BiGGAR Economics

Economic Impact of Research & Commercialisation at Leiden University & Leiden University Medical Centre

A report to
Leiden University Research and Innovation Services

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1 EXECUTIVE SUMMARY

In early 2011 BiGGAR Economics was appointed to assess the economic impact of the research undertaken at Leiden University and the Leiden University Medical Centre (LUMC). Founded in 1575, Leiden University is the oldest university in the Netherlands and has a reputation as one of Europe's top universities. The LUMC, one of the Netherlands eight medical centres, was established in 1997 out of Leiden University Hospital and Leiden University's Faculty of Medicine. In 2010, the combined research income of Leiden University and the LUMC was €338 million.

This report considers five categories of impact which together contributed approximately **€1,3 billion Gross Value Added (GVA)** to the Dutch economy in 2010 and supported around **18.000 jobs**. Of this, around €1,0 billion GVA and 14.000 jobs are in South Holland and €0,8 billion GVA and 11.000 jobs are in Leiden. This impact includes:

- **core impacts** associated with undertaking the research activity itself. This includes impacts arising directly from the income and employment created by research activity, supplier effects arising from expenditure on goods and services, income effects arising from expenditure by staff supported by research activity, impacts associated with international student spending and impacts arising as a result of capital investment projects. This category of impact is estimated to have contributed around €710 million GVA to the Dutch economy in 2010 and to have supported more than 9.300 jobs;

- impacts associated with the provision of infrastructure and an appropriate environment to stimulate the **growth of key sectors**. This category includes economic activity at Leiden Bio Science Park that can be attributed (wholly or partially) to its co-location with Leiden University and the LUMC including both capital spending and presence of tenants as well as investment stimulated or supported elsewhere in Leiden and the wider region. This category of impact is estimated to have contributed around €460 million GVA to the Dutch economy in 2010 and to have supported around 6.300 jobs;

- impacts associated with the **outputs from research activity**. This includes benefits from licensing and the impact of spin-out and start-up companies (not located on the Bioscience Park). This category of impact is estimated to have contributed around €120 million GVA to the Dutch economy in 2010 and to have supported around 1.700 jobs;

- impacts from **industrial research activity stimulated** by the research undertaken at Leiden University and the LUMC. This includes follow-on funding associated with national subsidy programmes such as the Netherlands Genomics Initiative and TI Pharma and activity stimulated by the University's seed fund and venture capital activities. This category of impact is estimated to have contributed around €20 million GVA to the Dutch economy in 2010 and to have supported around 200 jobs; and

- **tourism related impacts**. These include impacts arising from friends and family visiting research staff and students, people attending research related conferences and events and the contribution that Leiden

University and the LUMC make to the tourism product in Leiden through support for museums. This category of impact is estimated to have contributed around €10 million GVA to the Dutch economy in 2010 and to have supported around 100 jobs.

In addition to the substantial quantitative impacts summarised above, the research undertaken at Leiden University and the LUMC gives rise to a range of qualitative impacts. These include support for the Dutch knowledge economy and biotechnology sector in particular and helping to create the foundations for sustainable economic development in Leiden, South Holland and the Netherlands.

This report includes the results of a scenarios analysis which was undertaken to examine the potential impacts of changes in research funding and exploitation efficiency. Five scenarios were considered, these included:

- scenario 1 – research funding does not change but exploitation efficiency continues to improve at the current rate;
- scenario 2 – research funding increases by 5% but exploitation efficiency does not improve (perhaps because funding is diverted to other activities);
- scenario 3 – research funding increases by 5% and exploitation efficiency continues to improve at the current rate;
- scenario 4 – research funding falls by 5% and this leads to a proportionate fall in exploitation efficiency; and
- scenario 5 – research funding falls by 5% but exploitation efficiency continues to improve at the current rate.

The results of these scenarios are presented in Table 1.1. This demonstrates that even if research funding were to remain unchanged in the short to medium-term, if recent improvements in exploitation efficiency are maintained, the economic impact of Leiden University and the LUMC would be expected to increase by 15% (around €200 million). A relatively modest increase in research funding of 5% (around €17 million) could increase this by 20% (around €270 million).

On the other hand, a cut of 5% (around €17 million) in research funding could be expected to reduce economic impact by 7% (around €100 million). If it exploitation efficiency continued to improve at the present rate however, this effect could be mitigated such that total economic impact could increase by 8% (around €110 million).

Table 1.1 - Results of scenario analysis

Baseline/ Scenario	Economic Impact	Variance from Baseline
Baseline	€1,3 bn	-
Scenario 1	€1,5 bn	+15%
Scenario 2	€1,4 bn	+5%
Scenario 3	€1,6 bn	+20%
Scenario 4	€1,2 bn	-7%
Scenario 5	€1,4 bn	+8%

2 INTRODUCTION

This report summarises the findings of a study undertaken by BiGGAR Economics Limited into the economic impact of research and commercialisation activity at Leiden University and Leiden University Medical Centre (LUMC).

2.1 Objectives

The objectives of this report were to:

- quantify the economic impact of the research and commercialisation activity undertaken by Leiden University and the LUMC within Leiden, in the South-Holland region and across the Netherlands as a whole;
- assess the wider economic impacts associated with this activity; and
- estimate what the impact of research and commercialisation activity might be in the future under a range of potential funding scenarios.

2.2 Background

Founded in 1575, Leiden University is the oldest university in the Netherlands and has a reputation as one of Europe's top universities. The influential Shanghai Ranking places Leiden University 70th in the world and 20th in Europe while the QS World University Rankings lists Leiden in 82nd place. When it comes to research strength and innovation, Leiden University ranks even higher, reaching 14th place on the QS World University Ranking for citations and joint first for innovation in the 2010 Times Higher Education Supplement.

The LUMC was established in 1997 out of Leiden University Hospital and Leiden University's Faculty of Medicine and now employs approximately 7.000 people. It is one of eight medical centres in the Netherlands and is responsible for patient care, scientific research, education, study programmes and continuing education.

In common with other research-intensive universities in Europe (including the fellow members of the League of European Research Universities), although research activity of Leiden University and the LUMC has been established for hundreds of years, a strategic approach to the commercialisation of the excellent research base is more recent. The strategic approach adopted by Leiden University and the LUMC acknowledges the intense level of competition that exists between universities and recognises the need to focus on areas of research strength in order to maintain and strengthen research excellence. To this end, Leiden University has identified 11 priority research areas and the LUMC has identified eight key research themes which are summarised in Table 2.1.

Table 2.1 - Leiden University and LUMC key research themes

Leiden University	LUMC
Asian modernities and traditions	Ageing
Bioscience: the science base of health	Neurosciences
Brain function and dysfunction over the lifespan	Vascular medicine
Fundamentals of science	Infectious diseases and immunology
Global interaction of people, culture and power through the ages	Cancer immunotherapy
Health, prevention and the human life cycle	Regenerative medicine
Interaction between legal systems	Oncogenetics
Language diversity in the world	Genetic epidemiology and bio-informatics
Political legitimacy: institutions and identities	
Translational drug discovery and development	
Vascular and regenerative medicine	

Source: Leiden University and LUMC

2.3 Report Structure

The remainder of this report is structured as follows:

- section three describes key aspects of the economic impact methodology used in this report;
- section four presents the economic impacts arising from Leiden University and the LUMC's core activity including those associated with income and employment, purchase of bought in goods and services; expenditure on employment costs, international student spend and capital spend;
- section five describes the economic impacts associated with industrial investment attracted;
- section six describes the economic impacts associated with research activity undertaken at Leiden University and the LUMC;
- section seven summarises the economic impacts stimulated by Leiden University and the LUMC through participation in subsidy programmes;
- section eight presents the economic impacts arising from additional visitors to the economy due to the existence of Leiden University and the LUMC;
- section nine discusses the contribution of Leiden University and the LUMC to enhancing the attractiveness and vibrancy of Leiden;
- section ten summarises the baseline economic impacts;
- section eleven assesses what the future impact of research activity could be under a range of potential future scenarios; and
- an appendix provides a guide to abbreviations and terms commonly used.

3 ECONOMIC IMPACT METHODOLOGY

This section summarises the sources of impact considered in this report. It also describes the economic impact methodology and the concepts and terminology used in subsequent chapters.

3.1 Sources of Impact

The sources of impact considered in this report include:

- core impacts associated with undertaking the research activity itself, including:
  - direct income and employment associated with research activity;
  - supplier effects arising from expenditure on goods and services associated with research;
  - income effects associated with research staff spending their wages on goods and services;
  - PhD student and international student spending effects; and
  - capital spending effects.
- impacts associated with industrial investment attracted by the provision of infrastructure and an appropriate environment:
  - economic activity at Leiden Bio Science Park that can be attributed (wholly or partially) to its co-location with Leiden University and the LUMC including both capital spending and activity of tenants; and
  - investment stimulated or supported elsewhere in Leiden and the wider region.
- impacts associated with the outputs from research activity including:
  - benefits from licensing;
  - further funding stimulated by industry involvement with Leiden University and the LUMC;
  - impacts of spin-out and start-up companies;
- tourism impacts associated including those arising due to:
  - people visiting research students and staff;
  - research related conferences and events hosted in Leiden; and
  - the presence of museums.

3.2 Type of impacts

Every source of economic impact has three effects:

- direct effects – economic activity directly supported by the organisation or individual, including economic output (e.g. the turnover of the organisation)

and employment (i.e. staff employed by the organisation or employment supported by the direct spend of a student);

- supplier (or indirect) multiplier effects – the purchases of supplies and services associated with the direct impact and all the resulting purchases of supplies and services down the supply chain that has occurred because of the original purchase; and
- income (or induced) multiplier effects – the expenditure of employees supported by the direct effect and supplier effect.

3.3 Gross to Net impact

The total of these effects is the gross impact. This needs to be converted to net impact by taking account of:

- leakage – this considers how much of the economic activity occurs in the study area. This study considers the economic impact for Leiden, South Holland (as a whole), and the Netherlands (as a whole). Leakage is taken account of by considering the geographical source of the impact, the location of the impact and adjusting multipliers to the appropriate geography;
- displacement – this takes into account whether the activity of Leiden University and the LUMC has resulted in the reduction of activity elsewhere in the study area (e.g. would conferences hosted by Leiden University and the LUMC have been hosted elsewhere in Leiden if Leiden University and the LUMC did not exist, thus reducing the impact of other conference facility providers); and
- multiplier effects – this is a measurement of the effect of subsequent spending rounds as suppliers spend additional income on supplies and employee wages which is then re-spent elsewhere in the economy.

3.4 Economic Impact Measures and Geography

Economic impact has been reported using two measures:

- Gross Value Added (GVA) – Gross Domestic Product (GDP) is used as an indicator of the state of the whole economy and GVA provides an estimate of the contribution of the individual producer, industry or sector to GDP; and
- employment (jobs) measured in full time equivalent (fte) jobs supported.

The impacts have been calculated and three geographic levels:

- Leiden;
- South Holland (including Leiden); and
- Netherlands (including Leiden and South Holland).

4 CORE IMPACTS

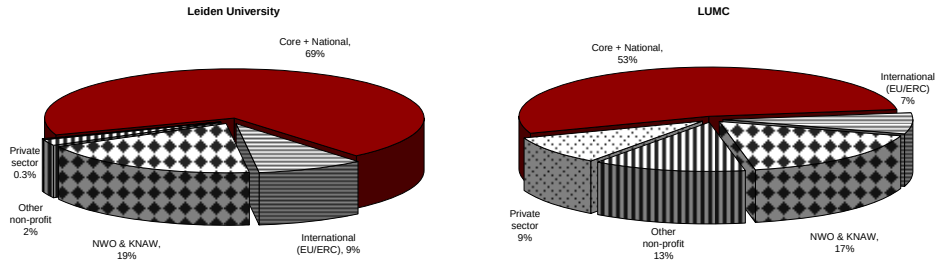
This is the impact occurring undertaking the research activity due to the activity attracting to the area additional income, staff and students. The core impacts covered in this Chapter includes:

- direct effect (income and employment);
- supplier effect (impact of expenditure on supplies and services and jobs supported by this spend);
- income effect (impact of the spending of employees);
- international student spending; and
- capital spending.

4.1 Research Income

The core impacts discussed in this section are generated by the research income secured by Leiden University and the LUMC. In 2010, Leiden University's research income was €186,2 million while the LUMC's research income was €151,7 million. This income was derived from various sources including core funding, national and European government, not for profit organisations and industry. A break-down of the research income secured by each both organisations by source is provided in Figure 4.1.

Figure 4.1 - Research income by source



Source: BiGGAR Economics analysis of data provided by Leiden University and LUMC

4.2 Direct Effect

Direct effect is the impact occurring in the area due to the institutions being located there and their income and staff contributing to the total income and staff in the area. Direct employment impact is simply the number of research related employees directly employed by the two organisations. In 2010 there were 1,981 research related employees in Leiden University and 2,111 in the LUMC. Direct GVA impact is calculated by subtracting expenditure on research related supplies from research income. In 2009/10, total research income to Leiden University and the LUMC amounted to €337,9 million while expenditure on supplies amounted to €65,7 million. This gives a direct GVA impact of €227,2 million. The result of this calculation and the assumptions upon which it is based are summarised in Table 4.1 and Table 4.2.

Table 4.1: Direct Effect Assumptions

	Value
Leiden University research income	€186,2 million
LUMC research income	€151,7 million
Total research income	€337,9 million
Research related employees – Leiden University	1.981
Research related employees – LUMC	2.111
Total research related employees	4.092

Source: Leiden University and LUMC

Table 4.2: Direct Effect

	GVA	Employees
Leiden, South Holland, Netherlands	€272,2 million	4.092

Source: BiGGAR Economics Analysis

4.3 Supplier Effect

Supplier effect is the impact occurring from buying in goods and services associated with research. This impact occurs as the purchase of goods and services increases turnover throughout the supply chain. The increase in turnover supports employment.

This is calculated by assessing the amount spent on goods and services in each of the study areas and converting it into GVA. This is done by using a turnover to GVA ratio. The amount of employment that is supported by this spending is found by applying a GVA per employee figure. The impact through the rest of the supply chain is found by applying multipliers.

This results in a supplier impact of €7,4 million and 96 ftes in Leiden, €31,3 million and 405 ftes in South Holland and €78,9 million and 1.041 ftes in the Netherlands.

Table 4.3: Supplier Effect - Assumptions

	Amount spent on goods and services (€m)
Leiden	11,5
South Holland	36,2
Netherlands	63,1

Source:

Table 4.4: Supplier Effect

	GVA (€m)	Employees (fte)
Leiden	7,4	96
South Holland	31,3	405
Netherlands	78,9	1,041

Source: BiGGAR Economics Analysis

4.4 Income Effects

Income effects arise when employees spend their wages. This spending increases turnover and supports employment in local businesses. In turn, these businesses then spend additional money on supplies and their employees spend their wages, resulting in a multiplier effect.

Income effects can be estimated by assessing the wage spent in each of the study areas. This is done by analysing how many employees there are, where they live and how and where they spend their income. Table 4.5 provides a break-down of the staff numbers in both organisations, including PhD candidates.

Table 4.5 - Leiden University and LUMC staff numbers

Number of	Leiden University	LUMC
Research related staff	1.347	1.542
PhD students	634	569
Total number of staff	1.981	2.111

Source: Leiden University and LUMC

The next step is to calculate the employment costs associated with these employees. In 2010, Leiden University spent €83,1 million on research related employment costs. This figure includes €25,3 million for PhD candidates, an average €41.899 per candidate. In the same year, the LUMC spent €93,5 million on staff costs but this figure does not include PhD candidates. Expenditure on PhD candidates is therefore estimated by multiplying the average employment cost of a PhD candidate by the number of PhD candidates at the LUMC. In this way it can be estimated that the total research related employment costs of the LUMC amount to €117,4 million. These assumptions are summarised in Table 4.6.

Table 4.6: Income Effect - Assumptions

	Value
Amount spent on wages – Leiden University	€83,1 million
Amount spent on wages – LUMC (excluding PhD students)	€93,5 million
Average employment cost of PhD student	€41.899
Total employment cost of LUMC	€117,4 million

The next step is to establish where research staff live. Records show that at present 41% of research staff and 51% of PhD candidates live in Leiden, 31% of research staff and 29% of PhD candidates live elsewhere in South Holland and 28% of research staff and 20% of PhD candidates live elsewhere in the Netherlands. These data are presented in Table 4.7.

Table 4.7 - Where staff live

	Research staff	PhD candidates
No. of staff living Leiden (%)	41%	51%
No. of staff living South Holland (%)	31%	29%
No. of staff living Netherlands (%)	28%	20%

Source: Leiden University

The next step is to consider how much of their wages each group of staff is likely to spend in each area. This can be done by considering the Dutch household expenditure survey which includes data about the proportion of household income that is spent on particular types of goods and services. From this it is possible to estimate how much of a typical household's income will be spent in the local area, how much will be spent in the wider region and how much will be spent elsewhere in the Netherlands.

The typical Dutch household for example spends around 15% of its income on food and drink. As people generally purchase their groceries close to home, it is therefore reasonable to assume that the vast majority of this expenditure will be made where employees live. This means that employees living in Leiden will purchase almost all of their groceries in Leiden and the rest in the South Holland region.

Rent and house maintenance accounts for around 24% of the typical Dutch household budget. It is logical to assume that this expenditure will occur where the employee lives, so employees living in Leiden will make all of their expenditure on rent in Leiden while employees living elsewhere in South Holland will make all of their expenditure on rent elsewhere in the region.

Around 6% of the typical Dutch household budget is spent on clothing and footwear. It is likely that almost all of this expenditure will be spent within the Netherlands; however, spending patters within the Netherlands will depend largely on the quality and availability of leisure retail opportunities available to residents of particular areas. Survey evidence[1] shows that 69% of Leiden residents who went "fun shopping", did so within the city and 75% did so within the wider region. This suggests that the leisure retail opportunities available to residents of Leiden are considerable and as such that most expenditure of this type will remain in the city.

By assessing each category of expenditure and cross referencing this with other relevant data it is possible to estimate approximately what proportion of their wages employees will spend in Leiden, in the surrounding region and in the rest of the Netherlands. The results of this analysis are presented in Table 4.8.

[1] Leiden City Survey, 2008.

Table 4.8 - Employee spending patterns

	Staff Living in		
% spending in:	Leiden	South Holland	Netherlands
Leiden	55%	20%	15%
South Holland	75%	75%	40%
Netherlands	95%	95%	95%

Source: BiGGAR Economics analysis of Dutch Consumer Expenditure Survey, CBS

By applying these proportions to the staff expenditure figures presented in Table 4.6, it is possible to estimate how much employees of Leiden University and the LUMC spend in each of the study areas. These figures can then be converted into a GVA impact by dividing by an appropriate GVA/turnover ratio[2], which has the effect of excluding taxation paid by employees from the impact estimates. The income effect estimated here is therefore a conservative estimate since it excludes the contribution of employees to the provision of public services paid for from Government taxation receipts.

Employment impacts are calculated by dividing GVA impact by an estimate of the average GVA/employee and finally multipliers[3] are applied to capture the effects of subsequent spending rounds.

This results in an income impact of €58,2 million and 716 ftes in Leiden, €137,9 million and 1.619 ftes in South Holland and €253,9 million and 2.939 ftes in Netherlands.

Table 4.9: Income Effect

	GVA (€m)	Employees (fte)
Leiden	58,2	716
South Holland	137,9	1.619
Netherlands	253,9	2.939

Source: BiGGAR Economics Analysis

4.5 International Student spending

Students create economic impact in the same way as research staff; by spending their income in local businesses which then increase their expenditure on supplies and are able to employ more people. Student spending is not directly attributable to research activity so this section does not consider the impact of all students; however, it does consider the impact of international research students. This is because the decision of these students to study in the Netherlands is driven largely by the research reputation of Leiden University and the LUMC. Although these students are not strictly engaged in research, they would not be in the Netherlands if it were not for the research undertaken at Leiden University and the LUMC so it is necessary to include them.

[2] All GVA:Turnover ratios used in this report have been sourced from Centraal Bureau voor de Statistiek (CBS), Statistics Netherlands

[3] All GVA per employee and multipliers used in this report have been sourced from CBS

The impact of student spending can be calculated in the same way as the impact of spending by research staff. The starting point is to establish how many research students there are at Leiden University and the LUMC and where they live. Then it is necessary to establish how much income these students have.

Average student income can be calculated based on information about student living costs provided by Leiden University[4]. This estimates that, on average, students will require €10.500 per year to cover housing, living and social costs while studying. It should be noted that this represents the basic minimum income that all students will require in order to complete their course however some students will have a higher income than this as a result of part time work or support from family. For this reason, the impact of student spending calculated below is likely to be conservative.

Table 4.10: International Student Spending Assumptions

Assumption	International taught research students
Average expenditure/student (€)	10.500
No. students living in Leiden	1,283
No. students living elsewhere in South Holland	171
No. students living elsewhere in the Netherlands	171
Total	**1,661**

Source: Leiden University and LUMC

The next step is to estimate how much of this income is spent in each of the study areas. This is done by analysing where students live and applying the spending assumptions from Table 4.8.

Total research student expenditure can then be converted into GVA impact by applying a GVA/turnover ratio. Employment impact is estimated by dividing GVA impact by the average GVA/employee and the impact of subsequent spending rounds is captured by applying multipliers.

This results in a student spending impact of €22,9 million and 285 ftes in Leiden, €41,6 million and 492 ftes in South Holland and €75,2 million and 867 ftes in Netherlands. This is summarised in Table 4.11.

Table 4.11: International Student Spending Impact

	GVA (€m)	Employees (fte)
Leiden	22,9	285
South Holland	41,6	492
Netherlands	75,2	867

Source: BiGGAR Economics Analysis

4.6 Capital Impact

In 2010, the LUMC spent just over €16,1 million on research related capital

[4] Leiden University website - http://www.students.leiden.edu/your-study/finances/study-living-costs.html

investments and Leiden University spent just under €7,0 bringing the combined capital expenditure of both organisations to €23,1 million per year. Although the nature of the capital projects varies from year to year, this figure is broadly typical of average annual expenditure and as such can be used to calculate annual impact.

This spending provides an important income stream for the Dutch construction sector. It is possible to convert this income into GVA by applying a turnover to GVA ratio for the construction sector. The employment impact of this expenditure can be estimated by dividing the GVA impact by an estimate of the average GVA by employees in the construction sector. The indirect impacts of this expenditure can then be calculated by applying GVA and employment multipliers for the construction sector. In this way it can be estimated that the total impact of research related construction expenditure amounts to €31,2 million GVA across the Netherlands, €22,5 million in South Holland and €15,5 million in Leiden and supports 354 jobs in the Netherlands of which 254 are in South Holland and 188 are in Leiden. This and the assumptions used in the calculation are summarised in Table 4.12 and Table 4.13.

Table 4.12: Capital Spend - Assumptions

	Leiden University	LUMC
Capital spending 2009/10 (€m)	7,0	16,1

Source: Leiden University and LUMC

Table 4.13: Capital Spend Effect

	GVA (€m)	Employees (fte)
Leiden	15,5	188
South Holland	22,5	254
Netherlands	31,2	354

Source: BiGGAR Economics Analysis

4.7 Summary

The impact associated with the core activity of undertaking research activity due results in an estimated impact of €376,3 million and 5.377 ftes in Leiden, €505,5 million and 6.862 ftes in South Holland and €711,3 million and 9.293 ftes in the Netherlands.

Table 4.14: Summary Core Impact - Leiden

	GVA (€m)	Employees (fte)
Direct Effect	272,2	4.092
Supplier Effect	7,4	96
Income Effect	58,2	716
International Student Spend	22,9	285
Capital Spend	15,5	188
Total	***376,3***	***5.377***

Source: BiGGAR Economics Analysis

Table 4.15: Summary Core Impact – South Holland

	GVA (€m)	Employees (fte)
Direct Effect	272,2	4.092
Supplier Effect	31,3	405
Income Effect	137,9	1.619
International Student Spend	41,6	492
Capital Spend	22,5	254
Total	***505,5***	***6.862***

Source: BiGGAR Economics Analysis

Table 4.16: Summary Core Impact – Netherlands

	GVA (€m)	Employees (fte)
Direct Effect	272,2	4.092
Supplier Effect	78,9	1.041
Income Effect	253,9	2.939
International Student Spend	75,2	867
Capital Spend	31,2	354
Total	***711,3***	***9.293***

Source: BiGGAR Economics Analysis

5 INDUSTRIAL INVESTMENT

This chapter examines how Leiden University and the LUMC have stimulated investment by the bioscience sector by providing research infrastructure such as the Leiden BioScience Park.

5.1 Leiden Bio Science Park

In 2009 the Leiden Bio Science Park celebrated its 25th anniversary. Since the Academic Business Centre and Centocor opened in 1984, the park has grown into the most significant biomedical science park of the Netherlands. More than 15.000 people now work at the Bio Science Park, including almost 4.000 who work in one of the 117 companies that are located on site.

The Leiden Bio Science Park has grown steadily over the past 25 years as companies have expanded and new buildings and institutions have been built. The Park now covers 110 hectares which is about as large as the inner city of Leiden. About a third of this area, or 36 hectares, is available for new development and several significant construction projects have either recently opened, are currently underway or are planned for the future. Some significant recent developments include the:

- relocation of HAL Allergy from Haarlem city centre of to their new production and office building at the Leiden Bio Science Park in December 2008;
- decision to locate the prestigious Netherlands Centre for Electron Nanoscopy (NeCEN), the consortium for life sciences and nanoscopy in the Cell Observatory at the Science faculty of Leiden University;
- construction of an extra multi-tenant Beagle II building;
- decision to locate The Netherlands Centre for Biodiversity NCB Naturalis at the Park. This will bring together the unique national natural history collections of several Dutch universities in the existing Naturalis museum in Leiden which will be renamed NCB Naturalis and enlarged;
- construction of a new 40.000 square metre regional vocational training school by ROC Leiden. The new building next to Leiden Central station will house about 5.000 students in 2013; and
- opening of the new Accelerator building (a facility for young Life Science companies that have outgrown the starters' facilities at BioPartner) in late 2010.

In the longer term, over €130 million will be invested in Leiden's Bio Science Park, allowing for further development, better quality and connectivity. The 36 hectare area zoned for new development, the Nieuw Rhijngeest area, is in the neighbouring town of Oegstgeest, between the A44 motorway and the Old Rhine (the Rhine's old riverbed). The two areas of the park, existing and new, will be separated by the motorway but linked by a tunnel.

5.1.1 Capital Investment in Leiden BioScience Park

The Leiden BioScience Park is home to a large and important cluster of life

science companies which make a significant contribution to the Dutch economy. The scale of this contribution is estimated in section 5.1.2. Apart from its role in the life science sector, the Park is also a very large piece of commercial real estate which has had many millions of Euro invested in it over the past 25 years. This means that the Park also generates a very significant construction impact as a result of the people employed to build the new buildings and the supplies purchased to construct them. As the Park would not exist if it were not for Leiden University and the LUMC, all of this impact can be attributed to these two organisations.

Over the past 25 years, approximately 355.000 sq. metres of office and laboratory space for life science companies has been created at the Leiden BioScience Park. Although in practice growth rates have varied from year to year, on average this equates to around 14.200 sq. metres of new space created each year (25 year average).

The most recent development is the BioPartner Accelerator building, which will provide around 5.600 sq. metres of space for small life science businesses. The new building will incorporate approximately 250 flexible workstations designed to accommodate up to 20 young firms that have outgrown the Park's two existing business incubators.

The total cost of developing the Accelerator building is expected to be around €15 million, or €2.679 per sq. metre. The ratio of office to laboratory space in this building is around 1:1 which is typical for the BioScience Park. An estimate of the annual value of capital investment at the BioScience Park can therefore be obtained by multiplying this by the average amount of floor space created each year. This suggests that on average, capital investment in the BioScience Park amounts to €38 million per year.

As this investment is equivalent to expenditure within the construction sector, the economic impact of this capital investment can be calculated by dividing by a GVA/turnover ratio for the construction sector. Employment impact can then be found by dividing this figure by a turnover per employee figure in the construction sector. The impact of subsequent spending rounds is then estimated by applying GVA and employment multipliers for the construction sector.

In this way it can be estimated that the capital expenditure associated with the Leiden BioScience Park contributes €51,4 million to the Dutch economy each year and supports 582 jobs. This impact and the assumptions used in the calculation are presented in Table 5.1 and Table 5.2.

Table 5.1: Science Park Capital - Assumptions

	Value
Cost/square metre of Accelerator Building	€2.679
Average floor space developed each year	14.200

Source: BiGGAR Economics Analysis

Table 5.2: Science Park Capital - Summary

	GVA (€m)	Employees (fte)
Leiden	25,5	310
South Holland	37,1	419
Netherlands	51,4	582

Source: BiGGAR Economics Analysis

5.1.2 Impact of Tenants at the Leiden Bio Science Park

This impact measures the additional economic activity generated by companies located at the Leiden Bio Science Park. In 2010 there were 117 companies located on the Leiden Bio Science Park, including 53 life science companies, 20 technological companies and 44 other service companies. These companies had a combined turnover of €6,6 billion and employed almost 4.000 people. These assumptions are presented in Table 5.3.

Table 5.3: Science Park Tenants - Assumptions

	Value
Turnover of companies	*€6.55 billion*
Number of employees	3.928
GVA/employee (commercialisation related sectors)	€68.342
Attribution of companies located in Leiden to LU and LUMC	100%
Attribution of companies located in South Holland to LU and LUMC	100%
Attribution of companies located in Netherlands to LU and LUMC	90%

Source: BiGGAR Economics Analysis

The total GVA impact of these companies can be calculated by multiplying the number of employees in tenant companies (from Table 5.3) by an estimate of the GVA by a typical employee in the life sciences sector. GVA and employment multipliers are then applied to capture the effects of subsequent spending rounds.

The next step is to estimate how much of this impact can be attributed to Leiden University and the LUMC. If it were not for Leiden University and the LUMC, the Leiden Bio Science Park would not exist. As there are no other comparable Parks elsewhere in Leiden or South Holland it is reasonable to assume that, if the Leiden Bio Science Park did not exist then none of the companies that are currently on-site would now be located in the area. For this reason, it is assumed that all of the impact generated by the Park in Leiden and South Holland is additional.

It is possible that some current tenants might have chosen to locate elsewhere in the Netherlands if space at the Leiden Bio Science Park had not been available however it is expected that the number of such companies would be low. Evidence for this can be found in the 2009 Bio Partner Centre Report which finds that location is the single most important factor influencing companies' decisions to locate at the Centre. For this reason, it is assumed that 90% of the impact generated by the Park in the Netherlands is additional.

By applying these additionality assumptions to the total impact generated, it is

possible to estimate that tenants of the Leiden Bio Science Park generate approximately €519 million GVA per year for the Netherlands economy and support almost 7.300 jobs. These impacts are presented in Table 5.4.

Table 5.4: Science Park Tenants - Summary

	GVA (€m)	Employees (fte)
Leiden	360,9	5.175
South Holland	453,3	6.421
Netherlands	518,9	7.275

Source: BiGGAR Economics Analysis

Although the entire impact of the Science Park is ultimately attributable to the University and the LUMC, impact arising from spin-out companies is more directly attributable than that generated by other tenants. For this reason, it is helpful to distinguish between the impact created by spin-out tenants and tenants that are less directly linked to the University and the LUMC. This can be done based on levels of employment in both types of tenant.

Approximately 22% of Science Park tenant employees work in spin-out companies. By applying this proportion to the total impact of the Science Park it can be estimated that spin-out tenants generate approximately €116,7 million GVA per year and support 1.635 jobs while non-spin-out tenants generate approximately €402,3 million GVA per year and support 5.639 jobs. This is summarised in Table 5.5 and Table 5.6. The impacts associated with start-ups and spin-outs are discussed further in Section 6.2.

Table 5.5: Science Park – spin-out tenants

	GVA (€m)	Employees (fte)
Leiden	81,1	1.163
South Holland	101,9	1.443
Netherlands	116,7	1.635

Source: BiGGAR Economics Analysis

Table 5.6: Science Park – non-spin-out tenants

	GVA (€m)	Employees (fte)
Leiden	279,8	4.011
South Holland	351,4	4.978
Netherlands	402,3	5.639

Source: BiGGAR Economics Analysis

5.2 Investment Stimulated Elsewhere

In addition to the companies located on Leiden BioScience Park, a further 20 life science companies are located elsewhere in Leiden, employing a total of 320 people. It is likely that the decision of these companies to locate and remain in Leiden was influenced to some extent by the presence of Leiden University and the LUMC and for this reason, some of the impact from these companies can be attributed to Leiden University and the LUMC.

The impact of these companies can be estimated in the same way as the impact of Science Park tenants, by multiplying employment by an estimate of the GVA by a typical employee in the life sciences sector. The impact of subsequent spending rounds is then calculated by applying appropriate multipliers.

It is possible that some of the companies would have located in Leiden even if Leiden University and the LUMC did not exist so it would not be reasonable to attribute all of the economic impacts generated by these companies to Leiden University and the LUMC. It is however reasonable to assume that the location decisions of these companies were influenced by similar considerations as those of the tenants of the BioScience Park and that the presence of Leiden University and the LUMC was an important factor. If Leiden University and the LUMC did not exist, it is likely that most of these companies would not now be located in Leiden however it is equally probably that most of them would have located elsewhere in the Netherlands and some may have located elsewhere in South Holland.

It is impossible to know what the location decisions of these companies might have been if Leiden University and the LUMC did not exist however, based on the discussion above, it is reasonable to assume that 25% of the companies would have located in Leiden even if Leiden University and the LUMC did not exist, 50% of them might now be located elsewhere in South Holland and 95% of them would have located elsewhere in the Netherlands.

Applying these assumptions to the total GVA generated and employment supported by these companies suggests that €22,1 million of the GVA generated by these companies in Leiden and 316 jobs can be attributed to Leiden University and the LUMC. As many of the companies would still have existed elsewhere in the Netherlands if Leiden University and the LUMC did not exist, the impact at the Dutch level is much smaller, amounting to £2,3 million GVA and 33 jobs. This impact and the assumptions used in the calculation are summarised in Table 5.7 and Table 5.8.

Table 5.7: Investment stimulated in the Leiden life science sector - Assumptions

	Value
Number of companies	20
Number of employees	320
GVA/employee (commercialisation related sectors)	€68.342
Attribution of companies located in Leiden to LU and LUMC	75%
Attribution of companies located in South Holland to LU and LUMC	50%
Attribution of companies located in Netherlands to LU and LUMC	5%

Source: BiGGAR Economics Analysis

Table 5.8: Investment stimulated in the Leiden life science sector - Summary

	GVA (€m)	Employees (fte)
Leiden	22,1	316
South Holland	18,5	262
Netherlands	2,3	33

Source: BiGGAR Economics Analysis

5.3 Summary

The impact due to attracting inward investment by providing an infrastructure and appropriate environment to stimulate growth results in an estimated impact of €327,3 million and 4.608 ftes in Leiden, €407,0 million and 5.658 ftes in South Holland and €456,0 million and 6.255 ftes in Netherlands. These impacts exclude start-ups and spin-outs which are discussed further in Section 6.2.

Table 5.9: Science Park Impact - Leiden

	GVA (€m)	Employees (fte)
Science Park Capital	25,5	310
Science Park Tenants (non-spin-outs)	279,8	4.011
Businesses Stimulated elsewhere	22,1	316
Total	**327,3**	**4.638**

Source: BiGGAR Economics Analysis

Table 5.10: Science Park Impact – South Holland

	GVA (€m)	Employees (fte)
Science Park Capital	37,1	419
Science Park Tenants (non-spin-outs)	351,4	4.978
Businesses Stimulated elsewhere	18,5	262
Total	**407,0**	**5.658**

Source: BiGGAR Economics Analysis

Table 5.11: Science Park Impact – Netherlands

	GVA (€m)	Employees (fte)
Science Park Capital	51,4	582
Science Park Tenants (non-spin-outs)	402,3	5.639
Businesses Stimulated elsewhere	2,3	33
Total	**456,0**	**6.255**

Source: BiGGAR Economics Analysis

6 OUTPUTS FROM RESEARCH

This section considers the impact occurring in the economy due to Leiden University and the LUMC's commercialisation and technology transfer outputs, including:

- licensing; and
- start-up companies and spin-out companies; and

6.1 Licensing

One of the main ways in which research activity is translated into economic activity is through licensing agreements with industry. Licence agreements give companies the legal right to use a particular technology or other type of intellectual property (IP) to generate additional sales, reduce costs or otherwise improve their profitability. In return, companies pay Leiden University and/or the LUMC royalties.

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 a licensing deal, negotiators must first form a view of how much the IP is worth to the prospective licensee. There are a wide variety of variables which may inform this judgement including potential risks to the company, the technology's stage of development, any capital investment which might be required and market conditions.

According to a training manual issued by the World Intellectual Property Organisation[5], a common starting point for many licensing professionals is to start valuation calculations with the "well known and widely quoted" 25% rule. 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 undertaken in the 1950s which found that royalty rates were around 25% of the licensee's profits (or 5% of sales) from products embodying the patented technology. In 2002[6] Goldscheider (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 the average royalty rate across all sectors was around 5.1% of sales. This was virtually identical to the rate estimated back in the 1950s and provides support for the continuing use of the 25% rule as a tool for calculating the value of IP.

In 2009/10 Leiden University and the LUMC earned €5,5 million in royalty income from licence agreements for 24 technologies. Of these, 15 technologies are licensed to companies on the BioScience Park, a further three are licensed to companies elsewhere in South Holland, two are licensed to companies elsewhere in Netherlands and the remaining four are licensed to companies located elsewhere in the world (mainly in the UK and US). As the impact of companies

[5] Exchanging Value, Negotiating Technology Licensing Agreements: a training manual, World Intellectual Property Organisation, 2005.
[6] Goldscheider, Use of the 25% rule in valuing IP, les Nouvelles, 2002.

located on the BioScience Park has already been estimated (in Section 5.1.2), the impact from the 15 technologies licensed to on-site companies has been excluded here to avoid double counting.

The details of the individual licensing agreements are commercially confidential and so are not listed in this report. However, based on consultations with LURIS, it is estimated that the licenses that are held by Netherlands based companies, not based on Leiden BioScience Park tend to be associated with considerably less income than those held by BioScience Park tenants and by international companies. It is therefore assumed that license agreements with (non-BioScience Park) companies located in the Netherlands generate around €0,2 million of royalty income for Leiden University and the LUMC, approximately 5% of total license income. For the reasons described above it can be assumed that this income represented approximately 5% of the total sales generated by the licensed technologies. This amounts to approximately €7,3 million of additional turnover across the Netherlands.

The next step is to convert this turnover into GVA by dividing it by a turnover to GVA ratio for the sectors in which licence agreements are made. The employment impact is then calculated by dividing the GVA impact by an estimate of the average GVA added by each employee in these sectors. The effect of subsequent spending rounds is then captured by applying GVA and employment multipliers.

In this way it can be estimated that the licensing activity of Leiden University and the LUMC contributes £4,3 million GVA to the economy of the Netherlands and supports 62 jobs. This is in addition to the impact generated by companies with licensing agreements that are located on the BioScience Park. This impact and the assumptions used to calculated it are summarised in Table 6.1.

Table 6.1: Licensing Impact - Assumptions

	Value
Licensing Income	€5,5 million
Royalties as % of additional turnover generated	5%
Companies located in Leiden BioScience Park	15 (excluded from analysis)
Companies located in South Holland	3
Companies located in Netherlands	2

Source: Consultation with Leiden University and LUMC

Table 6.2: Licensing - Summary

	GVA (€m)	Employees (fte)
Leiden	-	-
South Holland	2,1	30
Netherlands	4,3	62

Source: BiGGAR Economics Analysis

6.1.1 Factor V

An example of research at Leiden University and the LUMC that has been

successfully licensed and is now generating health and economic benefits around the world is the discovery of Factor V Leiden.

Factor V Leiden is the name given to a variant of human factor V that causes a hereditary hypercoagulability disorder (an abnormality of blood coagulation that increases the risk of blood clots in blood vessels), which is particularly common in people of Eurasian decent. People with Factor V Leiden thrombophilia have a higher than average risk of developing a type of blood clot called a deep venous thrombosis (DVT). DVTs occur most often in the legs, although they can also occur in other parts of the body, including the brain, eyes, liver, and kidneys. Factor V Leiden thrombophilia also increases the risk that clots will break away from their original site and travel through the bloodstream.

Factor V Leiden was first identified in Leiden by Prof Bertina et.al. in 1994. The discovery then gained international attention following the publication of a paper in the Journal Nature[7]. The markers for diagnosing Factor V Leiden have now been licensed to bioMérieux, a leading international diagnostics group which specialises in the field of *in vitro* diagnostics for clinical and industrial applications.

6.2 Start-ups and Spin-outs

Leiden University and the LUMC contribute to the economy through the creation of companies. Most of these companies are located in the Science Park and their impact has been calculated in that section. This section calculates the spin-outs and start-ups that are located elsewhere.

The GVA economic impact to the study areas is found by converting the estimated turnover of companies in each to GVA and applying multipliers. The employment impact is found by applying employees in each area to multipliers. The contribution of start-ups and spin-outs that are not located on the Science Park is €0,8 million and 20 ftes in Leiden, €1,3 million and 29 ftes in South Holland and €1,9 million and 49 ftes in Netherlands.

Table 6.3: Start-ups and spin-outs (excluding Science Park tenants) - Assumptions

	Turnover (€m)	Employees (fte)
Leiden	1,4	16
South Holland	1,7	18
Netherlands	2,1	24

Source:

Table 6.4: Start-ups and spin-outs (excluding Science Park tenants) - Summary

	GVA (€m)	Employees (fte)
Leiden	0,8	20
South Holland	1,3	29
Netherlands	1,9	49

Source: BiGGAR Economics Analysis

[7] Bertina RM, Koeleman BP, Koster T, et al. (May 1994). *"Mutation in blood coagulation factor V associated with resistance to activated protein C".* Nature 369

As discussed in section 5.1.2, many spin-out companies are located on the Leiden BioScience Park. The total impact of spin-out companies can therefore be calculated by adding the impact of the companies referred to in Table 6.5 to the impact calculated in Table 5.5. The total impact of spin-out companies is summarised in Table 6.6. This shows that the total contribution of start-ups and spin-outs from Leiden University and the LUMC amounts to €82,0 million and 1.183 ftes in Leiden, €103,2 million and 1.473 ftes in South Holland and €118,6 million and 1.685 ftes in Netherlands.

Table 6.5: Start-ups and spin-outs (total) - Summary

	GVA (€m)	Employees (fte)
Leiden	82,0	1.183
South Holland	103,2	1.473
Netherlands	118,6	1.685

Source: BiGGAR Economics Analysis

6.2.1 Crucell

A particularly successful spin-out is Crucell which began life in 1993 as a small biotechnology company called IntroGene, which was responsible for inventing and developing the first manufacturing based on human cells. In 2000, IntroGene merged with another Dutch biotech company called U-BiSys to form Crucell. In 2006, Crucell acquired the Swiss vaccine maker Berna Biotech and Swedish company SBL Vaccines and became the largest independent vaccine company in the world.

In October 2009, Crucell announced that it had secured the support of Johnson & Johnson, the world's largest healthcare company. The two companies signed a strategic agreement aimed at the discovery, development and commercialisation of antibody products and vaccines for the prevention and/or treatment of both infectious and non-infectious diseases. The agreement will support the commercialisation of Crucell's flu-mAb product, a potentially revolutionary approach to the control of influenza. It also provides funding for new discovery programmes targeting new therapeutic innovations, including a universal influenza vaccine.

6.2.2 Medis

Medis is a privately owned company, which was founded in 1989 as a spin-off of the LUMC's Laboratory for Clinical and Experimental Image Processing (LKEB). The company creates software solutions for the medical specialties of cardiology and radiology. Its software covers applications including MRI (magnetic resonance imaging), X-ray angiography, IVUS (intravascular ultrasound) and OCT (optical coherence tomography).

Since its foundation, Medis has introduced a range of products that are now being used in clinical practice and research. Medis' flagship products include QAngio® XA and QMass® MR. QAngio® XA incorporates a module that is widely considered the gold-standard solution for quantification of coronary vessels while QMass® MR is used by clinicians and labs worldwide to help assess cardiac function.

Although the company is still located in Leiden, it also has a subsidiary in Raleigh, NC, USA, meaning that the impact of the company is global.

6.2.3 Prosensa

One of the most high profile companies to be spun-out of Leiden University and the LUMC is Prosensa, a biopharmaceutical company focused on the discovery, development and commercialisation of RNA modulating therapeutics. The company is based on the Leiden Bioscience Park and now employs around 90 people. The company primarily targets neuromuscular and neurodegenerative genetic disorders such as Duchenne Muscular Dystrophy (DMD), Myotonic Dystrophy, Huntington's Disease and Spinal Muscular Atrophy.

Since Prosensa was founded in 2002, the company has developed a portfolio of clinical and pre-clinical RNA-based drug candidates. The company is currently partner to an alliance agreement with GlaxoSmithKlein (GSK) through which it received $680 million between 2008 and 2010.

Prosensa is currently developing two product candidates in collaboration with GSK. Its lead product aims at restoring dystrophin expression and improving muscle condition and function in a relatively large subpopulation of DMD patients. The product has already successfully completed a Phase I/II study and preparations are underway to start enrolling patients in a Phase III study in 2010. The company's second product candidate addresses another subpopulation of Duchenne patients and entered clinical trials in the last quarter of 2009.

6.3 Summary

This impact in Leiden due to outputs from research activity is €82,0 million and 1,183 ftes in Leiden, €105,3 million and 1,503 ftes in South Holland and €122,9 million and 1,747 ftes in Netherlands.

Table 6.6: Summary Outputs from Research Impact - Leiden

	GVA (€m)	Employees (fte)
Licensing	-	-
Start-ups and spin-outs (total)	82,0	1.183
Total	**82,0**	**1.183**

Source: BiGGAR Economics Analysis

Table 6.7: Summary Outputs from Research Impact – South Holland

	GVA (€m)	Employees (fte)
Licensing	2,1	30
Start-ups and spin-outs (total)	103,2	1.473
Total	**105,3**	**1.503**

Source: BiGGAR Economics Analysis

Table 6.8: Summary Outputs from Research Impact – Netherlands

	GVA (€m)	Employees (fte)
Licensing	4,3	62
Start-ups and spin-outs (total)	118,6	1.685
Total	**122,9**	**1.747**

Source: BiGGAR Economics Analysis

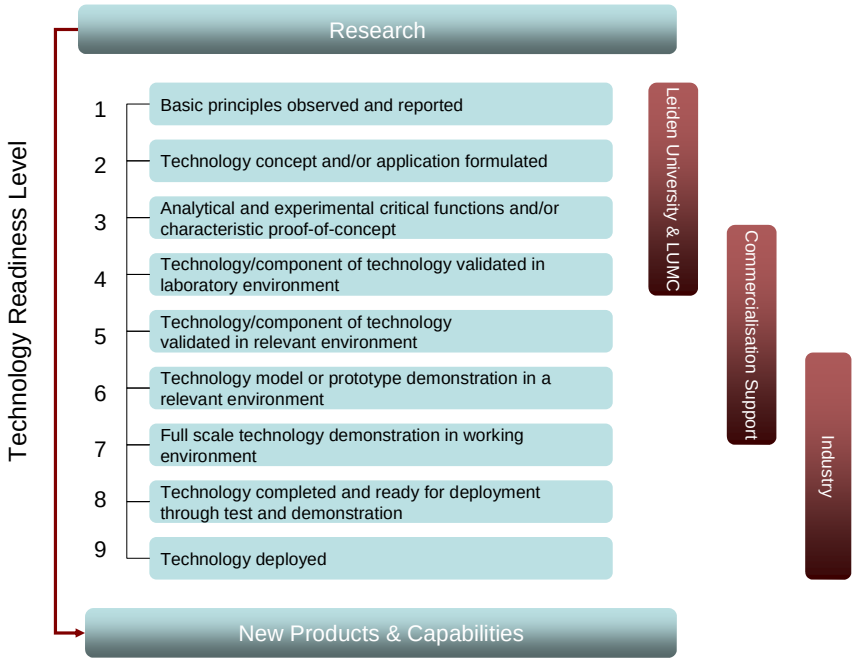
7 INDUSTRIAL R&D SPILLOVERS

The benefits of the research activity undertaken at Leiden University and the LUMC are not restricted to activity directly undertaken by academic researchers but also include the benefits of industrial R&D stimulated by academic research. Although the extent of this effect is difficult to quantify, industrial R&D is of such importance to the Dutch economy that it is essential that this impact is considered.

7.1 Academic Vs Industrial R&D

An important feature of academic research is that it does not typically represent the final stage of technology development process – i.e. in general it tends to be focused at an intermediate stage in the technology development cycle and is unlikely to lead to immediate full scale commercial production or application. This can be conceptualised using Technology Readiness Levels, a widely used scale used by the US Department of Defence, the Ministry of Defence and NASA and is illustrated in Figure 7.1.

Figure 7.1 – Technology Readiness Levels



Source: BiGGAR Economics, adapted from UK Environmental Transformation Fund Strategy

The type of research undertaken at Leiden University and the LUMC typically falls into one of the first four technology readiness levels described above. In order for the full results of such research to be realised, it is normally necessary for industrial partners to undertake further development work. The amount of subsequent research investment required will depend on the readiness level of the technology concerned and is likely to vary significantly between projects and could amount to many times the original investment.

7.2 The Importance of Business R&D

Recognition of the importance of business R&D amongst economists can be traced back to the seminal work of Nobel Prize winning economist Robert Solow[8] in 1956. In this work, Solow demonstrated that 87½% of the increase in US labour productivity between 1909 and 1949 could not be explained by increases in factor inputs of labour and capital. Solow attributed this residual to technological change.

This led to various attempts by researchers to model the so called 'Solow residual' using measures such as R&D spending and patenting. Most of these studies found that R&D spending makes a significant contribution to productivity growth, with a 1% increase in the R&D capital stock typically leading to a rise in output of between 0.05% and 0.1%[9].

In most European countries, business R&D typically represents between 1% and 2% of total GDP. The Netherlands is no exception to this and data from the Centraal Bureau voor de Statistiek (CBS) can be used to estimate that in 2009, business R&D in the Netherlands represented approximately 1.8% of GDP.

A report undertaken on behalf of the UK Institute of Fiscal Studies[10] estimated that the elasticity of output with respect to R&D is around 0.07. This means that a 10% increase in R&D expenditure can be expected to lead to an increase in output of around 0.7%. In the context of the Dutch economy, a 10% increase in business R&D expenditure is equivalent to approximately 0.18% of national GDP (i.e. 10% of 1.8%). Changes in business R&D therefore generate changes of almost four times the size in national output (i.e. 0.7%/0.18% = 3.88). This implies that each €1 invested in business R&D will generate an additional €3,88 in economic output.

7.3 Stimulating Business R&D

There are a number of mechanisms through which the research activity undertaken at Leiden University and the LUMC help to stimulate research activity within industry. Conceptually this activity corresponds to the 'commercialisation support' activity illustrated in the middle box to the right off Figure 7.1 and specifically it includes:

- subsidy programmes such as Top Institute Pharma and the Netherlands Genomics Initiative; and
- seed and venture capital funding provided through initiatives such as the Leiden Leeuwenhoek Pre Seed fund (LLPF) and BioGeneration Ventures (BGV).

[8] Solow, R. (1957), *Technical Change and the Aggregate Production Function*, Review of Economics and Statistics, pp. 312-20.
[9] Cameron G (1994), *R&D Productivity and the Case for a UK R&D Tax Credit*, Nuffield College, Oxford.
[10] Griffith R (2000), *How Important is Business R&D for Economic Growth and Should the Government Subsidise it?,* Institute for Fiscal Studies, Briefing Note no. 12.

7.3.1 Netherlands Genomics Initiative

The Netherlands Genomics Initiative was established by the Dutch government in 2001 and aims to provide excellence in research through a network of eleven centres that are large scale partnerships of university groups, research institutes, industry and societal organisations.

The Netherlands Genomics Initiative is in its second phase since 2008 and has grown to sixteen genomics centres. This phase emphasises valorisation which is creating added value from genomics research. This is done by translating research into innovative products and services and benefiting society.

Leiden University and the LUMC contribute to nine of the sixteen centres of which five are based in Leiden. The income of these centres, including their direct income, valorisation programmes and funding for further projects is €37 million.

7.3.2 Top Institute Pharma

Top Institute Pharma (TI Pharma) is a public private partnership that seeks to improve cooperation between Dutch universities and international industry and create social and economic benefit. The programme does this is by building partnerships and academic research groups and pharmaceutical companies in order to improve the development of socially useful medicine.

The research projects is based on the disease areas as specified in Priority Medicines, a report by the World Health Organization (WHO) and is mostly focused on research that is difficult or impossible for individual companies to perform. In total TI Pharma initiated 49 consortia working on projects ranging in size from €2 million to €18 million (over 4-5 years). These involve 28 academic partners (which include all Dutch universities and medical centres and also knowledge institutes) and 45 industrial participants (half of whom are global companies and half small and medium sized enterprises).

7.3.3 BioGeneration Ventures

Leiden University is also a major partner in BioGeneration Ventures (BGV), a venture capital company based in Leiden which was established to invest in Dutch in start-up and early stage life sciences companies. The University invested €2 million in the first fund and a further €2 million in the second fund. To date the fund, which is worth around €17 million, has invested in biotechnology ventures such as:

- **Arcarios** – a drug development company dedicated to the discovery and development of products in the field of bone and joint diseases such as osteoporosis and osteoarthritis;
- **arGEN-X** – a biopharmaceutical company that develops human therapeutic antibodies;
- **Bioceros** – a biopharmaceutical R&D contract organisation and developer of anti-inflammatory and anti-cancer drugs;
- **Flexgen** – commercialisation of a fast and flexible custom microarray synthesis instrument for genomic selection in next generation sequencing and other applications;

- **Xmedisse Medical Technology** – biomaterials company developing resorbable medical implants based on proprietary polymers;
- **Mucosis** – developer of innovative mucosal vaccines that can be applied needle-free via the nose or mouth;
- **NovioGendix –** a service lab for molecular diagnostics and research in biomarkers for cancer; and
- **Progentix –** developer of materials for use in bone regenerative surgery.

7.4 Quantifying Industrial Spillovers

It is possible to calculate how much business R&D is stimulated by Leiden University and the LUMC each year based on the amount of income the institutions secure from industry each year. This income represents direct investment by private companies in research undertaken by academic researchers. It is then possible to calculate the value of this activity to the Dutch economy by applying the multiplier derived in the previous paragraph.

In 2010 Leiden University and the LUMC received €15 million from private companies. In addition, both Leiden University and the LUMC derive some of their income from European Programmes. One of the most important of these programmes is the Seventh Framework Programme for research and technological development (FP7), the European Union's main instrument for funding research over the period 2007 to 2013. An evaluation of this Programme undertaken in 2010[11] estimated that European spending on FP7 had stimulated further industrial R&D expenditure amounting to 25% of the original investment.

Although the income accruing to Leiden University and the LUMC from these programmes has been taken into account as part of the direct impact (section 4.2), the impact of any additional industrial expenditure stimulated has not. This additional expenditure can be estimated by applying the 25% assumption described above to the total amount of European funding secured by the two organisations. In 2010, Leiden University and the LUMC received €27,4 million from European Programmes.

The final source of industrial income which must be accounted for is Leiden Leeuwenhoek Pre Seed fund (LLPF). This fund gives a personal loan of €15.000 to €100.000 to facilitate the start-up of new technology based companies. The fund amounts to €750.000 of which a third goes to projects that are not based in a spin-out or start-up companies associated with Leiden University or the LUMC. (It is important to only count this third of the funding as the impact of start-ups and spin-outs has already been considered, in Section 6.2.)

Taken together, these three sources of industrial R&D expenditure amount to €49,3 million per year. This expenditure and the assumptions used to estimate it are presented in Table 7.1.

[11] Interim evaluation of 7th Framework Programme, November 2010, European Commission.

Table 7.1 - Industrial R&D Stimulated by Leiden University and LUMC

Assumption	Leiden University & LUMC
Income received from industry	€15,0 million
Income from EU programmes	€27,4 million
Seed fund	€750.000
Industrial spending stimulated by EU spending	25%
Seed funding to non start-up/spin-out companies	33%
Total industrial spending stimulated	**€22,1 million.**

Source: Leiden University Annual Report for 2010 and Information provided by LUMC

7.4.1 Impact of Industrial Spillover Effects

The total value of the industrial spillover effects stimulated by Leiden University and the LUMC can be estimated by applying the 3.88 multiplier derived in section 7.2 to the total amount of industrial R&D stimulated from Table 7.2. The number of jobs supported by this activity can be estimated by dividing the GVA impact by an estimate of the average GVA per employee.

It is however possible that some of this activity would have occurred anyway and therefore should not be attributed to Leiden University and the LUMC. It is for example possible that, if Leiden University and the LUMC did not exist, similar research would have been undertaken at other Dutch universities and this would also have stimulated further industrial research. However, the international reputation and high international rankings of Leiden University and the LUMC demonstrate that the research undertaken at these institutions is of a particularly high quality. Although it is likely that if neither institution existed some of the research they undertake would be undertaken by other Dutch institutions, it is likely that this research would not be of such a high quality and would not stimulate as much industrial R&D activity. For this reason, it is reasonable to assume that most of the impact arising from industrial R&D spillovers can be attributed to Leiden University and the LUMC. This analysis therefore adopts the relatively conservative assumption that 20% of industrial R&D stimulated would not otherwise have occurred.

It is not known how much of this activity occurs within Leiden and the South Holland areas however, given the concentration of life science activity in the city and the location of the BioScience Park it is likely that the proportion is high. It is therefore estimated that 50% of the activity occurs within Leiden and a further 25% occurs in the rest of the South Holland region.

Applying these assumptions to the level of industrial R&D activity stimulated suggests that industrial spillover effects attributable to Leiden University and the LUMC contribute €17,2 million GVA to the Dutch economy each year and support 234 jobs. This is summarised in Table 7.2.

Table 7.2: Impact of business R&D stimulated - Summary

	GVA (€m)	Employees (fte)
Leiden	8,6	71
South Holland	12,9	141
Netherlands	17,2	234

Source: BiGGAR Economics Analysis

8 TOURISM

Leiden is a historic city with a rich cultural heritage and successful tourism industry. This section considers the important contribution that Leiden University and the LUMC make to sustaining this industry.

8.1 Museums

Leiden is particularly renowned for its museums which play an important role in attracting visitors to the city and helping to support the city's tourism economy. Many of Leiden's museums[12] have close connections with Leiden University and/or the LUMC either as a result of historical connections, existing relationships or both. For this reason, Leiden University and the LUMC play an important role in supporting the tourism economy of the city. A list of museums which have a close relationship with the University and the LUMC is provided below:

- **Corpus** – opened in 2008, Corpus is a unique building designed in the form of a human body which allows visitors to experience a journey through the human body during which the visitor can see, feel and hear how the human body works. Corpus is unique among Leiden's museums in that it is the only one that has been developed as a private enterprise. The decision to locate the museum in Leiden was strongly influenced by the co-location of the LUMC;

- **Naturalis** – Naturalis is the product of a merger between the Zoological Museum Amsterdam (ZMA) and the National Museum of Natural History Naturalis and the branches of the National Herbarium of the Netherlands (NHN). Naturalis brings together several first-class natural history collections and houses the world's fifth largest specimen collection, all of which have now been made available for research designed to advance knowledge of biodiversity. The decision to locate Naturalis in Leiden was strongly influenced by the presence of Leiden University and the availability of suitable space within the Leiden BioScience Park;

- **Museum of Ethnology –** was established with two national collections: one from Koninklijk Kabinet van Zeldzaamheden (established in 1816) and a collection from Philipp Franz von Siebold who brought a collection of around 5,000 objects from Japan in the early 1830s;

- **SieboldHuis –** located in the former residence of Philipp Franz von Siebold, SieboldHuis is the first official Japan centre in the Netherlands. The museum retains close links with Leiden University;

- **Hortus Botanicus Leiden** – the Hortus Botanicus was founded by Leiden University in 1590 before being turned into a medicinal herb garden in 1594. It is the oldest botanical garden in the Netherlands and one of the oldest in the world. Today plants from all corners of the world are still collected and cultivated in the garden and greenhouses for research, education and exhibition purposes. The Garden always been a place where students come

[12] LUMC also has an anatomical museum which houses over 800 medical specimines and models however, as the museum is only open to the public on one or two days a year it does not contribute to Leiden's tourism economy and as such is not covered in this section.

to study plants and retains close links with the Faculty of Science;

- **National Museum of Antiquities –** founded in 1818, this museum is the national archaeological museum of the Netherlands. The Museum grew out of the collection of Leiden University and still closely co-operates with its Faculty of Archaeology. The museum focuses on ancient Egypt, the ancient Near East, the classical worlds of Greece, Eturia and Rome and the early (prehistoric, Roman and Medieval) Netherlands; and
- **Museum Boerhaave** – the collections of the Museum Boerhaave, the Netherlands national museum of the history of science and medicine, are regarded as among the most important in the world. The Museum's history dates to 1907, when a Historical Exhibition of Natural Science and Medicine was held in the Academy Building of Leiden University. The Museum retains close links to the scientific and educational communities today.

All of the museums listed above either have strong links to existing academic departments within Leiden University or the LUMC or were originally founded by individuals connected with the University. If the University and the LUMC did not exist, it is likely that the museums listed above would either not exist or (in the case of Corpus and NBC Naturalis) would not be based in Leiden. Without the museums, Leiden would attract fewer tourists, less tourism expenditure and the tourism sector would support fewer jobs.

8.1.1 Visitor Numbers

Visitor numbers for six of the seven museums listed above are available from the Leiden Museums Group and are presented in Table 8.1. Visitor numbers for Corpus are not published in the same source but are understood to be around 200.000 per year.

Table 8.1 - Visitor numbers to Leiden Museums

Museum	Visitor numbers (2009)
Hortus Botanicus Leiden	100.339
Museum Boerhaave	41.000
Museum of Ethnology	94.000
Naturalis	260.000
SieboldHuis	29.000
National Museum of Antiquities	65.000
Corpus	200.000
Total	789.339

The next step in estimating the impact of the museums is to consider how important they are to the decision of tourists to visit the city. Evidence for this can is provided by a Netherlands Tourism Board report which states that 41% of the 9.9 million incoming tourists who visited the Netherlands in 2009 visited a museum and that culture (including museums) was the main reason why one in ten of these tourists visited the Netherlands. From this it can be assumed that 10% of visitors to the museums listed above would not otherwise have come to

Leiden. This amounts to 79.000 visitors per year.

8.1.2 Visitor Expenditure

The final stage in estimating the impact of museums connected with Leiden University and the LUMC is to calculate the expenditure of visitors visiting the museums. As overnight visitors typically spend a lot more than day visitors, it is first of all necessary to estimate how many of the additional visitors are day visitors and how many are likely to stay overnight.

Information from the Municipality of Leiden Infobank suggests that approximately 82% of visitors to Leiden live within 100 km of the city. From this it can be estimated that 647.258 of the visitors highlighted above will be day trippers and the rest will be over night tourists. A 2008 poll conducted in Leiden suggests that on average, visitors to Leiden spend around €40 per day while average expenditure by hotel guests was €277. By multiplying these figures by the appropriate visitor numbers it can be estimated that visitors to museums connected to Leiden University and the LUMC spend almost €57 million/year.

For the reasons outlined above, it is estimated that approximately 10% of this spending (€5,7) is attributable to Leiden University and the LUMC. This can be converted into GVA impact by dividing by a turnover/GVA ratio for the tourism sector. Employment impact can then be calculated by dividing the GVA impact by an estimate of the average GVA/employee in the tourism sector. Finally, the impact of subsequent spending rounds can be estimated by applying GVA and employment multipliers for the tourism sector.

In this way it can be estimated that the impact of visitors to museums connected to Leiden University and the LUMC, which can be attributed to the University and/or the LUMC amounts to €8,2 million GVA in the Netherlands and supports 122 jobs. This impact is summarised in Table 8.2.

Table 8.2 - Impact of museums

	GVA (€m)	Employees (fte)
Leiden	4,7	83
South Holland	6,2	98
Netherlands	8,2	122

Source: BiGGAR Economics Analysis

8.2 Visits from friends and family

The presence of staff and students in the area create economic impact through their friends and family. These visitors spend money in the economy. The impact occurs as the spending increases turnover in local businesses. The increase in turnover supports employment.

This impact is calculated by assessing the visitor expenditure in each of the study areas. This is done by analysing where staff and students live (and therefore where the visitors stay) and applying the figure to an assumed spend in each area. The economic impact to the study areas is found by converting trip spend (turnover) to GVA and employees and applying multipliers.

This results in an impact from visits to friends and family of €0.06 million and less than one ftes in the Netherlands.

Table 8.3: Visits from friends and family - Assumptions

Assumptions	Value
No. of visits from friends and family per person - domestic	0.01
No. of visits from friends and family per person - overseas	0.10
Trip spend per domestic visitor (€)	157
Trip spend per overseas visitor (€)	596

Source:

Table 8.4: Location of spend of visitors

% trip spend in:	Visitors staying in:		
	Leiden	South Holland	Netherlands
Leiden	50%	30%	20%
South Holland	90%	90%	50%
Netherlands	100%	100%	100%

Source:

Table 8.5: Visits from friends and family - Summary

	GVA (€)	Employees (fte)
Leiden	0,01	0,1
South Holland	0,02	0,2
Netherlands	0,06	0,4

Source: BiGGAR Economics Analysis

8.3 Conference Impact

The research activity undertaken by Leiden University and the LUMC leads to a variety of conferences and events which generate economic impact because they attract people to the area who would not otherwise have visited.

In 2010, the LUMC alone was responsible for organising 14 major research congresses which attracted almost 2.500 delegates. Equivalent figures for Leiden University are not available however an estimate can be derived based on the number of research active staff in each organisation.

In 2010 there were 2.111 research staff at the LUMC. Dividing this by the number of delegates suggests that the LUMC attracted approximately 1.6 delegates per staff member. By applying this to the number of research staff at Leiden University of Leiden suggests that the University may have attracted around 1.200 delegates in 2010.

The impact of conferences will depend on how long delegates spend in Leiden and crucially on whether or not they stay overnight. Information about where delegates come from and how long they spend in Leiden is not available

however, assumptions can be made based on data from economic impact studies of similar Scottish universities[13]. This data suggests that approximately 30% of delegates are overnight visitors.

The next step is to calculate the expenditure of these visitors. As overnight visitors will require accommodation during their stay in Leiden, their expenditure will be significantly higher than visitors who only make a day trip. The Netherlands Board of Tourism and Conventions estimates that the average expenditure per day of a delegate on a business trip in 2009 was €312 and a poll of tourists in Leiden published on the Municipality of Leiden Infobank, suggests that the average visitor spends around €40 in the city.

Total expenditure by conference delegates can be calculated by multiplying the number of overnight visitors by €312 and the number of day visitors by €40. In this way it can be estimated that delegates to conferences hosted at Leiden University and the LUMC spend almost €0,5 million in the Leiden economy each year. This expenditure is directly attributable to the University and the LUMC because if the academics and research expertise were not based in Leiden there would be no reason for the conferences and events to locate there.

This expenditure can be converted into GVA by dividing by a turnover to GVA ratio for the tourism sector. The employment impact is estimated by dividing total GVA by an estimate of the average GVA by an employee in the tourism sector. Finally, the effects of subsequent spending rounds are accounted for by applying multipliers for the tourism sector. In this way it can be estimated that research related conferences and events hosted by Leiden University and the LUMC generate at least €0,3 million GVA for the Dutch economy each year and support 7 jobs.

It is however worth noting that, for a number of reasons, this impact is likely to be an underestimate. For example, it is assumed that all overnight delegates only stay one night in Leiden; however, in practice this is unlikely to be the case. Some events will last more than two days and require delegates to spend more than one night in the city and there are also likely to be delegates who choose to extend their stay in the city for leisure purposes. It is also likely that some delegates will choose to bring their partners along with them and these partners will generate additional expenditure. Unfortunately, no data is available to enable this additional expenditure to be calculated so the estimate of the impact of conferences and events presented below is therefore conservative.

Table 8.6: Conference Impact - Assumptions

Assumption	Value
No. of delegate day trips	3.293
No. of delegate bed nights	1.382
Trip spend per delegate day trip	€40
Trip spend per delegate bed night	€312

Source: BiGGAR Economics Analysis

The estimated contribution of Leiden University and the LUMC to the economy through hosting events is €0,7 million and 11ftes in Netherlands.

[13] Economic Impact of the University of Edinburgh (2008), BiGGAR Economics.

Table 8.7: Conference - Summary

	GVA (€m)	Employees (fte)
Leiden	0,4	7
South Holland	0,6	9
Netherlands	0,7	11

Source: BiGGAR Economics Analysis

8.4 Summary

The contribution of Leiden University and the LUMC to the economy through attracting visitors and visitor attractions results in an estimated €5,1 million and 90 ftes in Leiden, €6,8 million and 108 ftes in South Holland and €9,0 million and 134 ftes in Netherlands.

Table 8.8: Summary Tourism Impact - Leiden

	GVA (€m)	Employees (fte)
Museums	4,7	83
Visits from Friends and Family	0,01	0,1
Conferences	0,4	7
Total	***5,1***	**90**

Source: BiGGAR Economics Analysis (numbers may not sum due to rounding)

Table 8.9: Summary Tourism Impact – South Holland

	GVA (€m)	Employees (fte)
Museums	6,2	98
Visits from Friends and Family	0,02	0,2
Conferences	0,5	9
Total	***6,8***	***108***

Source: BiGGAR Economics Analysis (numbers may not sum due to rounding)

Table 8.10: Summary Core Impact – Netherlands

	GVA (€m)	Employees (fte)
Museums	8,3	122
Visits from Friends and Family	0,06	0,4
Conferences	0,7	11
Total	***9,0***	***134***

Source: BiGGAR Economics Analysis (numbers may not sum due to rounding)

9 SUSTAINABLE DEVELOPMENT

In addition to the quantitative impacts described elsewhere in this report, the research activity undertaken by Leiden University and the LUMC also gives rise to a range of less tangible, qualitative impacts. Although these benefits can not be quantified, their economic importance should not be underestimated as they represent an essential component of future sustainable economic growth. These unquantifiable economic benefits fall into two broad categories:

- benefits that support the Dutch knowledge economy – Leiden University and the LUMC both generate knowledge and disseminate this knowledge to students and the wider business community. This in turn helps to create wealth and employment in knowledge intensive sectors in Leiden and the rest of the Netherlands;

- benefits that create healthy economic foundations – there are a number of intangible key factors that do not directly generate wealth or employment but which underpin economic development and enable sustainable growth to occur. Such factors are difficult to define but include attractiveness and vibrancy, social cohesion, health and well being;

Unlike the impacts previously discussed, these impacts are not specifically attributable to any particular type of research activity but are instead the combined result of all the various research related activity that occurs. The various different types of research activity supported by Leiden University and the LUMC have in effect reached a critical mass, capable of supporting a self-sustaining cycle of positive socio-economic benefit.

9.1 Dutch Knowledge Economy

The research activity undertaken by the University of Leiden and the LUMC plays an important role in supporting the Dutch knowledge economy and the growing Dutch biotechnology sector in particular. It does this by supporting the transfer of new knowledge from academia to industry, creating new companies and providing the skilled workforce necessary to sustain them. The presence of spin-out and start-up companies and an appropriately skilled workforce helps to make the area more attractive to similar companies and encourages them to relocate to Leiden.

The research activity undertaken by the University of Leiden and the LUMC has also helped to support the physical infrastructure required to support new company formation and growth. The most visible manifestation of this is the Leiden BioScience Park which is home to more than 70 specialised life science companies that generate turnover of around €6.55 billion each year.

The presence of this successful cluster has helped Leiden to develop a global reputation in the field of biotechnology. The effect of this is to make the city an attractive destination for ancillary service providers such as health insurance companies of which there are at least three in Leiden.

As a result of the research activity at the University and the LUMC, Leiden has also developed an excellent research reputation. This reputation helps the city to attract top researchers from around the world who, in the process of undertaking their own research, further enhance the city's reputation and attract new research

income. This in turn serves to make the city an even more attractive destination for biotechnology companies and other researchers and helps to sustain and reinforce the sector.

9.2 Economic Foundations

Leiden University and the LUMC also make an important contribution to the economic foundations required by a sustainable economy.

9.2.1 Attractiveness and Vibrancy

Maintaining an attractive and vibrant location is essential to sustainable development because it enables an economy to retain and attract firms, people and tourists. Recognition of the importance of this factor has grown in recent years as culture driven development has become increasingly central to economic development policy.

Although measuring attractiveness and vibrancy is extremely difficult, its importance is demonstrated by never ending quest of urban planners, economic development professionals and policy makers to achieve it. The reason for this is that there is a huge difference in the levels of economic activity and quality of life in areas which are attractive and vibrant and those which are not. Although this factor is hard to describe, let alone quantify, important components of this factor can be identified. These include cultural activity and opportunities, population density, community and diversity (i.e. in type of shops, entertainment etc).

The most obvious contribution that the research activity of Leiden University and the LUMC make to the attractiveness and vibrancy of Leiden is by enabling lots of people (staff and students) to live there which in turn supports many jobs in the wider economy. It is not just the number of people the University and the LUMC attract to the area but also the type of people because research staff and students will tend to have a higher than average demand for cultural activities and entertainment. This means that Leiden can support a higher density and diversity of cultural and entertainment providers than other cities. This in turn enables the city to retain and attract even more students, workers and tourists, which creates further demand for these activities and creates a positive and sustainable spiral of attractiveness and economic activity.

Although all universities have this effect on their local area to some degree, the impact is particularly pronounced in Leiden because of the scale of research activity relative to the size and level of economic activity in the city as a whole. This means that the Leiden provides cultural and recreational services on a scale comparable with much larger settlements. The importance of this to Leiden's tourism sector is discussed in detail in Section 8 but the wider contribution to the attractiveness and vibrancy of the city can be summarised as follows:

- supporting the tourism sector through involvement with Leiden's museums;
- promoting cultural awareness by providing opportunities for the public to access and engage with nationally important collections through Leiden's museums; and
- encouraging community engagement through educational and community programmes.

9.2.2 Health & Wellbeing

Good health and well being are essential for a sustainable economy. When people do not enjoy good health, this can impair their productivity or even prevent them from working entirely. This has important social consequences for those involved and in an economic sense also reduces the productive capacity of the population as a whole. Addressing ill health also requires treatment and care which represents a financial burden on society.

Research activity at Leiden University and the LUMC plays an important role in improving the health and well being of Dutch residents and others around the world. This is achieved directly through the development of new treatments for medical conditions and indirectly through the creation of knowledge which will form the basis of future medical discoveries. This activity is of immeasurable importance to the patients and carers affected and also helps to reduce the financial burden of ill health to society.

A particularly good example of the contribution that Leiden University and the LUMC are making in this area is the research undertaken by Prosensa. (As a spin-out company, this activity is attributable to Leiden University and the LUMC.) As discussed in section 6.2.1, Prosensa is currently working with global pharmaceutical giant GSK to develop treatments for Duchenne Muscular Dystrophy (DMD). DMD is a devastating genetic disorder which occurs in around one in every three thousand male births. It results in muscle degeneration, difficulty walking, difficulty breathing and ultimately death (see Figure 9.1).

Figure 9.1 - Duchenne muscular dystrophy

DMD is a recessive form of muscular dystrophy which occurs in approximately one in every three thousand male births. It results in muscle degeneration, difficulty walking, breathing and ultimately death. The disorder only effects males and is caused by a mutation in the dystrophin gene, located on the X chromosome.

Symptoms, which usually appear in children before age 5, include progressive muscle weakness of the legs and pelvis and loss of muscle mass. Eventually this weakness spreads to the arms, neck, and other areas. As the condition progresses, muscle tissue wastes and most patients are wheelchair dependent by age 12.

Later symptoms may include abnormal bone development that can lead to skeletal deformities, including curvature of the spine. Due to progressive deterioration of muscle, loss of movement occurs, eventually leading to paralysis. The average life expectancy for patients afflicted with DMD varies from late teens to early to mid 20s.

Source: Based on sourced Wikipedia entry

DMD is a devastating disorder that also has a significant financial cost for society. An Australian study[14] published in 2007 estimated that the financial cost of Muscular Dystrophy amounts to approximately €200.000 per sufferer per year (2011 prices[15]). This cost is increases to over €650.000 per sufferer per year when the value of lost wellbeing from disability and premature death is included. If Prosensa succeeds in developing a treatment for DMD, it will dramatically improve the lives of sufferers and create a substantial financial saving.

[14] Access Economics Pty Ltd (2007), The Cost of Muscular Dystrophy, Muscular Dystrophy Association (Australia)

[15] Costs from the Access Economics report have been inflated to 2011 prices using the Australian CPI and converted to €s using an exchange rate of €1:AU$ 0.75.

10 SUMMARY OF BASELINE ECONOMIC IMPACTS

By bringing together the various sources of impact discussed in this report it can be estimated that Leiden University and the LUMC contributed €1,3 billion Gross Value Added (GVA) to the Dutch economy in 2010 and supported around 18.000 jobs. Of this, around €1,0 billion GVA and 14.000 jobs are in South Holland and €0,8 billion GVA and 11.000 jobs are in Leiden. A break-down of this impact is provided in Table 10.1.

Table 10.1 - Summary

	Leiden		South Holland		Netherlands	
	GVA (€ms)	Jobs (ftes)	GVA (€ms)	Jobs (ftes)	GVA (€ms)	Jobs (ftes)
Core Impacts	***376,3***	***5.377***	***505,5***	***6.862***	***711,3***	***9.293***
Direct Effect	272,2	4.092	272,2	4.092	272,2	4.092
Supplier Effect	7,4	96	31,3	405	78,9	1.041
Income Effect	58,2	716	137,9	1.619	253,9	2.939
Student Spending	22,9	285	41,6	492	75,2	867
Capital programmes	15,5	188	22,5	254	31,2	354
Leiden BioScience Park	***327,3***	***4.638***	***407,0***	***5.658***	***456,0***	***6.255***
Science Park Capital	25,5	310	37,1	419	51,4	582
Science Park Tenants	279,8	4.011	351,4	4.978	402,3	5.639
Businesses Stimulated in the Wider Community	22,1	316	18,5	262	2,3	33
Other Valorisation	***90,6***	***1.254***	***118,2***	***1.644***	***140,1***	***1.981***
Licensing	0	0	2,1	30	4,3	62
Start-ups and spin-outs	82,0	1.183	103,2	1.473	118,6	1.685
Industrial spillovers	8,6	71	12,9	141	17,2	234
Tourism Impacts	***5,2***	***90***	***6,8***	***108***	***9,0***	***134***
Museums	4,7	83	6,2	98	8,2	122
Visits Friends & Family	<0,1	<1	<0,1	<1	<0,1	<1
Conferences	0.4	7	0.6	9	0.7	11
Total	**799,2**	**11.359**	**1.037,5**	**14.271**	**1,316.5**	**17.662**

Source: BiGGAR Economics Analysis

In addition to the quantitative impacts summarised above, the research undertaken at Leiden University and the LUMC gives rise to a range of important but unquantifiable economic impacts; in particular, the way in which the University and the LUMC enhance the vibrancy and attractiveness of the city.

11 FUTURE IMPACT SCENARIOS

This section presents the results of a scenarios analysis which was undertaken to illustrate the effect that future changes in the amount of research funding secured by Leiden University and the LUMC could have on the overall impact of research activity.

11.1 Exploitation Efficiency

The impact of research funding does not just depend on the total amount of research funding secured but also on the efficiency with which this funding is translated into commercial outputs. This means that changes in the impact of research activity could be disproportionate to changes in research income.

Exploitation efficiency can be measured by calculating how much research funding is required to generate each research output (i.e. each licence, spin-out company, disclosure or patent). As exploitation efficiency improves, the amount of funding required to generate each output falls. An illustration of the exploitation efficiency of Leiden University and the LUMC in 2009 is provided in Table 11.1.

Table 11.1 - Exploitation efficiency of Leiden University and LUMC

Annual Research $m required for…	University of Edinburgh	Top 11 US Universities	LU + LUMC (2009)
1 Disclosure	1,9	2,6	2,9
1 Patent	4,2	4,0	8,3
1 License	6,1	9,5	9,2
$1m p.a. Royalty	26,4	32,8	36,4
1 Spin-out	43,9	98,2	60,0

Source: Leiden University

This table demonstrates that Leiden University and the LUMC are currently at or near the levels of exploitation efficiency demonstrated by the top 11 US universities. If recent performance continues, it is expected that exploitation efficiency at Leiden University and the LUMC will match that of the University of Edinburgh in the short to medium-term. This equates to an improvement of approximately 37% from the current position. Achieving this would bring significant benefits to the Dutch economy in terms of both jobs and wealth creation, however the capacity of Leiden University and the LUMC to achieve this will be influenced by future research funding decisions.

11.2 Scenarios

In order to illustrate the potential impact of changes in exploitation efficiency and how this might be affected by future changes in research funding five scenarios are considered:

- scenario 1 – research funding does not change but exploitation efficiency continues to improve at the current rate;

- scenario 2 – research funding increases by 5% but exploitation efficiency does not improve (perhaps because funding is diverted to other activities);
- scenario 3 – research funding increases by 5% and exploitation efficiency continues to improve at the current rate;
- scenario 4 – research funding falls by 5% and this leads to a proportionate fall in exploitation efficiency; and
- scenario 5 – research funding falls by 5% but exploitation efficiency continues to improve at the current rate.

These scenarios are summarised in Table 11.1.

Table 11.2 - Scenarios

Scenario	Change in research funding	Change in research exploitation
1	0.0%	+37%
2	5.0%	+5%
3	5.0%	+42%
4	-5.0%	-5%
5	-5.0%	+32%

11.2.1 Note on Research Exploitation and Exploitation Efficiency

Before considering the potential impact of changes in research funding it is important to make the distinction between research exploitation and exploitation efficiency. The former is an absolute quantity (number of spin-outs, value of royalties income, etc) while the latter is a relative value (amount of valorisation activity which can be supported by each € or research funding). This means that continued improvement in exploitation efficiency will not necessarily lead to more research exploitation if they occurs in the context of research funding cuts. For this reason, if exploitation efficiency continues to increase at the current rate (37%) and research funding increases by 5%, this will lead to a total increase in research exploitation of 42% as in scenario 3 (i.e. 37% + 5%).

11.3 Impact Drivers

The next step in the scenario analysis was to consider each of the main sources of economic impact and determine which of the sources of funding it was most likely to be driven by. The main drivers for each of the impacts discussed in this report are summarised in Table 11.3.

Table 11.3 - Impact drivers

Impact	Main Impact Driver
Direct, supplier & income	Total research funding
Student spending	Total research funding
Capital investment	Total research funding
BioScience Park Tenants	Tenant turnover growth
Business stimulated	Total research funding
Licensing	Royalty income
Start-ups & Spin-outs	Turnover of spin-outs
Industrial spillovers	Industrial income secured
Tourism	Total research funding

Source: BiGGAR Economics scenario analysis

The next step is to consider the relationship between each of the impact drivers and the two variables considered in the analysis: exploitation efficiency and research funding. For impacts driven by total research funding the relationship is direct and no further calculations are necessary at this stage however for impacts that are driven by other income streams, it is necessary to quantify the relationship.

The future impact from tenants at the BioScience Park will be driven by the level of existing activity and the level of turnover growth experienced by new and existing tenants. As changes in research funding and exploitation efficiency will not directly affect existing activity on the park, ongoing activity is excluded from this analysis. Given the strong relationship which exists between Leiden University and the LUMC it is however likely that changes in research funding and exploitation efficiency will have a strong influence on the future growth of the park. A drastic cut in research funding for example would be expected to reduce the stream of new spin-outs locating on the park each year.

Since 2004, the turnover at companies located on the BioScience Park has grown by an average of around 6% per year. If exploitation efficiency at Leiden University and the LUMC continues to improve at the present rate (i.e. it increases by 37% over the short-medium term) then it is reasonable to expect this rate of growth to increase to around 8.2% (i.e. a 37% increase on 6%).

Royalties income is also affected by exploitation efficiency. At present, Leiden University and the LUMC receive around €5,5 million in royalties income each year. If exploitation efficiency at Leiden University and the LUMC continues to improve at the present rate (i.e. it increases by 37% over the short-medium term) then it is reasonable to expect this to increase to around €7,6 million per year, i.e. 137% of €5,5 million). The same logic can be applied to the turnover of spin-out companies and industrial income.

In this way it can be estimated that the value of each of the impact drivers identified above in each of the five scenarios would be as set out in Table 11.4.

Table 11.4 - Value of impact drivers in each scenario

Scenario	Research Funding	Royalties	Spin-out turnover	Tenant turnover growth	Industrial income
1	337,9	7,6	2,8	536,5	20,6
2	354,8	5,8	2,1	410,4	16,5
3	354,8	7,8	2,9	556,1	22,1
4	321,0	5,2	2,0	371,3	13,5
5	321,0	7,3	2,7	517,0	19,1

11.3.1 Impact Elasticity

In considering the drivers of each type of impact, it was also recognised that funding reductions may not be applied equally across all areas of activity and as such could lead to disproportionate changes in some areas. It is for example easy to envisage a situation where, faced with significant funding cuts, Leiden University and the LUMC would choose to drastically reduce the number of research conferences and exhibitions they host and the amount of engagement with SMEs they support in order to protect other areas of activity.

To reflect this effect, assumptions were also made about the elasticity of the relationship between each type of impact and its primary cost driver. An elasticity assumption of less than 1 implies that the change in the impact will be less than any funding cut while an elasticity assumption of more than 1 implies that the change in impact will be greater than the funding cut. The assumptions used are summarised in Table 11.5.

Table 11.5 - Sources of impact and elasticity assumptions

Impact	Elasticity	Rationale
Direct, supplier & income	1.00	Direct relationship with income
Student spending	1.00	Direct relationship with income
Capital investment	1.50	Research funders will tend to cut capital funding by more than research programme funding.
BioScience Park Tenants	1.00	Direct relationship with income
Business stimulated	1.00	Direct relationship with volume of research activity
Licensing	1.00	Directly related to volume of research undertaken
Spin-outs	1.00	Less research funding is likely to make it more difficult for spin-outs to secure venture capital.
Industrial spillovers	1.20	When funding is tight, academics are likely to focus on activity that generates additional research income.
Tourism	1.20	Less research funding will cause researchers to cut less essential activity such as conferences

Source: BiGGAR Economics Scenario Analysis

11.4 Scenario Impact

Combining the assumptions set out in section 11.3 with the various scenarios will bring about changes of a different scale in each of the different areas of economic impact. This effect is illustrated in Table 11.6.

Table 11.6 - Change in types of impact

Impact	GVA Impact variance from baseline				
	1	2	3	4	5
Direct, supplier & income	0,0%	5,0%	5,0%	-5,0%	-5,0%
Student spending	0,0%	5,0%	5,0%	-5,0%	-5,0%
Capital investment	0,0%	5,0%	5,0%	-36,7%	-36,7%
BioScience Park Tenants	37,3%	5,0%	42,3%	-5,0%	32,3%
Business stimulated	0,0%	5,0%	5,0%	-5,0%	-5,0%
Licensing	37,3%	5,0%	42,3%	-5,0%	32,3%
Spin-outs	37,3%	5,0%	42,3%	-5,0%	32,3%
Industrial spillovers	37,3%	10,0%	47,3%	-25,0%	27,3%
Tourism	0,0%	5,0%	5,0%	-20,8%	-20,8%
Total	**15,4%**	**5,1%**	**20,4%**	**-7,4%**	**8,2%**

Source: BiGGAR Economics Scenario Analysis

Table 11.6 demonstrates the potential value of continued improvements in exploitation efficiency. Even if research funding were to remain unchanged in the short to medium-term, if recent improvements in exploitation efficiency are maintained, economic impact of Leiden University and the LUMC would be expected to increase by more than 15%. A relatively modest increase in research funding of 5% would amplify this effect to more than 20%.

On the other hand, a cut of 5% in research funding could be expected to reduce economic impact by more than 7%. If it exploitation efficiency continued to improve at the present rate however, this effect could be mitigated such that total economic impact would increase by more than 8%. The impacts of each scenario are summarised below.

Table 11.7 - Summary scenario analysis

Baseline/ Scenario	Economic Impact	Variance from Baseline	
Baseline	€1,3 bn	-	-
Scenario 1	€1,5 bn	+€202 million	+15,4%
Scenario 2	€1,4 bn	+€67 million	+5,1%
Scenario 3	€1,6 bn	+€268 million	+20,4%
Scenario 4	€1,2 bn	-€97 million	-7,4%
Scenario 5	€1,4 bn	+€108 million	+8,2%

Source: BiGGAR Economics

12 APPENDIX – ABBREVIATIONS AND TERMS

This section contains a list of common abbreviations and terms used in this report.

Assumptions are the data upon which impact calculations are based.

FTE – Full Time Equivalent a unit to measure employed persons or students in a way that makes them comparable although they may work or study a different number of hours per week. The unit is obtained by comparing an employee's or student's average number of hours worked to the average number of hours of a full-time worker or student. A full-time person is therefore counted as one FTE, while a part-time worker / student gets a score in proportion to the hours he or she works or studies. For example, a part-time worker employed for 20 hours a week where full-time work consists of 40 hours, is counted as 0.5 FTE.

GDP – Gross Domestic Product refers to the market value of all final goods and services produced within a country in a given period.

Gross Impact is a measure of the total economic impact generated from all sources before factors such as leakage, displacement and multiplier effects are taken into account (see Section 3.3).

GVA – Gross Value Added is also a measure of the value of goods and services produced in an area, industry or sector. GVA is linked to Gross Domestic Product (GDP) because both are measures of output. The relationship is defined as:

GVA + taxes on products - subsidies on products = GDP

As the total aggregates of taxes on products and subsidies on products are only available at whole economy level, GVA is used for measuring entities smaller than a whole economy (such as universities).

GVA/turnover ratio is a measure of the relationship between the total turnover of a particular sector and the GVA it generates. It is calculated by dividing total GVA by total turnover and can be used to estimate how much GVA will be created as a result of an increase in output (turnover or expenditure).

Net Impact measures the *additional* impact created after factors such as leakage, displacement and multiplier effects have been taken account of (see Section 3.3).

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 companies 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.

Technology Readiness Level (TRLs) are a measure of the maturity of evolving technologies. When a new technology is first invented it is not usually suitable for immediate application but must be subjected to experimentation, refinement, and increasingly realistic testing. TRLs are used to indicate how close a particular technology is to practical application. The measure was first developed by NASA in the 1980s but is now used by other government departments many of the world's major companies and agencies.