede, Overijissel.

In 2021, it had 12,760 full-time students, 3,810 staff members and an income of €402 million.

UT has three research institutes which work with external parties on simulations, tests and prototypes. They offer a rich breeding ground for new companies and ideas that can boost existing businesses:

- **MESA+ Institute for Nanotechnology** (benefits from the NanoLab infrastructure);
- **TechMed Centre** – a leading Innovation Hub in the health tech field with state of the art infrastructure and simulated environments; and
- **Digital Society Institute (DSI)** – researches methods and techniques for integrating digital technology in the environment.

It also hosts multiple knowledge and research centres including the recently founded Centre for Energy Innovation. UT's mindset is governed by three principles:

- **Entrepreneurship** – it has around 240 successful new start up or spin off ventures;
- **Inclusivity** –a thriving and talented community which is a crucial asset in society; and
- **Openness** –the campus is the hub but they reach far beyond it.

Adjacent to UT is Kennispark Twente, which is one of the top three innovation campuses in the Netherlands. Its goal is to support start-ups, industrial companies and create a business climate for high-tech businesses. The Kennispark Twente ecosystem has more than 400 companies and institutions and employs over 5,000 people. It was the foundation for companies such as Demcom, Takeaway.com, Xsens and Booking.com. UT has played a strong role in attracting and retaining businesses to the park and it is working with the municipality of Enschede on an urban design plan to transform the Kennispark area into an innovation district.

UT has several strategic partnerships with universities, knowledge institutions and multinationals from all over the world. Key amongst these are:

- **VU Amsterdam** which builds on their earlier alliance on the mechanical engineering masters programme and includes alpha, beta and gamma sciences combined with technology;

- **European Consortium of Innovative Universities (ECIU)** with 10 other young and innovative unis across Europe;
- **Fraunhofer Project Centre** for Design and Production Engineering for Complex High-Tech Systems which is a joint initiative between UT and the Fraunhofer Institute in Aachen;
- **Max Planck Centre** for Complex Fluid Dynamics, the first one in the Netherlands, which opened in 2017;
- **TNO** i-Biotics, an open innovation centre where research is carried out to develop practical robotic innovations and applications with a relatively short time to market.

It has a Citizen Science Hub which works to reduce the gap between science and society.

10.4 Wageningen University & Research (WUR)

WUR's mission is to explore the potential of nature to improve the quality of life

Wageningen University & Research (WUR) in Gelderland was formed in 1997 as a collaboration between Wageningen University and the Wageningen Research foundation. It is a public university and an important centre for life sciences and agricultural research. In 2020/21, WUR had 13,680 full-time students (WU only), 7,140 staff members and an income of €804 million. It comprises two legally separate institutions:

- Wageningen University – established in 1876 as an agricultural college and recognised as a public university in 1918; and
- Wageningen Research – the former agricultural research institute of the Dutch Ministry of Agriculture which became responsible for rationing food and reconstructing the agricultural sector after the Second World War.

WUR is consistently ranked among the top 150 universities in the world by most major rankings and was placed in first position in the field of agriculture and forestry in the QS World University Rankings for 2022.

It is a cornerstone of Foodvalley, the knowledge-intensive agrifood ecosystem for the Netherlands, and a key stakeholder in Foodvalley 2030. This is a private-publicly funded ten-year programme aimed at achieving groundbreaking innovations in agriculture and food for a healthier and more sustainable future and for reinforcing collaborations between private and public partners.

WUR's focus is on innovation, entrepreneurship (StartLife), facilities and equipment (Shared Research Facilities) and hosting businesses and organisations on the Wageningen Campus. Key initiatives which support this are:

- StartHub – student incubator for students, PhDs and recent graduates who want to learn more about entrepreneurship and/or who have already started their own business; and
- StartLife – an accelerator programme for food companies.

It aims to make its research impactful on society through practical applications and to celebrate its 100th anniversary, it prepared an Impact Portfolio Report in 2018 which highlighted 50 projects that had an impact.

From an initial research focus on soil, dairy and plant sciences, other areas were later added to its portfolio, such as big data, healthy nutrition, genetics and geo-information sciences. It has developed new varieties for various crops, such as the Elstar apple and the Elsanta strawberry, and through this and other developments in plant breeding, it has partly led to the modernization of agriculture in the Netherlands. In the field of animal sciences, WUR's research has led to the development of optimized feeds and new vaccines which have improved animal welfare. Genetics and genomics are other areas in which WUR has made important discoveries, such as CRISPR-Cpf1, with enormous potential for gene therapy and genome editing and the Milk Genomics Initiative for selective dairy breeding.

11. Appendix B: Methodology

This section sets out the methodology followed in estimating the economic impacts of the 4TU universities and provides the sources for the underlying economic assumptions.

11.1 Economic Ratios and Multipliers

11.1.1 Economic Ratios

The analysis considers the ratios between turnover, gross value added and employment for the different sections of the Dutch economy. The ratios were derived the Organisation for Economic Cooperation and Development's (OECD) STAN Industrial Analysis[30] for the Netherlands in 2018.

11.1.2 Economic Multipliers

The economic contributions associated with the indirect and induced impacts are captured in the economic multipliers.

There are two types of multiplier. Type 1 (M_1) multipliers only consider the economic impact in the supply chain, whereas Type 2 (M_2) multipliers also include the spending of the staff involved in the process. The multipliers are expressed as the final figure for both GVA and Employment. For example, if there is a T_2 GVA Multiplier of 1.75, then € 1.00 of direct GVA (D_{GVA}) would result in € 1.75 of total GVA (T_{GVA}) impact. Therefore, to extract the pure multiplier effect, it is necessary to subtract 1 from the initial figure given as the multiplier.

$$T_{GVA} = \underbrace{D_{GVA}}_{\text{Direct}} + \underbrace{(M_1 - 1) * D_{GVA}}_{\text{Indirect}} + \underbrace{(M_2 - M_1) * D_{GVA}}_{\text{Induced}}$$

The economic multipliers were calculated using the Input Output Tables for the Netherlands[31], which are provided by the OECD. The multipliers that were calculated using input output tables were Leontief Type 1 GVA and Employment Multipliers and Leontief Type 2 GVA and Employment Multipliers. Type 2 multipliers consider the impact of supply chain and staff expenditure and Type 1 multipliers just consider supply chain expenditure.

In the analysis indirect and induced impacts were considered separately. While, at the level of the Netherlands, this is no different from applying Type 2 multipliers, this was necessary to provide accurate estimates of local impacts. This is because the extent of indirect and induced impacts may vary across different regions of the Netherlands.

[30] OECD (2021), STAN Industrial Analysis.
[31] OECD (2021), Input-Output Tables 2018 Edition.

There is likely to be a high degree of variation between the size of multipliers. This is linked to the size of the study areas, which affects how much household expenditure and supply chain spending is captured by local businesses. In order to address this, our current method is to adjust each multiplier (for each industry and both Type 1 and Type 2) by the same proportion.

11.2 Learning Impact

11.2.1 Graduate Premium

One of the most important sources of the economic impact of universities relates to the benefits of education for the economy. The idea is that a university education will mean that a graduate would be more productive (that is, add more to the economy) than they might have been if they had not had a university education. This approach is standard practice in the economic impact assessment of universities and captures the full added value of university education.

To capture this impact, the analysis, as standard practice, estimates the net lifetime financial returns that a graduate can expect to reap during her working life, the so-called "graduate premium". In doing so, the analysis accounts for differences in the returns of different degrees (vocational, undergraduate, master's and doctorate) and across subjects studied.

The starting point in estimating the graduate premium is to estimate the net financial returns at the individual level from attending tertiary education. These are estimated from:

- the costs of participation in tertiary education
  - direct costs of tertiary education (i.e. spending on tuition fees); and
  - foregone earnings while at university
- net benefits of participation in higher education, which are the difference between:
  - a graduate's gross lifetime earnings; and
  - taxes and benefits (income tax, social insurance contributions and any other transfers).

To estimate the earnings 'premium' compared to someone whose highest qualification is upper secondary education, the returns from an upper secondary education qualification are subtracted from the net financial returns from attending higher education. This is the standard approach taken when considering the benefits of university level education.

The difference between costs of participation and net benefits of participation gives the total benefits from achieving a degree. The net financial returns are then estimated by applying a discount factor that considers individuals' preference for present as opposed to future consumption (the OECD data on which this study relies adopt a 2% discount factor).

The data source underpinning this analysis was the OECD publication Education at a Glance 2019[32] and its tables on "private costs and benefits for a man attaining tertiary education" and "private costs and benefits for a woman attaining tertiary education". To estimate the graduate premium regardless of sex, data for men and women were averaged. In this way, it was estimated that in 2014, the latest year for which data is available for the Netherlands, the average financial return from achieving a degree in the Netherlands was (PPP) $ 240,000. As the OECD estimates costs and benefits with respect to purchasing power parity (PPP) US $, figures were converted into euros, taking the ratio of GDP per capita in 2014 PPP euros[33] and 2014 PPP Dollars[34]. In this way, it was estimated that the average net financial returns from tertiary education in the Netherlands in 2014 were €196,000, as shown in Table 11-1.

Table 11-1: NPV Lifetime Net Earnings Benefits from Tertiary Education

Netherlands, 2014	US$ PPP	€ PPP
Average	240,000	196,000

Source: World Bank (2020), GDP per Capita (Constant 2010 US$); Eurostat (2020), Real GDP per Capita, Chained Link Volumes, euro per capita. OECD (2019), Education at a Glance 2019.

The average net financial returns from tertiary education are then weighted to account for the differences in earnings across different degree levels, namely:

- bachelor;
- master's;
- doctorate; and
- overall tertiary education.

Again, these were sourced from the OECD[35] and refer to the average relative differences in earnings across these educational levels for full-time workers. To distinguish the premium linked to a doctoral degree from that to a master's degree, the graduate premium for doctoral students was further based on a study on the economic contribution of PhD students[36].

This found that the earnings premium associated with master's students is 23% higher than someone who had not gone to university for men and 38% for women. For PhD graduates the earnings premium was 26% for men and 38% for women. On this basis, the doctoral premium has been estimated to be 5% in addition to the combined master's and bachelor's premium. The average graduate premium associated with each qualification is set out in Table 11-2. This captures the benefits associated with each extra level of education achieved. Benefits by qualification

[32] OECD (2019), Education at a Glance 2019, available at: https://www.oecd-ilibrary.org/education/education-at-a-glance-2020_69096873-en
[33] World Bank (2020), GDP per Capita (Constant 2010 US$)
[34] Eurostat (2020), Real GDP per Capita, Chained Link Volumes 2010, euro per capita.
[35] OECD (2021), Earnings at a glance - Indicator A4 Earning advantage from education
[36] Casey (2009), The Economic Contribution of PhDs.

were estimated based on the relationship between different tertiary education qualifications and the average returns from tertiary education as a whole.

Table 11-2: Returns from an Average Degree 2014

	Value (€)
Bachelor	138,000
Master's	95,000
Doctorate	12,000

Source: BiGGAR Economics Analysis of OECD (2020) Education at a Glance 2020

The returns from a master's and a doctorate qualification are those attributable to that specific qualification. The returns from a master's degree given in Table 11-2 compares that of a master's graduate to a worker whose highest qualification is a bachelor's degree. Therefore, a masters graduate could expect a total lifetime premium on earnings from their university education equivalent to the sum of the returns from an academic bachelor and a master's degree.

Table 11-3: Mean monthly earnings of tertiary-educated adults, by field of education studied in the Netherlands, 2016

	Value (€)	Deviation from Average
Teacher training and education Science	4,000	-15%
Humanities, languages and arts	3,900	-17%
Social Sciences, business and Law	5,000	6%
Science, mathematics and computing	5,000	6%
Engineering, manufacturing and construction	5,300	13%
Health and Welfare	4,100	-13%
All fields/mean	4,700	0%

Source: OECD (2020) Educational Attainment and Labour Market Outcomes by Skills.

It was then possible to estimate the graduate premium across different degree types and subjects, where the difference across subjects was captured by considering the difference in median earnings across professions, as listed in Table 11-3.

To estimate the total graduate premium, the total number of graduates in each subject was multiplied by the premium associated to that subject and that educational attainment, as shown in Figure 11-1.

Figure 11-1: Calculation and Inputs for the Graduate Premium Contribution

Formulas
$$GVA = \sum_d (G_{(d)} * P_{(d)})$$

Inputs
$G_{(d)}$ = Number of graduates with degree (d)
$P_{(d)}$ = Graduate premium for graduate with degree (d)

11.2.2 Lifelong Learning

The 4TU universities also educate professionals through their engagement in lifelong learning. This is done by offering a range of short courses, which benefit participants by furthering their knowledge and skills and, in that way, improve their productivity.

The starting point in estimating the impact associated with lifelong learning courses was to consider the income that they generated. It was estimated that through these courses, the 4TU universities generated around €5 million. This income was then allocated to the economic sectors to which the courses taught related. To estimate the direct GVA generated by this income, this was multiplied by 340%. This is based on a study for the Department of Business, Enterprise and Regulatory Reform[37], which considered the impact of Regional Development Agency spending. One aspect considered in this report was the GVA returns to business development and competitiveness interventions between 2002 and 2007. This found that interventions in Science, R&D and innovation infrastructure had achieved cumulative GVA equivalent to 340% of the cost of the projects and that this could increase to 870% if the long-term benefits were considered.

Benefits from the interaction of university and businesses take time to realise. In a study on the subject, Danish consultancy DAMVAD[38] found that it requires around six years for productivity impacts from business-university interaction to be realised. On this basis, since this study covers one year worth of economic activity, total impacts were divided by 6.

GVA per job ratios were then applied to estimate the direct employment supported by lifelong learning. In addition to the direct impact generated by the delivery of lifelong learning courses, it was necessary to consider indirect and induced impacts.

Indirect impacts refer to the economic effects taking place within an organisation's supply chain. Induced impacts consider the effect of the spending of salaries and wages of those workers employed within the supply chain. These were estimated by

[37] PriceWaterhouseCoopers, Impact of RDA spending – National report – Volume 1 – Main Report, March 2009, DBERR.
[38] DAMVAD (2012), Measuring the Economic Effects of Companies Collaborating with the University of Copenhagen.

applying Type 1 and Type 2 GVA and employment multipliers to the estimates of direct GVA and employment. All the impacts were assumed to occur as a result of productivity improvements in the courses' participants.

It was assumed that all of the growth from lifelong learning would be from increased worker productivity, rather than organisation expansion. As a result, the employment impacts are solely associated with the increased activity in the supply chains and from increased induced impacts from higher staff salaries.

Figure 11-2: Calculations and Inputs for Lifelong Learning

Formulas

$$\text{GVA}(LL) = M(G)_i^2 * \sum_i 340\% * Income(LL)$$

$$\text{Employment } (LL) = (M(E)_i^2 - G(p)) * \sum_i \frac{GVA(LL_i)}{\frac{G_i}{E_i} * 6}$$

Inputs

$$\text{GVA}(LL) = Total\ GVA\ associated\ with\ Lifelong\ Learning$$

$$GVA(LL_i) = GVA\ associated\ with\ Lifelong\ Learning\ in\ industry\ (i)$$

$$M(E)_i^2 = \text{Type 2 Employment Multiplier in industry (i)}$$

$$M(G)_i^2 = \text{Type 2 GVA Multiplier in industry (i)}$$

$$\text{Employment } (LL) = Total\ Employment\ associated\ with\ Lifelong\ Learning$$

$$\left(\frac{G_i}{E_i}\right) = The\ \frac{GVA}{Employment}\ ratio\ in\ industry\ (i)$$

$$Income(LL) = Income\ from\ Lifelong\ Learning\ in\ industry\ (i)$$

$$G(p) = Share\ of\ growth\ from\ increased\ worker\ productivity$$

11.2.3 Student Internships

Students also contribute to economic activity when participating in internships within businesses. Their work supports the organisations where they intern as well as providing students with experience that will increase their future productivity and employability.

The analysis considered only those internships that lasted for longer than 12 weeks. This is because shorter internships were deemed as being mainly of an observational type and, as a result, interns were not assumed to make an economic contribution to the businesses where they did their placement.

It was estimated that across the 4TU universities around 1,540 students were involved in internships that lasted longer than 12 weeks. These students spent on

average around 12 weeks as part of their placements. To estimate the economic impact associated with these internships, it was first necessary to establish in which economic sector they took place.

To estimate the number of full-time equivalent jobs (FTEs) supported, the number of weeks spent by students in internships was then divided by the average number of weeks that an employee in that sector would spend in the workplace over a year. This was further discounted by 50%, to account for the fact that interns have a lower productivity than the average worker in each of the sectors considered.

It was then possible to estimate the direct GVA supported through internships by applying the relevant GVA per job ratio for the sectors where students undertook internships. Indirect impacts were further estimated by applying Type 1 GVA and employment multipliers to the direct GVA and employment estimates. Induced impacts were not considered, as the impact of student spending had already been considered elsewhere in the analysis. Details of the calculations performed are provided in Figure 11-3.

Figure 11-3: Calculations of Student Internships Contribution

Formulas

$$GVA = \sum_i \frac{G_i}{E_i} * \frac{\sum(Weeks)_i}{48}$$

Inputs

$$\frac{G_i}{E_i} = \frac{GVA}{Employment} \; ratio\ in\ industries\ of\ student\ placement$$

$$(Weeks)_i = Number\ of\ weeks\ student\ spends\ on\ placement\ in\ industry\ (i)$$

11.3 Valorisation Impact

11.3.1 Licencing Impact

The 4TU universities also contribute to economic activity through their scientific discoveries and technology development, which are then commercialised through licences. It was estimated that through their licencing activities the 4TU universities received €2 million.

Across the 4TU universities, it was estimated that 99% of the turnover from licences came from businesses located in the Netherlands. The economic impact from licences is dependent on the sector that the licence holder operates. Income from

licencing activity was therefore allocated to an economic sector according to the academic field where the licence was developed.

To estimate the value generated by licencing agreements, it was necessary to form a view over the value of the licence. The amount of royalties paid depends on the details of the licensing agreement and this can vary considerably from company to company. In order to agree on a licensing deal, negotiators must first form a view of how much the IP is worth to the prospective licensee. The 25% rule is a general rule of thumb according to which the licensor should receive around one quarter to one third of the profits accruing to the licensee and has been used by IP negotiators for at least 40 years. The rule is based on an empirical study first undertaken in the 1950s and updated in 2002. The study found that royalty rates were typically around 25% of the licensee's profits, which equates to around 5% of sales from products embodying the patented technology. This implies that royalties paid for a technology typically represent around 5% of the total turnover generated by that technology.

In 2002 Goldscheider[39] et al undertook further empirical analysis to test the continued validity of the 25% rule. The analysis was based on more than 1,500 licensing agreements from 15 different sectors between the late 1980s and the year 2000. The study found that although royalty rates ranged between 2.8% in the food sector to 8% in the media and entertainment sector, on the whole they differed very little from those used in the 1950s. Royalty rates by sector were applied to the income from licencing to estimate the total value generated by the licencing activity carried out by the 4TU universities.

Having estimated the value associated with each licencing agreement, this was then divided by the relevant sectoral turnover per GVA and turnover per job ratios to estimate the direct GVA and employment generated by licencing activity. The licencing payment covers 1 year and therefore the activity is assumed to occur within that time period. Type 1 and Type 2 GVA and employment multipliers were then applied to estimate indirect and induced impacts.

[39] Goldscheider et al, Use of the 25 Per Cent Rule in Valuing IP, December 2002.

Figure 11-4: Calculations and inputs for direct licencing GVA

Formulas

$$Rev(L_i) = \frac{Income\ (L_i)}{Rate_i}$$

$$GVA(L) = \sum_i \frac{Rev\ (L_i)}{\left({}^{T_i}/_{G_i}\right)}$$

Inputs

$$GVA(L) = \ Total\ GVA\ associated\ with\ licences$$

$$Rev(L_i) = \ Revenue\ generated\ from\ licences\ in\ industry\ (i)$$

$$\left({}^{T_i}/_{G_i}\right) = \ The\ \frac{Turnover}{GVA}\ ratio\ in\ industry\ (i)$$

$$Rate_i = \ Royalty\ rate\ for\ industry(i)$$

$$Income(L_i) = \ Income\ to\ the\ University\ from\ licences\ in\ industry\ (i)$$

11.3.2 Services to Businesses

The 4TU universities also make an economic contribution through the services to business they provide, including:

- consultancy;
- facilities hire; and
- commissioned research.

To estimate the direct GVA that was generated through these activities, turnover was multiplied by 340%, in line with what was done when considering the economic impacts from lifelong learning.

The model recognised the fact that some sectors are more likely to engage with academia than others. Eurostat provides data regarding the level of engagement with academia by sector. This shows that a third of the academic engagement with industry involves the Manufacturing sector[40]. The model used the proportions given for the Netherlands when the universities were not able to provide an industrial split of their collaborators.

[40] Source: Eurostat (2104) Enterprises co-operating with universities or other higher education institutions

Based on evidence from Danish consultancy DAMVAD[41], the impacts on employment were assumed to be realised over six years. In a 2012 study, they considered the economic impact of companies collaborating with the University of Copenhagen. Thanks to the availability of company level economic data for Danish companies DAMVAD was able to consider the productivity benefits associated with university collaboration and found these are realised gradually over six years.

Furthermore, it was assumed that around 25% of impacts from contract, collaborative and consulting activities were linked to increases in productivity, whereas the remainder was associated to increases in the level of employment of the businesses collaborating with the 4TU universities.

Figure 11-5: Calculations and Inputs Services to Businesses

Formulas

$$\text{GVA(SB)} = M(G)_i^2 * \sum_i 340\% * Income(SB_i)$$

$$\text{Employment (SB)} = (M(E)_i^2 - G(p)) * \sum_i \frac{GVA(SB_i)}{\frac{G_i}{E_i} * 6}$$

Inputs

$$\text{GVA(SB)} = Total\ GVA\ associated\ with\ Services\ to\ Businesses$$

$$GVA(SB_i) = GVA\ associated\ with\ Services\ to\ Businesses\ in\ industry\ (i)$$

$$M(E)_i^2 = \text{Type 2 Employment Multiplier in industry (i)}$$

$$M(G)_i^2 = \text{Type 2 GVA Multiplier in industry (i)}$$

$$\text{Employment (SB)} = Total\ Employment\ associated\ with\ Services\ to\ Businesses$$

$$\left(\frac{G_i}{E_i}\right) = The\ \frac{GVA}{Employment}\ ratio\ in\ industry\ (i)$$

$$Income(SB_i) = Income\ from\ Services\ to\ Businesses\ in\ industry\ (i)$$

$$G(p) = Share\ of\ growth\ from\ increased\ worker\ productivity$$

11.3.3 Spin-Outs and Start Ups

The 4TU universities also support the creation of new companies which bring to market a specific product, service or technology based on the research and expertise of the 4TU universities.

[41] DAMVAD (2012), Measuring the Economic Effects of Companies Collaborating with the University of Copenhagen.

In 2021, the 4TU universities had 380 active spin-out and start-up companies which collectively employed 33,040 people. The economic impact of the universities spin-out and start-up companies was estimated by first considering employment in each company. Employment data for each company was either provided by the Universities or sourced from publicly available financial accounts.

Impacts were attributed by study area based on the location of the spin-outs and start-ups. It was then possible to estimate direct GVA impacts by applying GVA/employee ratios for the sector in which the company operates to the number of staff employed in each company. Induced and indirect effects were captured by applying sector appropriate multipliers to the direct impacts of each company.

Figure 11-6 Calculations and Inputs Spin-Outs and Start-Ups

Formulas

$$GVA = \sum_i \frac{G_i}{E_i} * E_i$$

Inputs

$$\frac{G_i}{E_i} = \frac{GVA}{Employment} \; ratio\ in\ industries\ of\ spin-off\ and\ start-ups$$

$$E_i = employment\ in\ start-up\ or\ spin-out$$

11.3.4 Science Parks and Incubators

The 4TU universities contribute to economic activity also by hosting and supporting businesses in science parks and incubators. To estimate the impact that these facilities generate, it was first necessary to collect data on the employment, turnover and economic sector of the businesses operating within them.

It was necessary to consider how much of the economic activity created by these science parks and incubators would have happened anyway. It is likely that many of the companies would have found other locations elsewhere in the country if the science parks and incubators associated with the 4TU members did not exist. Previous studies by BiGGAR Economics, particularly one carried out for the University of Surrey, found that approximately 1/3 of the economic activity in the University's science park was additional.

For each science park and incubator, assumptions were also made about the extent to which activity was attributable to the Universities alone. This was done by considering the number of other partners in the science park or incubator, and reducing attributability to the 4TU member accordingly. This is because the involvement of other partners indicates that the University is not solely responsible

for the science park and its entire impact cannot therefore be attributed to the University.

Impacts were estimated based on the companies' direct employment. Employment was multiplied by sectoral GVA per job to estimate the direct GVA generated. Indirect and induced impacts were estimated following the same approach as in previous sections.

Figure 11-7: Calculations and Inputs for Science Park Contributions

Formulas

$$GVA\ (SP) = SPA_{(Study\ Area)} * Turnover\ (SP)/(\frac{T_{(i)}}{G_i})\ *\ M(G)_i^2$$

$$Employment(SP) =\ SPA_{(Study\ Area)} * Direct\ Employment\ (SP) * M(E)_i^2$$

Inputs

$$Turnover\ (SP) = Annual\ Turnover\ of\ Science\ Park/\ Incubator$$

$$Direct\ Employment\ (SP) = Employment\ in\ SP\ excl\ 4TU\ employees\ and\ spin - off\ companies$$

$$\left(\frac{T_{(i)}}{G_i}\right) = The\ \frac{Turnover}{GVA}\ ratio\ of\ the\ industry\ (i)$$

$$M(E)_i^2 = Type\ 2\ Employment\ Multiplier\ in\ industry\ (i)$$

$$M(G)_i^2 = Type\ 2\ GVA\ Multiplier\ in\ industry\ (i)$$

$$SPA_{(Study\ Area)} = Science\ Park/Incubator\ \ additionality\ in\ the\ study\ area$$

$$GVA\ (SP) = Total\ GVA\ of\ Science\ Park/Incubator$$

$$Employment(SP) = Total\ Employment\ of\ Science\ Park/Incubator$$

11.4 Core Impact

11.4.1 Direct Impact

The direct impact of an organisation captures its own exclusive contribution to economic activity. This is expressed in terms of its direct Gross Value Added (GVA) and its headcount employment. The direct GVA of an organisation is estimated as the difference between its income and non-staff operational expenditure.

The 4TU universities had a total income of around €2.5 billion and spent a total €580 million in non-staff operational expenditure. Over the same period, the 4TU universities supported around 29,890 direct jobs.

11.4.2 Expenditure on Supplies

The 4TU universities also contribute to economic activity through their expenditure on goods and services. This benefits the businesses where money is spent and supports their activities and employment.

It was estimated that the spending on non-staff operational costs of the 4TU universities was around €580 million. Based on data received from the universities, it was estimated that around 90% of this expenditure benefitted businesses in the Netherlands.

To assess the economic impact generated by this spending, it was first necessary to estimate in which sectors of the economy money were spent. Allocating spending by sector allowed for the use of sector-specific economic ratios and multipliers. In particular, the direct GVA and direct employment generated by supply spending were estimated by diving sectoral turnover in each study area by its respective turnover per GVA and turnover per job ratios. Indirect and induced effects were estimated by applying Dutch Type 1 and Type 2 multipliers for the relevant sectors.

The economic contribution made by supply spending was estimated in line with the methodology set out in Figure 11-8.

Figure 11-8 Economic Contribution of Expenditure on Supplies

Formulas

$$\text{GVA} = \sum_a (Exp_{(a)} \,/\, \frac{T_{i(a)}}{G_{i(a)}} * M(G)_i^2$$

$$\text{Employment} = \sum_a (Exp_{(a)} \,/\, \frac{T_{i(a)}}{E_{i(a)}} * M(E)_i^2$$

Inputs

$Exp_{(a)} =$ Expenditure on commodity (a)

$\frac{T_{i(a)}}{G_{i(a)}} = \frac{Turnover}{GVA}$ ratio in industry associated with commodity (a)

$\frac{T_{i(a)}}{E_{i(a)}} = \frac{Turnover}{Employment}$ ratio in industry associated with commodity (a)

$M(E)_i^2 =$ Type 2 Employment Multiplier in industry (i)

$M(G)_i^2 =$ Type 2 Employment Multiplier in industry (i)

11.4.3 Staff Spending

The 4TU universities also support economic activity through their employees spending their salaries and wages across the economy. It was estimated that the 4TU universities spent around €1.7 billion in staff costs. These include spending on staff wages, social security contributions, pension contributions and other benefits.

To estimate the economic impact that is generated by this expenditure it was first necessary to make assumptions on where staff would spend their money. As some money would benefit businesses from outside the Netherlands, there is no exact match between where staff is located and where spending takes place. In particular, it was assumed that staff living in the Netherlands would spend around 90% of their incomes in the Netherlands and 10% elsewhere in the world.

Having estimated the amount of spending taking place in each study area, it was then possible to allocate this to the sectors benefitting from it. This was based on an analysis of household expenditure in the Dutch Input-Output Tables.

Prior to estimating the economic impact generated by this expenditure, it was necessary to discount it by 7.7%, the share of household expenditure devoted to Value Added Tax (VAT) in the Netherlands, according to a 2013 study[42] carried out by the European Commission.

It was then possible to estimate the direct GVA and employment supported by this expenditure by applying the relevant turnover per GVA and turnover per job multipliers. Indirect and induced impacts were then estimated based on the relevant Type 1 and Type 2 GVA and employment multipliers. The calculations performed to estimate the economic impact from staff spending are displayed in Figure 11-9.

Figure 11-9 Calculating Staff Spending Contributions

Formulas

$$\text{GVA} = SE_{Study\ Area} \frac{T_S}{G_S} * M(G)_S^2$$

$$\text{Employment} = SE_{Study\ Area} / \frac{T_S}{E_S} * M(E)_i^2$$

Inputs

$\frac{T_S}{G_S} = \frac{Turnover}{GVA}$ ratio for staff spending

$\frac{T_S}{E_S} = \frac{Turnover}{Employment}$ ratio for staff spending

$M(E)_S^2 = Type\ 2\ Employment\ Multiplier\ for\ staff\ spending$

$M(G)_S^2 =$ Type 2 GVA Multiplier for staff spending

$SE_{Study\ Area} =$ Value of staff expenditure (less VAT) spent in each study area

[42] European Commission (2013), A study on the economic effects of the current VAT rates structure

11.4.4 Capital Spending

The 4TU universities create economic impact through their spending on capital projects such as the construction of new buildings and equipment.

Capital spending fluctuates from year to year, so an average was taken of the 4TU universities' capital spending over ten years (2017 to 2026). On this basis, annual capital spending was estimated at €259 million. As data on the location of capital suppliers was not available, it was assumed that the share of businesses who benefit from 4TU capital projects was the same as spending on supplies (90%).

Capital spending was categorised by the construction of buildings and spending on equipment. In order to estimate the direct GVA and employment impact from 4TU's capital spending, construction and equipment spending were each allocated a relevant economic sector. It was then possible to estimate the direct GVA and employment supported by capital expenditure by applying the relevant turnover per GVA and turnover per job multipliers. Indirect and induced impacts were then estimated based on the relevant Type 1 and Type 2 GVA and employment multipliers.

The calculations performed to estimate the economic impact from capital spending are displayed in Figure 11-10.

Figure 11-10 Calculating Capital Spending Contributions

Formulas

$$\text{GVA} = CS_{Study\ Area} / \frac{T_C}{G_C} * M(G)_i^2$$

$$\text{Employment} = CS_{Study\ Area} / \frac{T_C}{E_C} * M(E)_i^2$$

Inputs

$\frac{T_C}{G_C} = \frac{Turnover}{GVA}$ ratio for capital spending

$\frac{T_C}{E_C} = \frac{Turnover}{Employment}$ ratio for capital spending

$M(E)_i^2 = Type\ 2\ Employment\ Multiplier\ for\ industry$

$M(G)_i^2 =$ Type 2 GVA Multiplier for industry

$CS_{Study\ Area} =$ Value of capital expenditure spent in each study area

11.4.5 Student Spending

During their time at the 4TU universities, students spend money on a range of goods and services. This expenditure supports the businesses where money is spent, their turnover and employment. The analysis of student impacts considers only the impact that is generated by full-time students, as part-time students tend to have different spending patterns, due to their labour market participation.

The first step in estimating the economic impact from student spending was to establish how much students spend each month on a range of items, including housing costs, transport and other living expenses (e.g. food items). The analysis of student expenditure was based either on data from the 4TU universities or, where these were not available, data from Eurostudent was used[43]. It was estimated that on average, students who live with their parents spend €696 per month and students who live independently spend €1,149 per month.

In addition, it was necessary to consider in which type of accommodation students lived, as students' patterns of expenditure are expected to vary depending on their tenure. For instance, students living in parental accommodation would not incur any accommodation-related expenses.

Monthly spending by accommodation type was then multiplied by the number of months that students spend at university. Based on the duration of courses, it was assumed that all students spend the whole year at university. Spending was then discounted by the rate of VAT, depending on the different goods and services purchased by students.

Total student expenditure was then divided by the turnover per GVA and turnover per job of the relevant economic sectors to estimate the direct GVA and direct employment generated by student spending. The turnover generated by students' spending on university-maintained accommodation was not considered, since this was already included as part of the universities' income.

To estimate indirect and induced impacts, it was then necessary to apply to direct GVA and employment, the appropriate Type 1 and Type 2 GVA and employment multipliers, as done in previous sections. Details of the calculations performed are set out in Figure 11-11.

[43] Eurostudent (2021), Student Spending Data 2018-2021

Figure 11-11 Economic Contribution of Student Expenditure

Formulas

$$\text{GVA} = M(G)_i^2 * \sum_a (Exp_{(a)} / \frac{T_{i(a)}}{G_{i(a)}}$$

$$\text{Employment} = M(E)_i^2 * \sum_a (Exp_{(a)} / \frac{T_{i(a)}}{E_{i(a)}}$$

Inputs

$Exp_{(a)} =$ *Student* expenditure on commodity (a)

$M(E)_i^2 =$ Type 2 Employment Multiplier in industry (i)

$M(G)_i^2 =$ Type 2 GVA Multiplier in industry (i)

$\frac{T_{i(a)}}{G_{i(a)}} = \frac{Turnover}{GVA}$ ratio in industry associated with student expenditure in commodity (a)

$\frac{T_{i(a)}}{E_{i(a)}} = \frac{Turnover}{Employment}$ ratio in industry associated with student expenditure in commodity (a)

11.4.6 Student Part-Time Work

Students studying at the 4TU universities also contribute to economic activity through their part-time work. Doing so, they support the operations of those businesses where they work. Based on student employment data for the Netherlands[44], it was estimated that around 47% of the total number of full-time students at the 4TU universities, work part-time. Furthermore, according to research from Eurostudent[45], university students in the Netherlands work an average of 15 hours per week.

However, not all the economic activity engaged into by students can be considered as additional, that is, some of it would have taken place even if students had not carried it out. To estimate the extent of student part-time work's additionality, it was assumed that this would be negatively related to the unemployment rate of 16-24 years old in their region and the Netherlands as a whole. This was calculated in line with the approach taken by BiGGAR Economics in the study of LERU members[46]. Across the Netherlands, the rate of youth unemployment was 9%[47] and therefore the rate of labour additionality was 83%.

[44] Eurostudent (2022), Students' employment during the current lecture period, 2018-2021 aggregated data.

[45] Eurostudent (2022), Time spent on Paid Jobs, 2018-2021 aggregated data.

46 BiGGAR Economics (2017) Economic Contribution of the LERU Universities: Supplementary Methodological Appendix

47Eurostat (2021), Youth Unemployment by Region

To estimate the economic impact from part-time work, it was necessary to estimate in which sectors students would work while studying. Based on evidence from the UK[48], it was estimated that more than two thirds of students work in either retail (38%) or in food and beverages activities (33%). The other main sectors were residential care activities, office administration and the leisure sector.

It was then necessary to estimate the number of weeks that students would spend in employment and divide this by the average number of weeks worked across those sectors. In this way, it was possible to estimate for each sector the number of jobs that students support. To estimate the direct GVA that is generated by students' part-time employment, it was then necessary to multiply the number of jobs in each sector by their respective GVA per job.

Type 1 GVA and employment multipliers were applied to estimate the indirect impacts generated by student part-time employment. Induced impacts were not considered because they were already considered as part of student spending. Details on the methodology followed in estimating the impact from student part-time work are provided in Figure 11-12.

Figure 11-12: Calculations of Student Part-Time Work Contribution

Formulas

$$\text{GVA} = M(G)_i^1 * \left(Employment * \frac{G_i}{E_i}\right)$$

$$\text{Employment} = M(E)_i^1 * \left(SW * \frac{(Hrs_{st})}{(Hrs_i)} * LSA_{(Study\ Area)} * \left(\frac{Months\ studying}{12}\right)\right)$$

Inputs

$M(E)_i^1 =$ Type 1 Employment Multiplier in industry (i)

$M(G)_i^1 =$ Type 1 GVA Multiplier in industry (i)

$LSA_{(Study\ Area)} =$ Labour Supply Additionality in study area

$Employment = Equivalent\ employment\ in\ industries\ of\ student\ work$

$SW =$ Number of students with part time job

$(Hrs_{st}) =$ Average weekly hours worked by students

$(Hrs_i) =$
$Average\ weekly\ hours\ of\ student\ employment\ in\ industries\ of\ student\ work$

$(Months\ studying) = Average\ months\ of\ the\ year\ spent\ at\ University$

$\frac{G_i}{E_i} = \frac{GVA}{Employment}$ ratio in industries of student work

48 BIS Research Paper Number 142: Working while Studying (October 2013).

11.4.7 Student Volunteering

Students at the 4TU universities contribute to economic activity by volunteering during their studies. Their participation in these activities helps the organisations where they volunteer to expand their operations. In return, these experiences benefit students in several ways, including through the acquisition of skills that will be transferable once they will enter into the labour market.

On the evidence from CBS[49], it was estimated that 45% of students take part in volunteering activities and each volunteer student from 4TU universities spends around 3.7 hours volunteering each week. To estimate the value of their contribution the number of hours spent volunteering was multiplied by the average minimum wage rate of €8.02[50].

11.5 Tourism Impact

11.5.1 Visits to Staff and Students

When studying or working at the 4TU universities, students and staff receive visits from relatives and friends (VFR visits). These visitors contribute to economic activity by spending money during their trips, supporting the turnover and employment of local businesses. Based on data from Eurostat[51] on VFR tourism in the Netherlands, it was estimated that in a single year in the Netherlands there are around 0.5 domestic (i.e., visits from people living within the Netherlands) VFR trips and around 0.59 overseas VFR trips (i.e., visits from people living outside of the Netherlands) per capita.

These ratios were then multiplied by the total number of students and staff at each of the 4TU universities to estimate the total number of VFR visits taking place over a year. Based on data on expenditure by trip from Eurostat[52], it was estimated that on average each visitor would spend €57 per visit. Not all this spending could be considered as additional, since some of it would have taken place in any case. In particular, it was assumed that around 25% of VFR tourism spending was to be considered as additional to Dutch tourism.

[49] CBS (2020), Fewer Young Volunteers in 2019
[50] Government of the Netherlands (2022), Minimum Wage
[51] Eurostat (2020), Number of Trips by Purpose.
[52] Eurostat (2020), Tourism Expenditure by Purpose.

Figure 11-13: Calculations of Visits to Staff and Students Contribution

Formulas

$$\text{Visitor Spend} = (N_{students} + N_{staff}) * T_{(f)} * S_{(f)}$$

$$\text{GVA} = \text{Visitor Spend} * \frac{T_i}{G_i}$$

Inputs

$N_{students}$ = number of students

N_{staff} = number of staff

$\frac{T_i}{G_i} = \frac{Turnover}{GVA}$ ratio in industries of tourism spend

$S_{(f)}$ = VFR spend per trip in the Netherlands

$\frac{T_i}{G_i} = \frac{Turnover}{GVA}$ ratio in industries of tourism spend

Visitors' spend was then allocated to the economic sectors where it takes place (hospitality, transport and retail). Direct GVA and employment were then estimated by dividing turnover by the turnover per GVA and turnover per job ratios of those sectors where visitors tended to spend their money. Type 1 and Type 2 multipliers were then applied to estimate indirect and induced impacts, as done elsewhere in this study.

11.5.2 Conferences and Events

The 4TU universities have also an impact on tourism activity through the organisation of events and conferences, including open days for perspective students. To estimate the economic impact generated by these visitors, it was necessary to make a distinction based on where they came from and the length of their stay. This is because overnight domestic visitors, overnight overseas visitors and domestic visitors have all different spending patterns.

In addition, as done for visiting friends and relatives, it was necessary to take into account that not all the visits could be considered as additional.

In this way, it was possible to estimate the total expenditure generated by these visitors, which was then discounted by the prevailing VAT rate. Direct GVA and employment were estimated by dividing turnover by the turnover per GVA and turnover per job ratios of those sectors where visitors tended to spend their money. Type 1 and Type 2 multipliers were then applied to estimate indirect and induced impacts, as done elsewhere in this study. Details of the methodology followed are provided in Figure 11-14.

Figure 11-14: Calculation of Conference and Event Contribution

Formulas
$$\text{Visitor Spend} = A_{(o)} * S_{(F)}$$
$$\text{GVA} = \text{Visitor Spend} * \frac{T_i}{G_i}$$

Inputs
$A_o = \text{Overseas Attendees}$
$S_{(F)} = \text{Average visitor spend in the Netherlands}$
$\frac{T_i}{G_i} = \frac{Turnover}{GVA}$ ratio in industries of tourism spend

12. Appendix C: Consultees

TU	Name	Role
TUD	Paul Althuis	Director of the Innovation & Impact Centre, Delft Enterprises and TU Delft Services
TUD	Anne-Lize Hoftijzer	Manager Innovation Ecosystme, TU Delft Campus
TUD	Jaimy Siebel	Manager RoboHouse
TUD	Kjelt van Rijswijk	CEO SAM|XL (Smart Advanced Manufacturing XL)
TUD	Marjan Kreijns	Director The Green Village
TU/e	Katja Pahnke	Managing Director, Eindhoven Engine
TU/e	Isabelle Reymen	Scientific Director, InnovationSpace
TU/e	Madis Talmar	External Collaboration Coordinator, InnovationSpace
TU/e	Sharon Dolmans	Assistant Professor of Entrepreneurship and Technology Commercialization
TU/e	Paul Merkus	Head of Research Support Office
TU/e	Gerard van de Watering	Sr Policy Advisor Bachelor College, Education & Student Affairs
TU/e	Ines Lopez	Dean of Bachelor College
UT	Wiebke Eberhardt	Policy advisor for research and knowledge transfer
UT	Janneke Hoedemaekers	Business Director Strategic Partnerships and R&D collaboration
UT	IJsbrand Haagsma	Special Envoy for Public Affairs
UT	Ariana Need	Professor of Sociology and Public Policy
UT	Mike Verkouter	Manager Startup Acceleration at Novel-T
UT	Geert Dewulf	Chief Development Officer, SBD
UT	Remke Burie	Business director TechMed centre
WUR	Prof. Arthur Mol	Prof. dr A.P.J. Mol, Rector Magnificus/Vice President Executive Board
WUR	Dr. Sebastiaan Berendse	Director of Corporate Value Creation (for valorisation)
WUR	Prof. Arnold Bregt	Dean of Education
WUR	Wouter Hendriks	Dean of Research

13. Appendix D: Abbreviations and Terms

This section explains the common abbreviations and terms used in the report.

Assumptions are the data on which the economic contribution calculations are based.

Full Time Equivalent (FTE or fte) is a unit which reports employment or student numbers in a way that makes them comparable and accounts for different work or study commitments. It is calculated by comparing the average number of hours worked in a week to the average number of hours of a full-time worker or student. A full-time employee or student is counted as one FTE, while a part-time employee or student is reported in proportion to the hours they work or study. For example, where full-time employment consists of 40 hours worked per week, a part-time employee who is employed for 20 hours per week is counted as 0.5 FTE.

Gross Domestic Product (GDP) is a measure of economic output. It refers to the market value of all final goods and services produced within a country in a given period.

Gross Value Added (GVA) is a measure of economic output. It refers to the monetary value that an organisation, company or industry adds to the economy through its operations. In the case of the Universities this is estimated by subtracting the non-staff operational expenditure (mainly represented by expenditure on goods and services) from the total income of the Universities.

The report used the production approach to measuring the GVA contribution, where GVA is equal to the value of the service produced less the value of the inputs used. Typically this is estimated by subtracting the non-labour (goods and services) costs of the organisation from the organisation's total income.

Multipliers – every expenditure and employment has a multiplier effect throughout the economy. They are a numeric way of describing the secondary impacts that stem from a business, industry, service or organisation. For example, an employment multiplier of 1.8 suggests that for every 10 employees in Organisation A, 8 additional jobs would be created in other supplier industries so that 18 total jobs are supported by Organisation A.

Direct effect – this relates to the income and employees directly engaged by the Universities.

Indirect effect – this arises from the business-to-business transactions required to satisfy the direct effect. It is a second round impact that would not occur were it not for the Universities and it relates to the businesses engaged in their supply chain for goods and services.

Induced effect – as a result of the direct and indirect effects, the level of household income throughout the economy will increase as a result of increased employment. A proportion of this increased income will be re-spent on final goods and services, which is the induced effect.

Multipliers differ between sectors and countries. Each country calculates their individual multipliers in the form of Input-Output tables which form part of the national accounts. The Input-Output tables are quantitative techniques that represent the interdependencies between different branches of a national economy. The multipliers used in this report are the Dutch Input-Output Tables for 2018 (2021 edition).

Spin-outs are companies that are created to commercialise a university's intellectual property; usually involving a licensing agreement and/or staff transfer.

Start-ups are businesses that are set up by university staff and/or former students. Although such companies will draw on the experience acquired by the founders during their time at the university, they have no formal intellectual property relationship with the university.

Turnover/employee is a ratio of the amount of turnover required to support one full-time equivalent job for one year. It varies by sector depending on the relative labour intensities of different industries, for example, agriculture is a relatively labour intensive process compared to oil refining therefore the amount of turnover required to support an oil refining job is much higher than that required to support an agricultural job. The ratios used in this report are taken from the OECD's Input-Output Tables for the Netherlands.

Turnover/GVA is a ratio of the amount of turnover required to produce a certain amount of GVA in each sector. This relationship varies between sectors and countries.

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