Mapping Research and Innovation
Understanding Amsterdam’s Competitive Advantage

11× Comparator Cities
AMSTERDAM BARCELONA BERLIN BRUSSELS COPENHAGEN DUBLIN HAMBURG MADRID MANCHESTER STOCKHOLM VIENNA
Cities around the world compete to attract talent, jobs, and investment. How well they define and communicate their competitive advantages will determine whether their future is one of growth and prosperity or one of decline and deprivation.

Amsterdam has long been a center of innovation. This report explores how the city is building its future on a foundation of research to create a sustainable knowledge economy.

Powered by world-leading universities, corporate research, and the knowledge they foster, Amsterdam is home to a thriving ecosystem of innovation that creates jobs, attracts talent, and feeds entrepreneurship.

To maximize the return on intellectual capital, cities must align development strategies and priorities with research strengths. While every city must define a strategy based on a unique set of circumstances, challenges, and opportunities, our case study of Amsterdam provides many lessons:

→ For city and regional policy makers, planners, and economic development professionals, better understanding their innovation ecosystem helps prioritize policy and investment as well as shape the message to investors and employers.
→ For real estate investors and developers, better data is key to predicting demand and identifying market opportunities.
→ For employers, mapping research and innovation provides a valuable tool for discovering R&D partners and allows better evidence-based location decisions.

Universities are the cornerstone of a city’s research and innovation offerings. In the World Economic Forum’s annual Global Competitiveness Report, higher education and training was cited as one of the pillars upon which national competitiveness is measured.

Across the following pages we explore how Amsterdam’s innovation and research leadership are signposts to its future competitiveness. This offers all stakeholders in that future a valuable new lens for making better informed decisions.

In Chapter 1, the report explores the importance of aligning research with city development policies and provides a macro picture of Amsterdam’s research base.

Amsterdam has a strong claim to being one of the top knowledge cities in Europe. Among the peer cities examined in this report, its research output per capita is second only to Copenhagen, while the relative impact of its research is the highest. This enables Amsterdam to attract both young knowledge workers that want to live in a highly educated, collegial city and companies seeking to employ such talent.

In Chapter 2, we analyze four dimensions of research performance to identify Amsterdam’s current and future research strengths. Amsterdam has an indisputable strength in medicine; among the eleven cities under comparison, Amsterdam ranked first and second respectively in terms of relative volume and impact of medical research.

Amsterdam also has a growing comparative advantage in computer science. Its output in computer science grew 9% per year over the past decade, from fewer than 400 articles in 2004 to over 800 in 2013. Over 32,000 people are employed in nearly 9,000 information and communication enterprises.
The city has a critical mass of expertise in these areas that can be leveraged to attract companies providing products or services in related sectors. Pharmaceutical companies seeking to develop new cancer drugs and looking to open or expand their R&D operations, for instance, may be interested in Amsterdam’s strength in oncology as they seek to partner with leading researchers to find solutions for some of the world’s toughest medical problems.

In Chapter 3, we look at how connected Amsterdam’s universities are to industry. From ING Group to KPMG, from Royal Philips Electronics to MRC Holland, Amsterdam is already home to companies spanning a diverse range of business sectors such as finance, electronics, and biotechnology. Our analysis shows that although Amsterdam produces highly impactful research, the connections between its universities and companies could be further strengthened.

In Chapter 4, we look at how companies benefit from co-locating their R&D facilities or offices in academic neighborhoods. Amsterdam offers corporate investors and placemakers many options, especially those looking to co-locate next to highly impactful medical research organizations, both those close to major academic medical centers and throughout the rest of the city.

At the same time, one of the drivers of Amsterdam’s success as a knowledge city is the constant influx of new ideas and talent into the city. More than 60% of all Amsterdam researchers began their scientific careers outside of Amsterdam. At the same time, between 2004 and 2013, Amsterdam researchers co-authored more than 100 publications with researchers from 66 different countries. This high level of academic mobility and international collaboration means that Amsterdam is a magnet for and benefits greatly from new talent and new ideas.

Although this study focused on the immediate Amsterdam Metropolitan area, the city benefits from proximity to other major knowledge cities, such as Rotterdam, The Hague, and Utrecht. The combined research enterprise of the larger Randstad area is formidable, rivalling that of the world’s largest metropolises such as London or Tokyo.
Preface

Elsevier Research Intelligence and the Urban Innovation Network are proud to partner on this project to examine how a city’s research strengths can help drive innovation, investment, and future jobs growth.

This report draws on Elsevier’s expertise in research management and evaluation to measure and analyze city competitiveness across multiple dimensions. Using Amsterdam as an extended case study, the report provides a holistic view of the city’s research strengths and its efficiency of knowledge transfer and research commercialization. Such insights can help policymakers and business leaders to better coordinate local development policies, inform corporate location decision-making, and direct long-term real-estate investments.

Elsevier and the Urban Innovation Network would like to thank everyone who helped provide insights and feedback on this report.
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Introduction

Cities are complex spatial, social, and economic systems. Forecasting their future is a difficult but necessary task for city leaders, employers and investors as they shape policy and define business strategy, and investment priorities. Understanding the human and intellectual capital assets that are key to being a truly “smart city” is essential to predicting a city’s future. Making better evidence-based decisions will help fuel innovation, growth, and prosperity.

Amsterdam has a long and well-established history of embracing new ideas and encouraging innovation. The symbiosis between research capacity and economic prosperity is an important dynamic in the city.

Whether it is medical research, computer sciences, its connections with major global pharmaceutical companies, or its position as a leading center for life and health sciences innovation, Amsterdam is a vibrant place of innovation – and that stimulates job growth and opportunities for businesses and stakeholders alike.

In today’s hyper-competitive, global knowledge economy, research institutions play a key role in generating innovation and defining future job growth, particularly when they work in the context of city-wide strategies for smart specialization.

For those with an interest in developing cities, this is a vast resource that will help them locate where economic prosperity and innovation will come from.

Universities, innovation hubs, and corporate research represent huge sources of such information as well as human capital. They define what cities are good at and enhance a city’s brand. More than simply anchor institutions employing large numbers of residents, universities and knowledge-hubs attract and train world-class knowledge workers. They also connect a city to cutting-edge ideas. They are hubs of expertise, technological innovation, and economic activity.

Universities create jobs and demand for real estate space, attract and retain talent, stimulate investment beyond their walls. They are the glue for clusters of industry as businesses position themselves nearby, hoping to absorb and learn from them. They have an impact on the development of their surrounding environment. For real estate investors they are occupiers and demand-drivers, and they are essential sources of information that can help them better forecast market performance.

But, the central role played by universities in the innovation ecosystem is not well understood and an untapped resource. While the relationship between research outputs and economic success is often acknowledged, it has rarely been systematically and strategically analyzed, especially at the city level – where there is most to gain.

Post financial crisis - where interest in short-term cycles has given way to a concern with long-term value - exploring a city’s innovation ecosystem is a valuable way of seeing the future with greater clarity.

Aligning a city’s policies, urban planning frameworks, and capital investments with the research strengths of nearby universities creates the potential for significant growth. It also allows for more confident investment and development strategies because they are based on an understanding of why a city thrives, where it is going, and what is really happening with business and innovation at the micro level.

Priorities shaped by collaboration between city, university, and business stakeholders where there interests are

[By the fifteenth century] Amsterdam had become a magnet for people of a modernizing bent … here people were grinding lenses for telescopes and perfecting the microscope. There were forty publishers in the city, and dozens more in other Dutch cities, and they were the most liberal – and freest from constrain – in Europe. Descartes had come to the Dutch provinces to have published what would become arguably the touchstone of modernity, A Discourse on the Method of Rightly Conducting One’s Reason and of Seeking Truth in the Sciences.

— Russell Shorto, Amsterdam: A History of the World’s Most Liberal City
introduction

Aligned have a much better chance of creating desired outcomes and defending against near-term shocks.

However, to gain competitive advantage from aligning decisions with a city’s research strengths, we must first answer several important questions:

→ What are a city’s comparative research and innovation advantages?
→ In what areas do we find the strongest connections between a city’s academic sector and industry?
→ How can a city promote and capitalize its competitive advantages to attract companies and more investment?

This report uses Amsterdam as a case study for a broader approach of identifying competitive advantage through research. In the following pages, we analyze Amsterdam’s research strengths and benchmark its performance against ten other European cities of comparable size and standing: Barcelona, Berlin, Brussels, Copenhagen, Dublin, Hamburg, Madrid, Manchester, Stockholm, and Vienna. We use multiple measures to show Amsterdam’s current and potential research strengths, particularly relative to other cities.

What makes Amsterdam stand out? How can the city use these strengths to attract more talent, companies, and investment? To help answer these questions, we will explore the existing nexus of collaborations between universities and companies in the city.

The data and analysis in this report are intended to help drive evidence-based decisions on which companies and industries should invest in Amsterdam, and how planning and policy-making can augment this process. It looks at the research landscape underlying the urban landscape, highlighting opportunities for collaboration, innovation, and economic development.

Universities and Real Estate

University cities are becoming hotspots for investment, as capital recognizes the many opportunities created by world-class educational and research institutions.

Take London. In recent years Imperial College has developed a flagship Research & Translation Hub, providing education and facilities for thousands of scientists and global corporate stakeholders – providing world-class knowledge transfer capabilities, and a £200m opportunity for real estate firm Voreda, which will develop the site.1

The same trends are present in Cambridge. Liberty Property Trust and Countryside are developing a 2.4m sq ft campus for biomedical research. Cambridge Biomedical Campus is being built in partnership with University of Cambridge, Cambridge University Hospitals among others as an urban healthcare village to foster innovation and collaboration between what the developers term an ‘ABC community’ of academics, businesses, and clinicians.2

The investment has already paid off. Anglo-Swedish pharmaceutical giant AstraZeneca recently announced its decision to locate its new R&D centre and corporate HQ to the campus.

Universities are also knowledge hubs that drive demand for office property. Universities have become important occupiers as they compete in the race for space. Their demand for large buildings capable of accommodating thousands of students that are close to transport links means universities are now competing with multi-national corporations for the best quality buildings. Due to this Savills recently reported that London universities had leased 597,569 sq ft of office space in the city centre since 2012 as they take part in an increasingly fierce battle for students.3

The strength of Amsterdam’s knowledge economy is perhaps one of the reasons why property services firm DTZ recently ranked it one of the top five business locations in Europe. With a research output per capita second only to Copenhagen and 32,500 research and development personnel in the city, its intellectual capital and innovative potential is an exciting prospect to businesses from all over the world and of all descriptions.4

1 http://www.ft.com/cms/s/0/6b317348-1c96-11e4-98d8-00144feabdc0.html#axzz3RenIIwvs
2 http://www.propertyweek.com/green-light-for-23m-sq-ft-cambridge-biomedical-campus/3151455.article
3 http://www.propertyweek.com/universities'-battle-for-students-sparks-race-for-london-campuses/5072774.article
4 http://www.dtz.nl/media/261170/choosing%20key%20cities%20january%202014.pdf
In 2013, Amsterdam published nearly 9 scholarly papers per 1,000 residents, second only to Copenhagen amongst the eleven European comparator cities.
In this chapter, we talk about the importance of aligning research with city development policies and provide a big picture of Amsterdam’s research.

BEYOND EDS AND MEDS        ALIGNING RESEARCH WITH CITY DEVELOPMENT
THE BIG PICTURE OF AMSTERDAM RESEARCH        EXAMPLES FROM AROUND THE WORLD

Madrid        In 2013, Madrid published over 19,000 publications, the highest among all eleven European comparator cities. However, normalized by population size, the city published only 3 scholarly papers per 1,000 residents.
1.1 The Importance of Research to City Competitiveness

Beyond Just an “Eds and Meds” Strategy

Universities and their research play a key role in defining the future of cities. Since the late 1990s, policymakers have touted the importance of an “Eds and Meds” strategy for two main reasons. First, universities and medical centers are the archetypal anchor institutions – those that tend to not move location and around which cities can build decades-long development plans. Second, universities and medical centers are major local employers of high-wage workers, whose sector has traditionally been less susceptible to forces of globalization and outsourcing. ¹

Yet, universities contribute far more to a city’s long-run economic prosperity than just being a stable and large employer. Universities train world-class knowledge workers in cutting-edge technologies. They act as incubators for innovations and products. Through the international collaborations that researchers cultivate, universities connect a city to the best thinkers and the newest ideas around the world. The indirect contributions that universities make to cities’ social and human capital help attract economic capital – large and growing companies, strong investment, and high-wage jobs.

Analyses of global competitiveness place strong emphasis on the importance of universities and research. In the World Economic Forum’s annual Global Competitiveness Report, “higher education and training” is one of twelve pillars via which national competitive is measured. ² In the Economist Intelligence Unit’s Hot Spots 2025 report that benchmarks cities’ future competitiveness, quality of education and higher education leadership are also key indicators. ³

The Importance of Knowing What You’re Good at

Focus and self-awareness are as important for a city as they are for an individual or company. In order for cities to maximize the return on their intellectual capital, it is important for them to align their development strategies and priorities with their research strengths. For example, it would be much easier for Amsterdam to attract the world’s foremost companies and the world’s best talent in advanced manufacturing or automobile R&D if its universities were outstanding in mechanical engineering. On the other hand, the city’s world class information and communication technology (ICT) research facilities and leading medical nanotechnology researchers should be as important in defining its identity and brand as its historical monuments or architecture.

“The strongest basis for regional economic growth is activity rooted in sound understanding of a locality’s comparative economic advantage […] Universities have extraordinary potential to enhance economic growth.”

— Sir Andrew Witty, CEO of GlaxoSmithKline and Chancellor of the University of Nottingham

“A robust innovation ecosystem depends on attracting talent, keeping it here, and making talent work for you. Universities play a key role in attracting young people, the talent of the future, but the city has to be attractive for those students to want to come. Businesses have to provide jobs to keep them here. By working together, we can make our city a place where innovative, creative, and young talent comes together.”

— Louise Gunning-Schepers, President of the Executive Board, University of Amsterdam at UIN Amsterdam Summit (January 28, 2015)

AMSTERDAM’S HISTORICAL AND CURRENT REPUTATION AS A KNOWLEDGE CITY

From the Enlightenment in the seventeenth century to today, Amsterdam has a long historical reputation of being a Knowledge City, a crossroads for ideas and an incubator of great thinkers.

In his book on Amsterdam, Russell Shorto writes, “Baruch de Spinoza was the first true philosopher of modernity, the first to argue systematically that religion and politics should be pulled apart, and an early advocate of democracy. His take on philosophy’s thorniest problems – that of the relationship between mind and brain – matches up with much of what scientists today have deduced from empirical study. He was the first and maybe greatest philosopher of liberalism, who made it his life’s work to comprehend what ‘freedom’ means and how individuals can be free. Spinoza did all of this precisely because he was born in Amsterdam. … He took in the events of his time, the history and deeds of the city where he was born, and distilled that experience into a philosophy.”

Today, Amsterdam continues to be seen as a major knowledge city. While economic prosperity undoubtedly generates great research, this is decidedly a two way process. In Ernst & Young’s 2014 attractiveness survey, Amsterdam is considered Netherlands most attractive city, with 22% citing the skills level of local employees as the most attractive aspect. In 2011, Amsterdam’s two major universities – the University of Amsterdam and VU University Amsterdam granted over 700 PhDs, over 10,000 Master’s degrees, and over 7,500 Bachelor’s degrees. Within North Holland, which comprises Greater Amsterdam and the surrounding suburbs, EuroStat/OECD estimated in 2012 that there are over 32,500 total R&D personnel across all sectors.

For this report, we found over 1,200 institutions and organizations within Amsterdam in our publications database, 67 of which have produced more than 50 publications. These 67 entities comprise the core of our dataset for defining the research output and strengths of Amsterdam. They include the aforementioned major universities and affiliated medical centers, research institutes (such as the Netherlands Cancer Institute, CWI [Centrum Wiskunde & Informatica] Amsterdam, Foundation for Fundamental Research on Matter, the Netherlands Institute for Neuroscience), local hospitals (such as Slotervaart and Antoni van Leeuwenhoek Ziekenhuis), and corporations (Royal Phillips Electronics).

Using City-Level Research Data to Identify Your Research Strengths

So, how can we identify a city’s research strengths? Just as there are many ways to forecast the strengths of a company, there are many ways to analyze the research strengths of a city. One way to analyze the research performance of any entity – a university, city, or even country – is to look at the quantity and quality of peer-reviewed publications produced. Simply put, how much science is being produced, and how good is it? The rest of this chapter and the next provide examples of indicators to help answer that question.

The Big Picture: Amsterdam produces a high level of research per capita

From 2004 to 2013, researchers in Amsterdam produced over 90,000 publications, or about 0.45% of all publications in the world. On average, the city’s annual research output grew from ~6,700 publications to nearly ~11,500, a compound annual growth rate (CAGR) of over 6%. Even when adjusting for the growth rate of all publications in the world (5.19%), which is analogous to adjusting for inflation, Amsterdam’s publication growth rate is still above average, and it ranks sixth among the eleven European cities. Over this period, Barcelona and Dublin saw the highest growths in their overall research output (8.6% and 8.2%, respectively) and their research output per capita.

→ Amsterdam is quite prolific in generating research, producing more publications per capita than all the other European cities except Copenhagen.

→ The relative impact of Amsterdam’s research is ahead of that of all ten other European cities and well above the world average of 1.0.

→ The relative impact of research from all eleven cities has increased from 2009 to 2013, with Brussels and Barcelona achieving the greatest absolute and relative growths.

Main Takeaways

→ Amsterdam has a strong claim to being one of the top knowledge cities in Europe. Its research output per capita is second only to Copenhagen within this group of peer cities, and the relative impact of its research is the highest.

→ Further promoting this identity as a top knowledge city can help Amsterdam attract knowledge workers that want to live in a highly educated and collegial city as well as companies seeking to hire such talent.

How do we measure research performance? Output and Impact

For academic researchers, peer-reviewed publications are the medium via which they both communicate new ideas and assess each other’s contributions. Scholarly peer-review is a practice by which a publication draft or manuscript is scrutinized by other experts in the same field; the draft will be published only if those experts determine that it is suitable for publication.

A publication usually cites or makes formal references to previous works upon whose findings or ideas its research builds. The number of citations a publication receives from subsequently-published articles can therefore be interpreted as a proxy of the quality or importance of that publication.

We used Scopus®, the world’s largest database of publication abstracts and citations, to analyze the amount of research produced by Amsterdam and the other ten cities. Simply counting the number of publications produced and citations received is a straightforward and transparent way of measuring research output and impact respectively. However, as with other macroeconomic indicators, we often normalize or benchmark these raw counts to put research output and impact in context.

Just as reporting GDP figures per capita provides a more nuanced indicator of a country’s economic performance, dividing a city’s research output by its population provides a proxy for how productive a city’s research sector is. Likewise, just as using PPP (purchasing power parity) provides a consistent way to compare values of economic goods over time and across different national currencies and price indexes accounting for inflation, we use a normalized measure of citation count called “Field-Weighted Citation Impact” (FWCI) that accounts for differences in the expected citation rate across different research subject areas, years, and types of publications.

For more detailed information on the data sources and methodology of this report, please see the supplementary methods appendix, available online at http://www.elsevier.com/research-intelligence/amsterdam-report/.
Figure 1.1 — Publications per 1,000 residents for Amsterdam and ten other European cities, from 2004 to 2013 per year. Missing data represented by gaps in graph. Sources: Publication data from Scopus®, city population data from Eurostat

Figure 1.2 — Change in field-weighted citation impact for Amsterdam and ten other European cities, from 2004 to 2013. Sources: Publication data from Scopus®
DRAWING INSPIRATION FROM AROUND THE WORLD

Aligning research strengths with larger economic development goals is a hot topic. Below are some examples around the world of other initiatives, at both the national and regional levels, that have also focused on how research can inform and catalyze economic growth.

In 2013, Sir Andrew Witty, CEO of GlaxoSmithKline and Chancellor of the University of Nottingham, published an independent review for the UK Department of Business, Innovation and Skills that explored “how UK universities can support growth by working with organizations such as Local Enterprise Partnerships (LEPs), as the local bodies responsible for creating strategies to drive economic growth across the country.” Working with Elsevier Research Intelligence, the Witty Review analyzed the research output and impact of UK universities in eleven Industry Strategy Sectors and “Eight Great Technologies,” such as Big Data and Energy-Efficient Computing, Regenerative Medicine, and Robotics and Autonomous Systems. Below (left) is an excerpted heat map from the analysis which displays the top 20 UK universities in the field of Regenerative Medicine.

In 2014, the Illinois Science and Technology Coalition (ISTC) published the “Illinois Science and Technology Roadmap.” Working closely with Elsevier and other partners, the report analyzed the state’s main research and innovation strengths using publication and patent data and provided recommendations on how local governments and businesses can further leverage those strengths to increase their business competitiveness. Below (right) is an excerpt from an in-depth analysis of Illinois’s strengths along multiple metrics relating to the area of Alloys and Metals.

### Alloys and metals collaboration scorecard

#### Metrics

<table>
<thead>
<tr>
<th>Organizations (companies and research institutions)</th>
<th>Unique potential connections</th>
<th>Illinois impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>151</td>
<td>1,726</td>
<td>Relevant industries from state economic development plan¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agribusiness, food processing, and technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biomedical and biotechnical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information technology and telecommunications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machinery and fabricated metals product manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transportation and logistics</td>
</tr>
</tbody>
</table>

#### Illinois impact

- **Leading counties²**: Champaign, Cook, DuPage, Effingham, Jackson, Jasper, Kane, Lake, McLean, Madison, Mercer, Peoria, Rock Island, Sangamon, St. Clair, Tazewell, Warren, Will, Winnebago

#### Research impact

As measured by field-weighted citation impact (FWCI)⁴

<table>
<thead>
<tr>
<th>Leading research areas</th>
<th>FWCI (average = 1.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals and alloys</td>
<td>1.24 (+24%)</td>
</tr>
<tr>
<td>Surface coatings and films</td>
<td>1.04 (+4%)</td>
</tr>
</tbody>
</table>

#### Related patent strengths

As measured by OTR™⁵

<table>
<thead>
<tr>
<th>Leading patent classes</th>
<th>OTR™ (average = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal treatment</td>
<td>111.1</td>
</tr>
<tr>
<td>Specialized metallurgical processes, compositions for use therein, consolidated metal powder compositions, and loose metal particulate mixtures</td>
<td>111.0</td>
</tr>
</tbody>
</table>

#### Community

**Key research institutions**

- Argonne National Laboratory
- Illinois Institute of Technology
- Northwestern University

**Federal funders**

- Department of Defense
- Department of Energy
- Department of Homeland Security
- National Science Foundation
- National Institute of Standards and Technology
- National Institutes of Health

**Notable companies**

- Caterpillar
- Deere & Company
- Illinois Tool Works
- QuesTek Innovations

#### Notes

¹The Illinois economic development plan, Department of Commerce and Economic Opportunity (DCEO), July 2014.

²Innovation activity measured based on datasets used to create the Illinois technology cluster network model.

³A connectivity index below 0.4 indicates a lack of cluster integration. A value above 0.7 suggests an increasingly insular community with more limited assimilation of new ideas and partnerships.

⁴The U.S. average FWCI is 1.0; therefore, a score of 1.5 indicates Illinois research publication strength is 50 percent above the national average.

⁵The OTR™ system employs a regression model to determine the probability that a patent will be maintained—an indication of patent quality.

Amsterdam’s research in medicine is one of its current strengths. Among the eleven European comparator cities, it is second only to Manchester in terms of relative world download share.
In this chapter, we analyze four dimensions of research performance to identify Amsterdam’s current and future research strengths.

**Dimensions of Research Strength**

<table>
<thead>
<tr>
<th>Current Strength in Medicine</th>
<th>Future Strength in Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam’s research in computer science is one of its possible future strengths. From 2004-2013, 6.7% of Barcelona’s research output in computer science ranked in the top decile worldwide in terms of citation count, second among the eleven European comparator cities.</td>
<td></td>
</tr>
</tbody>
</table>
2.1 Amsterdam’s Current Research Strengths

If aligning economic development strategies with research strengths is important, how do we determine what a city’s research strengths actually are?

Given a city’s size and overall level of research, in what research areas does it specialize? How many of Amsterdam’s publications in a particular research areas are downloaded, not only by academic researchers but by anyone interested in the research? What is the relative impact of that research, especially compared to research from other peer cities, such as Berlin or Stockholm? In what areas does Amsterdam produce the world’s top publications in terms of citations?

In order to identify the areas in which Amsterdam has a comparative advantage in research relative to other European cities, we looked at four main dimensions of research performance – relative volume, usage, impact, and excellence.

**Dimensions of Research Strength**

**Relative Volume**
This measure is analogous to the location quotient for an industry; it divides the relative proportion of a city’s research publications in a given area by the relative proportion of the world’s publications in that area. For example, from 2004 to 2013, Amsterdam’s relative volume of neuroscience publications was 2.45, or 145% above the world average. Relative to the other ten European cities, Amsterdam ranked first. The cities with the next closest relative volumes in this area were Stockholm and Berlin at 1.97 and 1.79, respectively.

**Relative Usage**
Usage provides a different perspective on research strength. First, unlike citations, which take time to accumulate, usage metrics provide a more immediate snapshot of how much attention a publication gets. Second, while citation counts provide a good measure of how much the academic research community is building on a piece of research, usage metrics are collected from all users, including those that tend not to publish (e.g., researchers working in clinical medicine or based in corporations). For this report, we draw on publication usage statistics from Elsevier’s ScienceDirect® publishing platform, which publishes nearly 25% of all articles in the world and records over 700 million downloads per year.

**Relative Impact**
As mentioned in the previous chapter, field-weighted citation impact (FWCI) provides a normalized measure of citation counts.

**Research Excellence**
This measure looks at a city’s relative share of the most impactful research – that which is among the top decile worldwide in terms of citations within a given subject area. We call these star articles.

For more detailed information on the data sources and methodology of this report, please see the supplementary methods appendix, available online at http://www.elsevier.com/research-intelligence/amsterdam-report/.
High relative volume and relative impact in medicine

- As the radar pie chart below shows, Amsterdam produces a high absolute (denoted by the size of the pie slice) and relative volume (denoted by the height of the pie slice) of its publications in medicine. It is nearly twice the world average in relative volume, given the city’s size and overall research output. Moreover, as indicated by the color gradient, the relative impact of Amsterdam’s research in medicine is also quite high, more than twice that of the world average.

- How did Amsterdam fare relative to other peer European cities? Among the eleven cities under comparison, Amsterdam ranks first and second respectively in terms of relative volume and impact in medicine.

Amsterdam produces a high relative volume of output in other subject areas adjacent to medicine, such as psychology, neuroscience, health professions, and dentistry.

Figure 2.1 — Radar pie graph of Amsterdam’s publications by subject area, where absolute publication volume corresponds to size of the pie slices, field-weighted citation impact corresponds to color, and relative publication volume corresponds to the height of the pie slice, from 2004 to 2013. Source: Publication data from Scopus®
Diving deeper: Uncovering Amsterdam’s specific research strengths within Medicine

→ Over the past decade, within Medicine, Amsterdam produced the highest level of output in oncology (over 3,600 publications) followed by radiology, nuclear medicine and Imaging (over 2,400 publications). For both sub-areas, Amsterdam’s output was more than that of each of the other ten European cities.

→ Amsterdam’s output in clinical neurology and cardiology and cardiovascular medicine achieved citation impacts of 2.18 and 2.03, respectively. In both cases, the relative citation impacts of Amsterdam’s publications in these areas are higher than those of the other ten European cities.

→ Amsterdam’s high levels of relative output and impact in these sub-areas suggest that the city has a critical mass of expertise, which can be further leveraged to attract companies providing products or services in adjacent areas. For example, pharmaceutical companies seeking to develop new cancer drugs and looking to open or expand their R&D operations may be especially interested in Amsterdam’s strength in oncology.

**Figure 2.2** — Scatterplot of total publications versus field-weighted citation impact of Amsterdam’s publications by sub-areas within medicine, from 2004 to 2013. Source: Publication data from Scopus®
AMSTERDAM AS A HUB FOR BRAIN SCIENCE

Brain science is a highly interdisciplinary research field that spans medicine, neuroscience, and several other subject areas. In 2012, the European Commission approved €1 billion in funding for the Human Brain Project (HBP), a massive collaboration across 24 countries and 112 institutions. The main goals of the HBP are to create new platforms for collecting and integrating brain research data and then use that data to develop a computational model of the human brain.

Of the eight partner institutions from the Netherlands in this project, five are based in Amsterdam (Centrum Wiskunde & Informatica [CWI], VU University Amsterdam, University of Amsterdam, the Royal Netherlands Academy of Arts and Sciences, and Synaptologics BV).

In 2014, as part of a larger study that examined changing trends in brain science, Elsevier analyzed the top 15 countries producing research in this field. The graph below displays a radar chart detailing the relative impact (FWCI) and relative usage (FWDI) for each country. In the lower left corner, the Netherlands occupies a leading position in both categories.

Strong relative usage of Amsterdam’s research in Medicine

- Amsterdam’s research in medicine is downloaded at a rate of nearly 40% above the world average, just second only to Manchester, whose publications in medicine are downloaded at a rate of 44% above the world average.

- The high relative levels of usage suggest that Amsterdam’s research in Medicine is popular and relevant not only to other academics, but also corporations and the general public. Unlike citation-based measurement, usage statistics cover readers who do not routinely publish (and therefore cite or are cited). Corporate researchers often fall into this category because of in-house confidentiality rules surrounding the development of new technology or products, which are likely to be commercially sensitive. High corporate readership of Amsterdam’s research in Medicine suggests that this work is particularly relevant to their day-to-day concerns.

Figure 2.3 — Relative world download share of publications in medicine for Amsterdam and ten other European cities, from 2004 to 2013. Sources: Usage Data from Elsevier ScienceDirect®

High level of research excellence in medicine

- 23.5% of Amsterdam’s publications in medicine are classified as star articles, those whose citation counts are in the top decile of all publications in medicine in the world. Only Copenhagen has a higher proportion of its publications in medicine classified as star articles.

- Amsterdam’s high level of research excellence suggests that its research is not just above average but truly world-class. This can help attract companies that are looking to partner with the best researchers in the world to find solutions to some of the world’s toughest medical problems.

Figure 2.4 — Proportion of star articles in medicine for Amsterdam and ten other European cities, from 2004 to 2013. Sources: Publication data from Scopus®
2.2 Amsterdam’s Future Research Strengths

Corporate location decisions and real estate investments have long term horizons which require detailed knowledge and a heightened awareness of both local and global market trends. In the same way, it is important to be able to identify and anticipate the growth and decline of a city’s research competencies. By tracking growth rates and other trends related to the four main dimensions of research performance that we introduced in the last section, we can make informed predictions about a city’s future research strengths and the development opportunities this entails.

Computer Science and Data Science

Many cities want to emulate the technology template of Silicon Valley or the biotechnology template of the Cambridge/Boston area, but few have the same comparative advantages that Amsterdam possesses in terms of existing human capital. According to the last update of business demography in Eurostat in 2010, Amsterdam has more than 32,000 people employed (about 6.7% of all employees) in nearly 9,000 information and communication enterprises.4

Amsterdam’s output in computer science nearly doubled over the past decade, from fewer than 400 articles in 2004 to over 800 in 2013. This growth rate of 9% per year easily surpassed the growth rate of Amsterdam’s overall output (6.15%). In terms of publications per capita, Amsterdam’s output in computer science is second among the eleven European cities. Moreover, at 85% above the world average, the relative citation impact of Amsterdam’s research in computer science is higher than that of the ten other European cities.

Usage of Amsterdam’s research in computer science has increased in relative as well as absolute terms in recent years. Amsterdam’s research in computer science from 2004 was downloaded on average 15% less than the world average, but its 2013 research has been downloaded on average 9% more than the world average. Moreover, the proportion of Amsterdam’s research in computer science that is in the top decile worldwide in terms of citation count has increased from 14.5% to over 20%. These growth trends suggest that Amsterdam is growing a world-class base of computer science researchers, which can both help train the next generation of tech workers and attract the most promising tech companies.

Furthermore, the quality of Amsterdam’s research output is quite high in sub-areas adjacent to computer science, such as applied mathematics (FWCI of 1.91, 1st among the eleven European cities), modelling (1.62, 2nd among the eleven European cities), and information systems and management (FWCI of 2.33, 2nd among the eleven European cities). The city’s research strength in these areas is particularly important for further growing its current cluster of finance and logistics companies.

Lessons from New York: Identifying and Cultivating Research Strengths

As Bruce Katz and Jennifer Bradley detail in their book, The Metropolitan Revolution, New York City’s Applied Science Initiative is a good example of how city leaders identified research areas in which the city had a growing but not dominant strength and then made additional investments in those areas.

“For its part, New York City already had a few tech clusters - some quite established, others just emerging. There was what one report called ‘a better than average foundation of [information technology] and biotech companies that could easily be built upon’ as well as a large and growing digital media sector. Since these and many of the city’s other clusters, such as fashion, media, and health care, needed engineering and technical talent, the NYEDC [New York City Economic Development Corporation] concluded that the game changer they were looking for would be a new science and engineering graduate campus.”

After a year-long competition in which universities around the world were invited to submit proposals to build campuses, the city actually moved forward with three ideas – a joint Cornell and Technion-Israel Institute of Technology graduate school on Roosevelt Island, a New York University campus called the Center for Urban Science and Progress, and Columbia University’s new Institute of Data Sciences and Engineering.

Table 2.1 — Number of Amsterdam’s publications in sub-areas within computer science and adjacent sub-areas, rank among eleven European cities, and publication output growth trend lines, from 2004 to 2013. Sources: Publication data from Scopus®

<table>
<thead>
<tr>
<th>Sub-areas within Computer Science and Adjacent Fields</th>
<th>Total Output, 2004–2013</th>
<th>Rank Among Eleven Cities</th>
<th>Output Growth Trend Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Computer Science</td>
<td>2,099</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>1,854</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Computer Science Applications</td>
<td>1,479</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Artificial Intelligence</td>
<td>1,041</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Applied Mathematics</td>
<td>985</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Computer Networks and Communications</td>
<td>897</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Computational Theory and Mathematics</td>
<td>825</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Information Systems</td>
<td>824</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Statistics and Probability</td>
<td>805</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Human-Computer Interaction</td>
<td>708</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Computer Vision and Pattern Recognition</td>
<td>656</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Modelling and Simulation</td>
<td>613</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Hardware and Architecture</td>
<td>512</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Management Science and Operations Research</td>
<td>492</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Computer Graphics and Computer-Aided Design</td>
<td>405</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Statistics, Probability and Uncertainty</td>
<td>334</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Computer Science (miscellaneous)</td>
<td>246</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Information Systems and Management</td>
<td>215</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Signal Processing</td>
<td>210</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Summary View: Amsterdam’s Research Performance across Subjects

The ranking table on the next page summarizes Amsterdam’s performance along the 27 subject areas for the following research metrics.

A Relative Publication Volume
B Publication Output Growth
C Field-Weighted Citation Impact
D Field-Weighted Citation Impact Growth
E Research Excellence (Top 10% Worldwide)
F Research Excellence (Top 10% Worldwide) Growth
G Relative Usage Volume
H Relative Usage Volume Growth
Table 2.2 — Relative ranking of Amsterdam among eleven European cities in multiple research performance metrics, from 2004 to 2013. Sources: Publication data from Scopus®

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural &amp; Biological Sciences</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Arts &amp; Humanities</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Biochemistry, Genetics &amp; Molecular Biology</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Business, Management &amp; Accounting</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>11</td>
<td>11</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Chemistry</td>
<td>11</td>
<td>11</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Computer Science</td>
<td>7</td>
<td>10</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Decision Sciences</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Dentistry</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Earth &amp; Planetary Sciences</td>
<td>10</td>
<td>11</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Economics, Econometrics &amp; Finance</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>1</td>
<td>8</td>
<td>4</td>
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<tr>
<td>Energy</td>
<td>11</td>
<td>9</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Engineering</td>
<td>11</td>
<td>11</td>
<td>1</td>
<td>11</td>
<td>2</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>9</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Health Professions</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Immunology &amp; Microbiology</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Materials Science</td>
<td>11</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Mathematics</td>
<td>7</td>
<td>11</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Medicine</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Neuroscience</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Nursing</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Pharmacology, Toxicology &amp; Pharmaceutics</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Physics &amp; Astronomy</td>
<td>11</td>
<td>10</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Psychology</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Veterinary</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>
In 2013, nearly 5% of Amsterdam’s scholarly papers were the result of academic-corporate collaborations; More than 7% of Hamburg’s scholarly papers were the result of academic-corporate collaborations, third among the eleven European comparator cities.
In this chapter, we analyze how well connected Amsterdam's universities are with industry through several indicators of knowledge transfer.

### Measures of Knowledge Transfer
- Collaborating with Industry
- Patent Citations

### Evaluating Current and Potential Connections in the Pharmaceutical Industry

Amsterdam's research in immunology & microbiology is cited in patents nearly six times more than one would expect, the highest among the eleven European comparator cities; similarly, Berlin's research in the same area is cited more than four times more than one would expect.
3.1 Connecting the Dots: Moving from Research to Commercialization

There is a powerful relationship between research strengths and economic value. A key consideration for city planners and place makers making decisions about where to invest is how well connected Amsterdam’s universities are to industry. How much are people from the academic and corporate sectors collaborating with each other? How much knowledge transfer is occurring? To what extent are the insights generated by Amsterdam’s universities being used and commercialized by industry?

From the ING Group to KPMG, from Royal Philips Electronics to MRC Holland, Amsterdam is already home to companies spanning a diverse range of industries, such as finance, electronics, and biotechnology. Moreover, although not globally headquartered in Amsterdam, several other companies maintain large campuses in the greater metropolitan area, such as Cisco Systems, Nike, Hewlett Packard, Adidas, and General Electric.5

Collaborating with Industry

→ From 2004 to 2013, about 5.3% of Amsterdam’s publications were co-authored with at least one corporate researcher, putting it in the seventh position among the eleven European cities.

→ Copenhagen and Stockholm have the highest levels of academic-corporate collaboration over the entire period, at 10.3% and 8.5% respectively. In recent years, however, the relative share of academic-corporate collaborations for those cities has declined.

→ Although Amsterdam produces highly impactful research, there is clearly an opportunity to strengthen the connections between its universities and companies.

Figure 3.1 — Proportion of total publications that are academic-corporate collaborations for Amsterdam and ten other European cities, from 2004 to 2013 per year. Sources: Publication data from Scopus®


Knowledge Transfer from Universities to Industry

There are many ways to analyze how knowledge is transferred from university research labs to industry, from the number of highly skilled graduates that companies hire to the number of startups or spinoffs created from university research projects. One of the main challenges with any approach is the availability of data that goes beyond case studies or the ad hoc measures of individual universities, allowing for comparisons across cities or regions. We deal with this challenge by drawing on globally comprehensive, linked datasets on peer-reviewed publications and industry patents.

Academic-Corporate Collaboration
One way of measuring knowledge transfer is to directly count the number of publications in which there are co-authors from both a university and a company. We call these academic-corporate collaborations.

Academic Patent Citations
Another way of measuring knowledge transfer is to count formal citations of academic publications in industry patents. We analyze this phenomenon through linkages between the Scopus® and the Lexis-Nexis® patent databases, which includes over 96 million records from over 100 patent authorities, including the World Intellectual Property Organization (WIPO), the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO).

For both of these research measures, context is key. For example, there will naturally be more (in absolute terms) academic-corporate collaborations in subject areas with higher overall levels of academic publications, such as medicine and fewer (in absolute and relative terms) academic-corporate collaborations in less commercializable subject areas such as the arts & humanities. Likewise, cities that produce more research overall will also generate more (absolute) academic-corporate collaborations. To normalize for these distortions, we calculate a city’s relative share of a given measure, similar to an industry’s location quotient. For example, relative academic patent citation share in immunology & microbiology is the actual number of times Amsterdam’s publications in immunology & microbiology are cited in patents divided by the expected number, which is based on the world average rate of academic patent citations in immunology & microbiology.

For more detailed information on the data sources and methodology of this report, please see the supplementary methods appendix, available online at http://www.elsevier.com/research-intelligence/amsterdam-report/.

Strong Connections between Academia and Industry in Life and Health Sciences

→ Within medicine, immunology & microbiology, neuroscience, and other adjacent life and health sciences areas, Amsterdam’s academic research is cited at a higher relative proportion in patents. This suggests that Amsterdam’s research in these areas is very commercializable.

→ Amsterdam’s research in immunology and microbiology scores highly along both metrics of knowledge transfer. Given the subject’s publication share, it is cited in patents nearly six times more than one would expect. Likewise, the share of academic-corporate collaborations in immunology and microbiology is nearly three times what one would expect given the subject’s publication share.

→ Amsterdam’s relative performance on these metrics is the highest among all eleven European cities. This suggests that although the overall connections between universities and industry in Amsterdam can be improved, its cross-sector connections within the life and health sciences are among the strongest of any European cities. The dense social capital can help attract other top companies working these areas.

Evaluating Current and Potential Connections in the Pharmaceutical Sector

→ All eleven European cities collaborate heavily with major pharmaceutical companies. GlaxoSmithKline, Pfizer, Eli Lilly, Novartis, Merck, and Bayer (represented in blue labels in the collaboration network on page 31) are all among the Amsterdam universities’ top ten most frequent collaborators.

→ While Amsterdam has strong connections with most of the major pharmaceutical companies in the world, the chart indicates that the city has the potential to develop stronger ties with especially biotechnology companies in the US, such as Abbott Laboratories, Johnson & Johnson, Biogen IDEC, and Amgen.
Figure 3.2 — Radar chart of relative academic patent citation share for Amsterdam by subject area, from 2004 to 2013 per year. Sources: Publication data from Scopus® and Patent Data from Lexis-Nexis®

Figure 3.3 — Proportion of total publications that are academic-corporate collaborations versus relative academic patent citation share for Amsterdam by subject area, from 2004 to 2013 per year. Sources: Publication data from Scopus® and Patent Data from Lexis-Nexis®
Figure 3.4 — Network graph of top corporate collaborators for Amsterdam and ten other European cities, from 2004-2013. Source: Publication data from Scopus ®. Circle size refers to number of publications, line thickness refers to number of collaborations between entities; grayscale color (for either circle or line) refers to field-weighted citation impact of publications associated with that entity or collaboration, with darker colors associated with higher field-weighted citation impacts. Amsterdam and its collaborations are colored orange; pharmaceutical companies have blue labels.

Building capacity and infrastructure for the future in pharmaceutical and life sciences

As Amsterdam continues to attract more businesses in the pharmaceutical and related sectors based on its strong medical and life sciences research base and talent pool, Amsterdam Airport Schiphol has made an advanced investment in future sector growth. In 2013, it opened the KLM Pharma 15-25 zone, which enables the temperature-controlled ground handling at 15-25°C (hence the name) of materials.

60% of all Amsterdam researchers begin or primarily establish their scientific careers outside of Amsterdam. A similarly high percentage of Stockholm researchers also have non-local roots.
In this chapter, we take an in-depth look at Amsterdam’s research at a neighborhood level, a bird’s-eye view of how Amsterdam’s research fits into the research enterprise of the larger Randstad region, and a global view of Amsterdam’s research connections to countries around the world.

Brussels

A city’s close neighbors can contain important and complementary R&D assets, as demonstrated not only by Amsterdam and the Randstad but also Brussels and the Flemish Diamond.
4.1 Research in Amsterdam’s Neighborhoods

Although advances in transportation and communication technology have made it easy for researchers or entrepreneurs from around the world to work together to publish a paper or launch a new product, proximity still matters. Companies benefit greatly from co-locating their R&D facilities or offices in academic neighborhoods. For example, biotechnology firms in Kendall Square (Cambridge, Massachusetts) such as Amgen, Biogen Idec, and Genzyme have benefited greatly from their close collaborations with labs at MIT and Harvard University.7

Strong foci of research across most Amsterdam districts

→ Although neighborhoods such as the Amsterdam Science Park (in Oost), Buitenveldert (in Zuid), or the University of Amsterdam Medical Center (in Zuidoost) are traditionally associated with research due to the presence of Amsterdam’s two major universities, the relative impact of research from Amsterdam’s other districts is quite high as well.

→ Institutions such as the Sanquin Blood Supply Foundation, the Netherlands Cancer Institute, and city hospitals in Nieuw-West produced highly impactful research as can be seen from the district map (below).

→ Corporate investors and place-makers, especially those looking to co-locate next to highly impactful medical research organizations have lots of options, both close to the major academic medical centers and those throughout the rest of the city.

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>FWCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdam Nieuw-West</td>
<td>2.21</td>
</tr>
<tr>
<td>Amsterdam-Zuidoost</td>
<td>2.10</td>
</tr>
<tr>
<td>Amsterdam-Zuid</td>
<td>1.95</td>
</tr>
<tr>
<td>Amsterdam-Oost</td>
<td>1.92</td>
</tr>
<tr>
<td>Amsterdam-Centrum</td>
<td>1.92</td>
</tr>
<tr>
<td>Amsterdam Westpoort</td>
<td>1.81</td>
</tr>
<tr>
<td>Amsterdam-Noord</td>
<td>1.60</td>
</tr>
<tr>
<td>Amsterdam-West</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Figure 4.1 — Heat map of Amsterdam’s neighborhoods based on field-weighted citation impact of research produced by institutions in each neighborhood, for 2013. Created using R and ggmap package. Sources: Publication data from Scopus®. Map tiles by Stamen Design, under CC BY 3.0. Underlying map data by OpenStreetMap, under ODbL

4.2 Amsterdam, the Randstad, and the Global Network

The Flow of Researchers to and from Amsterdam

The flow of ideas, capital, and talent are seldom bound by a city’s defined borders. Much of Amsterdam’s success, both historic and current, can be traced to its strengths in attracting a globally diverse talent pool.

→ The city attracts and keeps a high percentage of talented academics. More than 60% of all Amsterdam researchers begin or primarily establish their scientific careers outside of Amsterdam. Moreover, researchers who begin or primarily establish their careers outside of Amsterdam tend to be more productive than those who begin or primarily establish their careers in Amsterdam.

→ Netherlands as a whole attracts a large number of foreign researchers. 42% of Dutch researchers begin or primarily establish their scientific careers outside the Netherlands.

→ This high level of academic mobility means that Amsterdam benefits greatly from the constant influx of new talent and new ideas.

“Amsterdam is good at attracting talent […] but, we want to attract even more international talent than we currently do. This means that the infrastructure in the universities needs to improve so that more international students can study here, in especially English language […] It also means that the residential infrastructure needs to improve so that they [international students] can live and stay here after they graduate. The residential market needs to be open and accommodating to people that come in on a temporary basis.”

— Bob van der Zande, Director Residential Markets, City of Amsterdam at UIN Amsterdam Summit (January 28, 2015)

<table>
<thead>
<tr>
<th>42%</th>
<th>60%</th>
<th>9.8 P/Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>of Dutch researchers begin or primarily establish their scientific careers outside the Netherlands</td>
<td>of Amsterdam researchers begin or primarily establish their scientific careers outside of Amsterdam</td>
<td>Such researchers produce 9.8 publications per year on average, more than twice that of the average Amsterdam researcher</td>
</tr>
</tbody>
</table>

Figure 4.2 — Researcher mobility for over 90,000 active Dutch researchers, 1996-onwards. Source: Publication data from Scopus®
Amsterdam and the Randstad

Although Amsterdam often competes directly with neighboring Dutch cities for local investment, one of the city’s chief advantages for international companies is its proximity to other major knowledge cities in Rotterdam, The Hague, and Utrecht. The combined research enterprise of the larger Randstad area is quite formidable, rivalling that of the world’s largest megacities such as London or Tokyo.

While Amsterdam contributes strongly to the greater Randstad’s research output in subject areas such as medicine (excluded from graph below) and biochemistry, genetics, & molecular biology, the Randstad complements Amsterdam in several areas in which the city does not otherwise produce a critical mass of research, such as engineering and earth & planetary science.

**Figure 4.3** — Comparison of absolute publication output of the Amsterdam relative to that of the Randstad by subject, for 2013 only. Source: Publication data from Scopus®
Amsterdam and the World

Another measure of Amsterdam’s global reach is the extent to which Amsterdam researchers collaborate with those from other countries. The strong ties that Amsterdam researchers cultivate around the world are a major selling point for the city – companies that move and invest in the city can not only tap into a wealth of local expertise but also a global network of experts. Similarly, a city’s research collaboration profile may provide an indication of where the most promising international investment opportunities lie.

→ From 2004 to 2013, Amsterdam researchers co-authored more than 100 publications with researchers from 66 different countries.

→ Amsterdam researchers’ most common international collaborators are from the United States, the UK, Germany, France, and Italy.

→ Relative to the total research output of each country, Amsterdam researchers collaborate the most proportionately with those from the UK, Germany, and Belgium.

Figure 4.4 — Map displaying co-authored publications between Amsterdam and other countries, from 2004 to 2013. The width of the lines between Amsterdam and the countries indicate the relative density of co-authored publications, which is directly proportional to the absolute number of co-authored publications and inversely proportional to the total number of publications by each entity. Source: Publication data from Scopus®
Amsterdam’s research in computer science is one of its possible future strengths. However, Amsterdam’s relative level of academic-corporate collaboration in computer science ranked seventh among the eleven European comparator cities. Dublin ranked first.
From 2004-2013, the relative citation impact of Amsterdam’s output in computer science was the highest among the eleven European comparator cities. The relative citation impact of Vienna’s output in this area was the fourth highest.
Amsterdam is home to a dynamic and productive hub of universities and businesses undertaking world-class research and innovation.

This collective knowledge is a huge resource for all stakeholders in the city – whether it is those engaged in determining economic or planning policy, business strategies, or companies seeking to locate there.

It is a key asset in assessing how and where to invest time and capital.

Amsterdam’s innovation ecosystem – which includes world-class research in manufacturing, automobile, medicine, biochemistry, neuroscience and information research – gives a comprehensive evidence-based view of what the city is good at and where its growth will come from in both the near and long term. It also provides an important insight into what infrastructure is required to further support these trends.

The idea that research and innovation within a city is intrinsically linked to its economic competitiveness is one that is beginning to gain ground, as we have seen in the previous pages.

But, to maximize those potential synergies it is important that development and investment strategies are faithful to a city’s strengths.

This report has identified how many businesses already recognize this, and how they are working in tune with what the city is good at. Amsterdam’s strength as a knowledge hub in the field of medicine and computer science has seen multi-national brands from many different industries clustering around these hubs.

These forward-thinking businesses know this as an opportunity to position themselves appropriately, leverage knowledge and innovation, and absorb talented graduates. They understand that their future competitiveness depends on creating strategies based on evidence.

Today, many investors and economic development professionals want to know where the next Silicon Valley will emerge, as investment in technology becomes a key priority. As this report has shown, analytic tools and data that reveal where the leading information and technology researchers are based could help find those answers. These same tools allow stakeholders to ask questions about the future of many other industries, as well as the specific impacts of innovation in a given area.

Amsterdam is just one example of where innovation can be used to make robust knowledge-based decisions. Whichever city you are working in, or planning to locate to – be it Copenhagen, Berlin, Shanghai, or Manchester – it is possible to map its strengths on the basis of its knowledge-ecosystem. It is an opportunity that should not be missed.

“Like many cities, Amsterdam’s main source of innovation is its knowledge economy [...] the base of which are the universities that are here and its educational system. From that, new employees are created that are innovative, energetic, and extremely well educated. It’s also a great city that draws talent from other places that want to come here and work here. When you put those two together, that creates a powerful base that creates a nexus for innovation.”

– Dr. Brad Fenwick, Senior Vice President of Global Strategic Alliances, Elsevier at UIN Amsterdam Summit (January 28, 2015)
About

This study is a collaboration between Elsevier and the Urban Innovation Network. It was conducted and written by George Lan, Sarah Huggett, Dr. Judith Kamalski, Georgin Lau, Jeroen Baas, and M'hamed Aisati of Elsevier, William Kistler of the Urban Innovation Network, and Lucy Anna Scott.

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For more information on the data sources and methodology behind the analysis in this report, please see the supplementary methods appendix, available online along with the full report at www.elsevier.com/research-intelligence/amsterdam-report/.

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