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Professors on the Move

Scientific migration to the Netherlands and the relation between individual and institution quality in the context of migration

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Summary

Using new research methodology to trace migration, the total population of newly appointed professors from abroad was used to study the patterns of migration to the Netherlands and the relation between the individual quality and the university of origin quality. Through selection mechanism on the side of the scientists and the university; and a growing job market and selection pool for both parties through the forces of internationalization and globalization quality; would mean that talent manifest itself in high quality institutes. Earlier research has shown that scientific migration is stratified, meaning that thus university quality should correlate to individual quality. This correlation was found and highly significant (0,005). Furthermore the pattern of migration to the Netherlands showed that most immigrants come from the United States and United Kingdom; move to a university in the city of Amsterdam; and work in the research areas Nature; Law; or Language and Culture. The approach used is particularly useful to trace and study individuals working in the research areas Behaviour and Social Sciences, Economics, Health as these research areas are better suited for bibliometric analysis.

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1 Introduction

1.1 Societal background: Scientific mobility and its consequences

The theory of national innovation systems stresses that the flows of technology and information among people, enterprises and institutions are key to the innovative process (Lundvall et al., 2002; OECD, 1997). Innovation and technology development are seen as the result of a complex set of relations among actors, in the system which includes enterprises, universities and governmental research institutes. Knowledge itself plays an ever increasing important role in modern societies as it is a source of innovation, competitive advantage, and policy making. Modern economies can thus be characterised as 'learning economies' in which knowledge is the crucial resource and learning is the most important process (Lundvall & Johnson, 1994; Archibugi and Lundvall, 2001). Scientists play a vital role in modern economies because they are both the carriers and producers of knowledge; some even argue that knowledge can be considered as the major economic production factor in the new global knowledge society (Moed & Plume, 2013; Brown et al. 2001; Nonaka and Takeuchi, 1995). However knowledge producers are moving more freely than they did in the past (Moed & Plume, 2013). This is important because codified knowledge is easy to gain, but tacit knowledge is not. Scientific publications are relatively easily accessible through online scientific journals and can be perceived as codified knowledge. Codified knowledge that stands alone is not (economically) useful, it is only valuable to those who possess the knowledge and experience to handle such information. (Jensen, Johnson, Lorenz, & Lundvall, 2007). It is this tacit knowledge which is not geographically equally spread. To utilize and produce knowledge successfully, institutes and infrastructure are necessary but also tacit knowledge embedded in individuals. And these individuals are becoming increasingly mobile; attracting these individuals – especially the highly potentials - can be a competitive advantage of a national innovation system (Laudel, 2005).

1.2 Recent findings

There is an increase in the number of scientists who move abroad to continue their career in another country; this is a new aspects of the international character of the world of academic research (Hunter, 2013). As knowledge workers play an increased importance in new learning economy, the international migration of scientists is receiving increased attention, both from academics and policy makers (Lundvall, 1997; Børing et al, 2015). A recent extensive survey on the mobility of university and non-university research institute researchers in the EU shows that 61% of respondents (N=4,538) had experienced international mobility at least once in the course of their research career and half of them had experienced international mobility during the past three years (2007-2010) (Børing, 2015). As researchers move more freely than they did in the past, the academic job market is becoming a global market. And as researchers becoming more mobile the capability of a country, to attract foreign talent is fundamental to building and sustaining the quality of national science and engineering workforce (Franzoni, 2012). This is why policy makers are so keen on attracting and retaining talented and top scientists in order to maintain a competitive science system (Laudel, 2005). But the link between migration, internationalization and quality, or productivity, has been hinted at, but these concepts are involved in an intricate, complex process which is still unclear. Spanish research showed a modest positive correlation between mobility and productivity (Cruz-Castro & Sanz-Menéndez, 2010). OECD research suggest internationally mobile scientists tend to publish in higher-quality journals than their counterparts who stay in the same country throughout their research careers (OECD, 2013). Other research suggests that mobile scientists generally outperform the domestic scientists (Franzoni et al., 2014). The OECD Science, Technology and Innovation Scoreboard 2013 states that 'On average, the research impact of scientists who move affiliations across national boundaries is nearly 20% higher than that of those who never move abroad' (OECD, 2013). The Times Higher Education University ranking 2014-2015 reveals that the Top-200 universities have more staff from abroad, publish more papers with at least one international co-author, and have a more international student body then the next 200 universities on the list. Such data would suggest a strong link between the internationalization of an institution and its quality. However, such statements are often broad generalization based on surveys which present a fraction of the migration population (Boring 2015, Franzoni 2012, 2014), or unclear bibliometric analysis and too vague as a basis for making policy on internationalization (OECD, 2013)(using for example the normalized impact factor of a journal as a means to asses individual and nationwide quality). So far little empiric research has systematically investigated the cross border mobility of scientists. This is mainly because of the lack of international comparable data (Stephan, 2013). This research will approach this matter differently, by assessing the total migration to the Netherlands

1.3 Dutch ambitions in internationalization of science system

In the Netherlands, the Ministry of Education, Culture and Science's (OCW) Vision on Science for 2025 report argued that the Dutch Science System belongs to the world's top but it also mentioned a number of threads (Wetenschapsvisie 2025: Keuzes voor de Toekomst, 2014). One of the concerns, formulated by the Commission Interdepartmental Policy Research (*IBO*), is the increase of international competition and the rise of global investments in science over the last decade (OECD, 2013) ;IBO – Wetenschappelijk onderzoek, 2014). As more nations aim to become a knowledge economy, international competition in science is rising as is the competition for talented scientists through science funding. Especially since Dutch spending on R&D has been decreasing and will likely decrease in the future (van Steen, 2014), whereas other countries have been increasingly investing, the Netherlands has not (Ambtelijke Commissie Heroverweging, 2014; IBO Wetenschappelijk onderzoek. Ministerie van Financiën, Rijksoverheid, Den Haag, p.22, 2014). Although, government spending on universities has not decreased in the Netherlands, increased competition and decreased R&D funding will make it harder for the Netherlands to attract talented scientists. Meanwhile, the Dutch Ministry of Education, Culture and Science has come to an agreement with the Association of Universities in the Netherlands (VSNU) in which they state: "Universities and government should make efforts jointly, in order to maximize the benefits of internationalization by focusing on quality. Among other things by entering into excellent partnerships and attracting and maintaining top talent" (Hoofdlijnenakkoord OCW- VSNU, 2014). Internationalisation is seen as a goal of the Dutch Science System and attracting foreign students, research talents and foreign top scientists is considered as an important means to achieve this goal. But only when one attempts to assess how well the stated ambitions match the current scientific migration to the Netherlands, you will find that this is largely unknown territory. Research on knowledge workers in the Netherlands shows that the Netherlands only attracts relatively few highly educated migrants in comparison to other OECD countries despite the Netherlands belongs to the top of competitive economies (Basri & Box, 2008; Raspe et al, 2014). And not only is only a small part of the migrants in the Netherlands highly educated, the Netherlands is also behind when it comes to the growth of highly education migrants when compared to competing economies. There is little know with regard to the scientific migration to the Netherlands and what is known about a broader group of migrants, knowledge workers, seems to differ from the goals set in Dutch policy.

1.4 Knowledge gap regarding scientific migration patterns

What is known about scientific migration to the Netherlands is largely based on university staff data and science surveys. The University Staff Information System (WOPI) statistics for 2013 shows that German nationals represent the largest group of non-Dutch nationals working as part of the academic staff at Dutch universities followed by Italian, Chinese, Belgian, and Indian nationals. VSNU statistics shows that the group of foreign scientists among Dutch university academic personnel has risen with 50% in the period of 2007-2013; and currently one third of all scientific staff of Dutch universities has a non-Dutch nationality (VSNU, 2014; Elsevier, 2013). In their study on scientific mobility Franzoni et al. (2012) have used the country of residence at the age of 18 as indicator for the scientists' nationality. The VSNU data concern the nationality as registered in the scientists' passport (a double nationality, including Dutch, is registered as Dutch). However, measuring academic staff's nationality does not necessarily measure migration, neither does the country of residence at the age of 18. This is all data available which means that there is only a very poor picture of the migration pattern of academics to the Netherlands. The current data does not provide answers to questions on the characteristics of the scientists that come and work at Dutch universities: From which countries do these scientists come from? From which universities or research institutes do they come? To which universities in the Netherlands do they move? In what field do these individuals work? How does the quality of these universities compare to the Dutch destination universities? What are the differences in country or origin? And as the aim is to attract foreign talent: To what degree does their prior university say something about their individual quality?

This set of questions has an explorative character; answering them will provide more insight into the migration stream of scientists to the Netherlands. This is the first aim of this research as currently there is little overview of the migration stream to the Netherlands. If the Dutch government and VSNU wish to attract foreign talent, the first step in developing a strategy to do so, is to get an overview of the current situation. Providing such an overview by mapping the pattern of migration in terms of country of origin, university of origin, university of destination, and research area. By proving details on the character of the migration stream a more focused strategy on scientific migration can be developed. It can support the decision making on where more focused investments in resources and facilities is needed in order to attract specific talent. In addition a question that deals with measuring the quality of these scientists (talent) using a specific migration related indicator is added. This question is: Do more talented scientists come from better ranking universities? This question links two concepts: the quality of a university and quality of the scientific migrant. So far earlier studies have hinted at this relation, but it is yet to be confirmed. This leads to the central research question for this study: *What patterns do we find in the scientific migration to the Netherlands and to what degree is a scientist's prior university an indication for its individual quality?*

1.5 The research approach

Via the Rathenau Institute the Data Archiving and Networked Services (DANS) department of the Royal Netherlands Academy of Arts and Sciences (KNAW) has provided a list of all newly registered professors in the Netherlands within the period October 2012 - January 2014. This means, theoretically the sample consist of all the scientists that have been appointed as professors at Dutch universities in a fifteen months period. By studying this is definite group, it will allow for some first preliminary statements to be made on scientific migration to the Netherlands not based on an individual's nationality (VSNU, 2014) or country of origin (Franzoni et al., 2014) but based on being newly registered in Dutch Academia via the DANS data base. The testing of the relation between the scientist's former institute's quality and the quality of the individual scientist will be done using bibliometric data from CWTS Leiden. Analyzing the relation between the quality of the individual and the institution will contribute to a further understanding of scientific mobility, quality and internationalization also will show to what degree a person's prior affiliation server as a quality proxy.

1.6 Outlay of the thesis

In the subsequent section the concepts of quality, globalization, migration and internationalization will be addressed and theorized how the interplay of these concepts make scientific quality geographically concentrated. In the method section the novel method that is used to answer the research question will be addressed. The result section show the descriptive statistics of the migratory scientists as well as the correlation of university and individual quality. In the discussion section the results are addressed as are the theoretical and managerial implications, finishing with suggestions for further research. In the concluding section the new research method is briefly assessed, the pattern of migration to the Netherlands is addressed, and the correlation between individual and university quality is evaluated.

2 Theory

The first part of the theory section focuses on quality and migration aims to investigate why quality concentrates geographically, and to what degree an institute can be seen as a proxy of the quality of the individual (2.1). This is the second part of the research question as formulated in Chapter 1. The aim of the second part is explorative, and is focused at discovering the (2.2). This is the first part of the research question.

2.1 Theoretical framework for quality of migration scientist

Both globalization and internationalisation have led to a global academic market. This bigger global academic market has led to a bigger selection pool for new jobs for both universities and scientists. With the selection pool of possible candidates and possible employing universities stretching across national boundaries, the academic job market has become bigger and more international. Previous research has suggested that scientists are not driven by monetary incentives, instead they find means to succeed their personal aspirations and career path the most important reason for migration (Franzoni et al., 2012). Universities with a high reputation and ranking are most likely to help fulfil such aspirations. The most ambitious scientists want to work at the best universities because these universities will most likely have more advanced facilities for doing research. This in turn attracts other researchers, not only because they want to work with such facilities but also because they will want to with other talented scientists (Franzoni et al., 2012). Equally, universities are driven to appoint the best candidate scientists in order to maintain their top position and reputation. In this sense there is a double selection mechanism, on the one side of the applicant scientists and on the other side of the university. Because the double selection mechanism and the fact that barriers for scientific migration are becoming less high (through internationalisation and globalization), this should globally lead to a concentration of high quality scientists in high quality universities. Deville's (2014) work has shown that migration is stratified, meaning some individuals move from high ranking institute to high ranking institute and vice versa, there being little cross group movement. This fit very much with the notion of the double selection mechanism. Now it should be noted that this research has its limitations as focussed on physicists in the United States but if so, then the university where the migrating scientist comes from (origin) could serve as a proxy for the quality of a scientist's work, meaning that the quality of the individual correlates with the quality of the university of origin.

In the rest of this section the motivation of the scientists (2.1.1); the motivation of the university (2.1.2); and the interplay of the concepts of mobility and quality (2.1.3) will be addressed. The mechanism that leads to concentration of quality in high quality institutes is represented in the conceptual framework (2.1.4).

2.1.1 The scientist, a different animal

Scientific migration is a complex phenomenon that is much discussed in science policy debates but there is little agreement with regard to definition, conceptualization or impact (Ackers and Gill, 2008). Although scientific migration has been happening for centuries, it has only recently become a topic of study itself.

In this thesis scientific migration is defined as follows: the phenomenon of scientists moving on a more permanent basis than work visits from one country to another country for work related reasons. It is important to understand that when a scientist gets a job on another country, two parties - the employer (the university), and the employee (the scientist) - have to come to an agreement. When these parties have come to an agreement and scientific migration is a fact, it is important to understand what drives these two parties and how these actors have chosen each other. How can we understand their choices in terms of the concepts of migration and quality? Neoclassical economic theory of migration states that individuals are mainly motivated to migrate because of wage differences between two geographic locations. Yet research from Franzoni et al. (2012) showed that migrated academics perceived wage and earning possibility the least affected by their migration. Perceived to be most affected by the migration were ‘enlarging my research network’ and ‘entering into new fields of research’ (Franzoni, Scellato & Stephan, 2012a). Franzoni, Scellato & Stephan’s research showed which the factors influence migration of postdoc researchers the most: ‘the opportunity to improve my future career prospects’; ‘outstanding faculty, colleagues or research team’; and ‘the excellence/prestige of the foreign institution in their area of research‘(2012). The factor ‘monetary compensation’ was perceived as a less then neutral factor influencing their migration, clearly one of the most important factors. The scientists can better be compared with athletes than with the *homo economicus* when it comes to what drives them: they are driven not by monetary incentives, but by the need to acquire new knowledge and skills and to cooperate with colleagues (Hunter, 2013). The broader school of job mobility literature links mobility with career and personal development following three macro-dimensions: status, functions, and the organisation/employer (Nicholson 1984; Nicholson and West. 1989; Arthur et al. 1989). This school of thought links job mobility to personal aspirations, which supports the idea that mobility is the realisation of personal aspirations. The migration of scientists seems to be better explained by this broader school of job mobility literature.

Scientists can become mobile if their personal aspirations can better be realized at another university, in perhaps another country. Universities of a high reputation and ranking are most likely to help fulfil such aspirations because they will have more resources and will more have more talented scientists working then a university with a lower ranking reputation. Whom in turn also attract other talent, as working with talented peers is also an important pull factor for scientists. It is no coincidence that of the ten richest universities in the world, six are within the top 10 of the CWTS Leiden Ranking 2014 of universities (in which the University of California is split into multiple universities of which three are in the top 10) (Leidenranking; Nonprofitcollegesonline). As scientists are motivated and driven by their personal aspirations, they will move to universities to realize their aspirations, abroad if need be.

What effect does mobility have for the scientist? As for scientists, a foreign job position exposes the mobile scientists to ideas, perspectives, and paradigms. Literature suggests that being a mobile scientist has many advantages: mobile academics tend to be employed with full-time contracts more often than their non-mobile colleagues. They also tend to favour research over education and are more likely to engage in international activities and collaborations then their non-mobile counterparts (Probst & Goastellec, 2013). And internationally co-authored papers have, on average, a higher citation impact than nationally co-authored paper. In fact citation impact increases with the geographical distance between the collaborating countries (Nomaler et al. 2013). When the non-mobile researchers do collaborate, their networks span fewer countries than are either foreign born or returnees (Scellato, 2012).

2.1.2 What drives universities? Why would they want to attract foreign scientists?

Universities have three main functions: education; knowledge production through research; and to valorise the results of their work in economy and society. Although it’s educational and valorisation functions are also vitally important, this thesis will focus on the knowledge production function of universities.

There are a few reasons for universities to attract foreign talented scientists, the most obvious one being that their talent helps in keeping the excellence of the knowledge production of the university at a high level. Another is that attracting scientists from abroad will be of help against academic inbreeding. Hiring one's own graduates is not considered unusual or problematic around the world. It is often seen as a point of pride for the higher education system as it is able to retain its best intellectual talent. However, Altbach, Udkevich & Rumbley (2015) argue that academic inbreeding impedes change and reform, enhances existing power relations and status quo. It limits the scope of hiring the best possible candidates for academic appointments, nationally and internationally. In institutes where there is academic inbreeding scientists tend to be less innovative. Also new perspectives, ideas, and paradigms have more difficulty to take hold. This effect can be found in departments, faculties, or even entire universities (Altbach, Udkevich & Rumbley, 2015). Apointing foreign scientists most likely provides for an influx of new ideas and perspective which helps in the progress of science and knowledge production. Not all universities are aware or recognize this issue of academic inbreeding and it seems that in many institutes no policy is developed to prevent academic inbreeding. But foremost universities are driven to make their knowledge production as efficient and high quality requiring talented scientists, from abroad if need be.

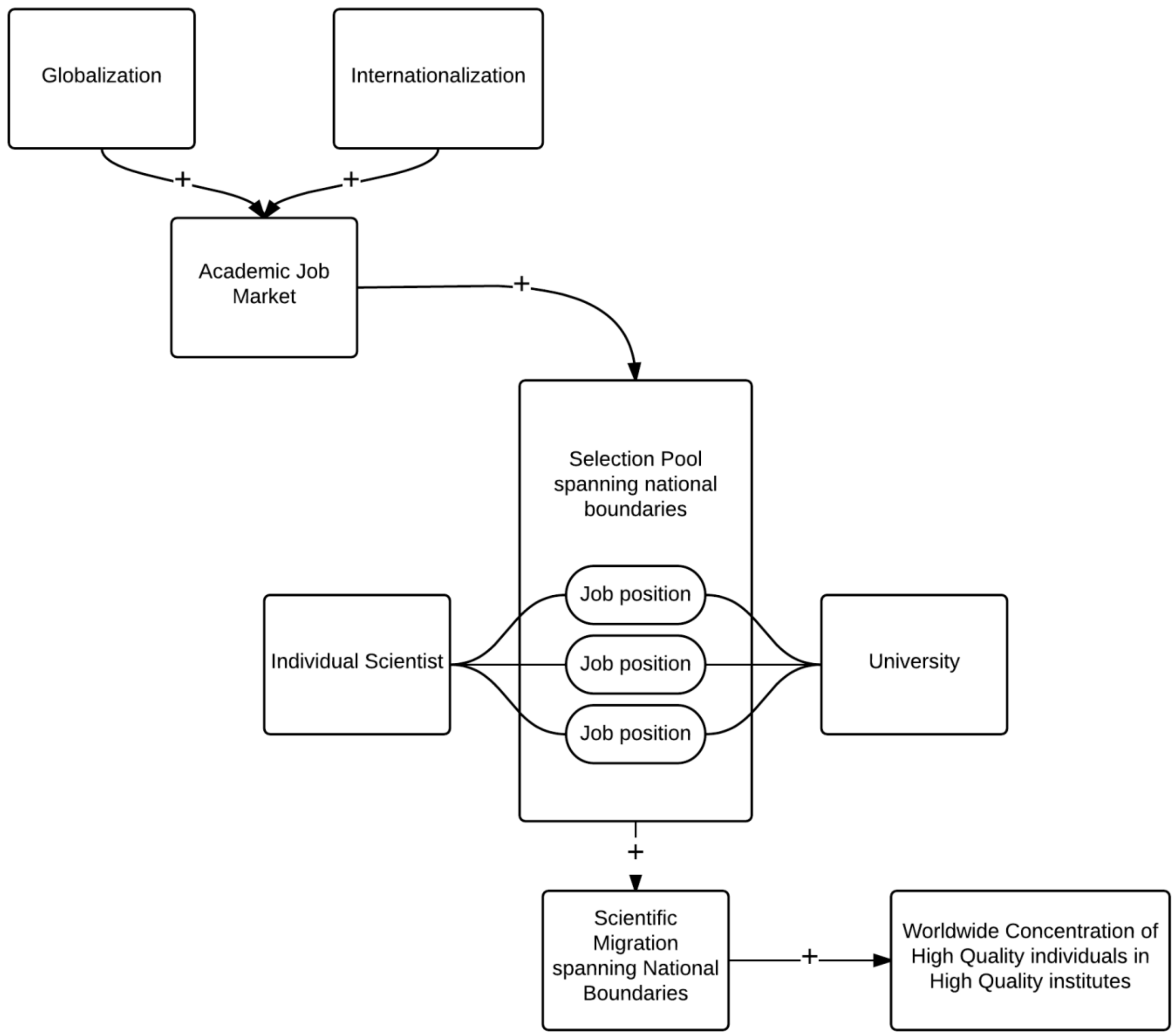
2.1.3 The relation between quality and mobility

There seems to be a correlation between mobility, collaboration and quality expressed in terms of scientific impact. But how are the concepts of mobility, international collaboration and quality related? Does mobility lead to more international collaboration? And does mobility lead to better quality? Or is mobility the consequence of international collaboration and better quality by a scientist? Most likely both. This seems to be confirmed by Cañibano's work (Cañibano & Bozeman, 2009; Andújar & Cañibano 2010) as her group studies the relationship between mobility and productivity of researchers (i.e. publication output) and between mobility and collaboration with international colleagues. The studies show that there are differences between scientific research area, and the connection between productivity and mobility cannot be confirmed unambiguously. Do good scientists become more quickly internationally mobile? Or does being mobile make for better scientists? In what direction is the causality? It works both ways. An international operating scientist will get more recognition because his or her network will be a larger network, and high quality work by talented scientists will get noticed more internationally and get offered collaborations or job positions abroad. Scientists that do international collaborations will have a more international network and thus have easier access to foreign jobs (including through informal applications processes). Working abroad can been seen as an opportunity to experience different lab cultures, acquire new skills, learn new methods and establish personal contacts and networks that can be important for future career progressions (Schiermeier, 2011). This helps to explain why the top institutes are more internationalized, they have a pull which extends across nations boundaries and thus their selection pool also includes talent from abroad. Developed countries have more advanced science system as compared to less developed countries, which allows their top universities to select from a bigger selection pool. For this reason developed countries also have the highest proportion of foreign scientist according to the GlobSci survey (Franzoni, 2012), they are also able to select talent from abroad. This effect also works the other way: countries with underdeveloped science system have more difficulty attracting and retaining talent and might see an influx of talent (Hunter, 2013).

The concepts of globalization and internationalization are closely related but not the same. Altbach (2009) makes a useful distinction between the two concepts with respect to the academics; globalization can be seen as "the broad economic, technological, and scientific trends that directly affect higher education and are largely inevitable in the contemporary world." (Forest & Altbach, 2006) whereas internationalization can be seen as the response to globalization through "specific policies and programs undertaken by governments, academic systems and institutions, and even individual departments to deal with globalization" (Forest & Altbach, 2006, p. 123). Both globalization and internationalisation have led to a global academic market. This global academic market implies also a global selection pool for new jobs for both universities and scientists. With the selection pool of possible candidates and possible employing universities stretching across national boundaries, the academic job market has become larger and more international. Probst & Paradeise (2008) found that the degree of internationalization is linked to the level of prestige of an institution. This is no coincidence. There is a double selection mechanism, on the side of the applicant scientists and on the side of the university. Because the double selection mechanism and the fact that barriers for scientific migration are becoming less through internationalisation, this should globally lead to a concentration of high quality scientists in high quality/reputation institutes. If so, then the university origin should serve as a proxy for the quality of a scientists work. Meaning that the quality of the individual should correlate to the quality of the university.

2.1.4 Conceptual Model of Quality Concentration

Below in figure X. a representation of the mechanism which makes high quality concentrate in high quality institutes, as theorized above is represented.



2.2 What kind of migration patterns does literature suggest?

In this section the expectations for the migration pattern based on literature will be addressed. With the fact that the Netherlands has a competitive science system, we expect it to be attractive to foreigners and thus expect a considerable high migration level. Deville (2014) found that migration is to a high degree stratified by institutional ranking; meaning that scientists move from elite to elite university or from non-elite to non-elite university with hardly any cross-group movement. This suggests that scientists that come to the Netherlands come from top research countries and top universities as the Netherlands can be considered as a top research country. The double selection mechanism of the university and the individual as presented above (Section 2.1.3) suits this finding well. This means that high quality scientists move from high quality institute to high quality institute. The Netherlands can be considered a top research country as the Netherlands ranks No. 1 in publication impact per research article*, No. 1 in citations generated per unit of research and development spending, No. 2 in publications generated per unit of R&D spending and No. 1 by level of international collaboration (Elsevier.com). This would imply that foreign scientists that are appointed professor in the Netherlands come from countries with high performing science system (H1) and from high ranking institutes (H2).

In which fields can we expect the migrant scientists to work? There are disciplinary differences in mobility and expectations of the need for mobility may vary from discipline to discipline but also from national context to national context (Ackers, 2005). As different degrees of abstraction from place-specific realities inherent in the research work of different disciplines, standardisation of the practices involved and their materiality (e.g. the need for specific equipment) all imply spatial relations and thus determine to what degree research is bound and place-specific (Jöns, 2007). Ackers (2013) has elaborated on this though and describes a continuum from more contextualised disciplines, such as anthropology or history, to highly standardised disciplines such as mathematics (Børing et al., 2015). Following this line of thought, the expectation is that more migrants coming to the Netherlands will work in standardized, then in contextualized fields because they experience less barriers of migration (H3).

A recent study on foreign knowledge workers has shown that migrant scientists are unequally spread over the Netherlands. They favour to live in metropolitan agglomerations such as Amsterdam, The Hague and Rotterdam. And in these metropolitan agglomerations they like to concentrate in the town centre where theatres, museums, and other culture which foreign knowledge workers prefer, are located. They are attracted to international operating regions: regions with many foreign companies; regions with companies that operate internationally; and regions that have other foreign knowledge workers (Raspe et al., 2014). As scientists can be considered knowledge workers, this would suggest a distribution of scientific migrants that favours the universities in the more metropolitan areas with university presence of the Netherlands; Amsterdam, Rotterdam, Utrecht (H4).

3 Method

3.1 Method in short

Desk research was used for the explorative part of the study: from where do the newly appointed professors in the Netherlands come in terms of the university that was their former employer and the country this university was located. By assessing the subject of their research and appointed faculty the group of foreign professors was grouped by scientific discipline (HOOP research areas).
For measuring the quality of the university of origin and of destination the CWTS Leiden Ranking 2014 sorted by Mean Normalized Citation Score (MNCS) was used. To assess the quality of the scientists, the average MNCS score of their work was used as a quality indicator. All data was entered into an operation table (Table 1.) which formed the basis for analysis.

To answer the questions on the explorative part of this research descriptive statistics were generated to investigate the pattern of migration to the Netherlands. In order to test to what degree the university quality can function as a proxy of an individual's quality the Pearson's R correlation between the foreign university of origin MNCS was compared to the scientists average MNCS.

Table 1. Operation Table

	Author A	Author B
Person ID		
Dutch University (As found in NARCIS database)		
Dutch University score (CWTS Leiden Ranking 2014 by MNCS)		
Disciplinary field (Defined by HOOP area)		
Prior affiliation abroad (University or research institute)		
Prior Affiliation Country (Nation)		
Foreign University Score (CWTS Leiden Ranking 2014 by MNCS)		
Individual Quality (Expressed in MNCS average over the period 2009-2012)		

One of the challenges of this research and a central challenge of science policy in general, is the proliferation of academic publications (Abbot et al., 2010). This research does not aim to solve such problems but does make use of a more recent tradition of using scientific output and references to this output as a means to conceptualize 'quality' in scientific output. In this view the better scientific work is the more important and influential it is perceived by others the more often it will be referred too. There is much criticism on such an approach to meaningfully measuring science and defining it as quality, examples of this are the Leiden Manifesto and the San Francisco Declaration of Research Assessment (DORA) and in part in the Netherlands the Science in Transition movement (Hicks et al., 2015; Cagan, 2015; Dijstelbloem et al., 2013). Even though this quantifying approach and conceptualization of scientific quality has its criticisms (Bornmann & Leydesdorff, 2014; Radicchi & Castellano, 2012; Abbot, Cyranoski, Jones et al., 2010), it does provide for a means to measure and compare scientific quality which is vital for this thesis.

3.2 Data restrictions

Due to data constraints the scope of this research is limited to professors moving to Netherlands. Professors make an interesting sample to investigate for a number of reasons as they:

1) Are a clearly demarked group, the title and position of professor makes them easy to distinct form other academic researchers.
2) Are the highest academic rank and represent the scientific elite.

3) Have an important function monitoring and controlling universities; making them responsible for academic quality.
4) Have had a long and stable career which makes them more suitable to research.

It should be noted that this research will only focuses on full professors. Associate professors, assistant professors and endowed professor are excluded from the research. Please note that in this research when we refer to professor, it can might very well be possible that the migrant did not have a professor position prior to his or her appointment in the Netherlands.

3.3 The Building of the Data Sample

In order to find the migratory scientists the Rathenau Institute, where the data gathering and analysis took place, had received the NARCIS database which registers academic personnel in the Netherlands. The NARCIS database is made by the Data Archiving and Networked Services (DANS) Institute which is an institute of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO). However, the database did not hold information on where the newly appointed professor came from, from abroad or from another university in the Netherlands. In order to find out who was previously affiliated abroad and thus was a migratory professor, desk research was performed. If the scientist was working at a foreign university or was otherwise affiliated abroad, the scientist was considered to have migrated.

The search for the scientists' prior affiliations was done by reviewing the scientists CVs; university staff pages; personal webpages; and bibliometric affiliations. If a scientist had left the Netherlands, the individual was removed from the NARCIS database. If he or she were to return to work at university in the Netherlands, he or she would be reentered in the database. This means that through this approach the sample consists of the entire population of professor's migrating to the Netherlands for work, including return migration. Whereas earlier research relied on surveys and taken nationality or country as residence as a point of reference to measure migration (Franzoni et al, 2012; Børing et al. 2015; Raspe et al., 2014), this research defines migration as being newly affiliated at a university in the Netherlands.

For the period October 2012 up to January 2014, the database held a list of 531 newly appointed professors. After analysis of these 531 individuals, it showed that 39 were newly appointed from abroad to work as a full professor at a Dutch university. There were some cases where hardly any information was found on the migrating professors' prior affiliation. For this the criterion was held that if no foreign activity could be found, the person would not be regarded a migrant. Particularly those who were active in medical science were significantly harder to trace, and most of them were not previously affiliation abroad. This is not surprising as being a doctor can be pretty geographically binding job. Perhaps these individuals were also harder to find because their medical profession forces them to protect their privacy. But for most individuals tracing their migration through desk research was relatively easily as most people make their career paths public through LinkedIn or personal websites.
The group of 39 individuals formed the population that had migrated to work as full professor in Dutch academia in the period October 2012 up to January 2014 and that could be traced through desk research. They formed the basis for analysis of scientific migration to the Netherlands.

3.4 University information data collection

The NARCIS database provided information on the individual names, new Dutch university affiliation; the department they started working at; and the mutation data through the DANS data. Once the prior affiliation was established, the country of migration origin could easily be found. This information provided the descriptive statistics on where the individuals came from. The indicator for quality of the foreign university the scientists came from and the Dutch university they went to is linked to their position in the CWTS Leiden Ranking 2014. The CWTS Leiden Ranking 2014 ranks the 750 universities in the world with the largest contribution in international scientific journals in the period of 2009–2012 and is based on data from the Web of Science bibliographic database produced by Thomson Reuters (LeidenRanking.com). The CWTS has a detailed methodology description available on their website.

For each migrant in our sample the respective score of the foreign university they came from; and the score of the Dutch destination university was found in the CWYS ranking (it ranged from 1 to 750). In case a university was not included in the ranking, the score for this university was ranked as 'Not in Ranking'. This is because of the fact that in case a university is not in the ranking, this does not necessarily gives an indication of the quality of the university. It just might not fit the criteria; for instance the new number one ranking university in 2014 - Rockefeller University - was not included in last year's list. Therefore it cannot assume that if a university is not in the ranking, it is because it is a less good university that didn't make it in the ranking. If the scientist wasn't priory affiliated to a university the scientists was listed as 'Not a University'.

There are multiple different rankings that each year assess the quality of the world universities: Academic Ranking of World Universities (ARWU), the Times Higher Education World and Reputation ranking, QS World University Ranking, CWTS (Centre for Science and Technology Studies) Leiden Ranking. Of these ranking the Leiden Ranking seems to be the most appropriate ranking to use because it is based solely on the analysis of bibliometric data. Whereas other rankings include other quality indicators such as past Nobel prizes won, the quality of teaching, and degree of internationalization, the Leiden Ranking only focuses on scientific performance. The best known ranking is according to the proportion of the publications of a university belonging to the top 10% of their field in international scientific journals in the period of 2009–2012. This is the part of the ranking is best known and that is most referred to when news articles or individuals refer to the Leiden Ranking. But the Leiden Ranking also published a list based on the Mean Normalized Citation Score of a university. For this analysis the Mean Normalized Citation Score is taken as quality indicator. Even though this top 10% is a good indication of quality of an institute, the Mean Normalized Citation Score represents the quality of all publications made by the university and thus gives a fairer image of the quality of a university. Because the Leiden ranking is based on the totality of publications in the Web of Science, and can account for differences in publication and citation behavior in different research areas, and measures individual quality and institute quality in using the same metric, it is the most suitable metric for this research. By making sure that the same metric is used to express the quality of both the institute and the individual, the correlation between the institute and individual will be more meaningful then when two separate indicators are used.
The CWTS Leiden ranking 2014 performance was chosen as a quality indicator because of their methodology. It seems the most appropriate rating for two reasons, it is based only on scientific performance based bibliometric data and the method for measuring quality can be used for both university and individual.

3.5 On using Scientometrics

Although the use of scientometrics for measuring quality (by citations) is not without any drawbacks, it does provide for a means of comparison and analysis. Scientometrics is a field in which the meta-data of vast amounts of scientific articles is studied in a quantitative manner to answer questions in science and technology studies. In the field of scientometrics the impact of scientific work is measured by the amount of references to a publication (citation) and the number of citations is held as a quality indicator. This stems from the assumption that the more scientifically valuable a research (published in a scientific paper) is, the more often other researchers will refer to it (in their publications). Even though objections can be made to this approach, metrics are widely applied to evaluate individual's scholars, journals, institutions, and countries (Kaur et al., 2013). And bibliometrics, the statistical analysis of written publications, has become a standard tool in research management and science policy when academic institutions have to make decision on hiring, promotion, tenure, and funding scientific research (Weingart, 2005).

3.6 Field Bias and the Mean Normalized Citation Score as a measure of quality

There is an ongoing debate on how to meaningfully measure research when using references and a central challenge of science policy is the proliferation of academic publications to objective evaluate scientific production (Abbott et al., 2010; Bornmann & Leydesdorff, 2014). One of the main critiques of using bibliometric measurements is that there is a presence of bias in citation numbers; this is a fundamental problem in citation analysis (Radicchi & Castellano, 2012). A top scholar in for instance Life Sciences has a very different publication and citation profile then a scholar in Computer Science. Such biases in citation numbers are caused by the variation of publication and citation patterns across disciplines, due to difference in breadth and practices in scientific disciplines (Kaur et al., 2013). Papers in mathematics accumulate citations at a rate much lower than papers in chemistry (Radicchi & Castellano, 2012). Also, some research area are not as well covered by bibliometric databases as others. For example the most popular index the Hirsch-index as well as most other widely used metrics do no compensate for differences in citation patterns between disciplines, hereby making them unfit for comparisons between different areas of science. As an answer to this problem, alternative impact metrics have been suggested, so called *field normalized impact metrics* which would eliminate the bias created by citation pattern differences. As the migrants coming to the Netherlands it is vital that they are compared in a meaningful manner.

This research aims to compare researchers from many different research areas. These researchers may act very different from each other in terms of publication, citation and database coverage. In some research areas scientists tend to publish more than other research areas, in some research areas cite each other more other, in some research areas authors tend to publish in books where in other research areas publications in journals is more ordinary. Research areas such as medicine, chemistry and computer science each have their own history, their own culture, and also their own publishing and citation behaviors. This does not mean that they are incomparable, but it does mean that comparison should be made cautiously. Knowing this, it is important to choose a metric wisely so that such differences behaviors are accounted for. The means normalized citation score (MNCS) of the author's publications; this is considered as the quality indicator for a scientist's work. The means normalized citation score (MNCS) is the average number of citations of the publications of a scientist, normalized for field differences. For example: an MNCS value of three means that a publication has been cited three times the above world average corrected for citation practices in that particular scientific field. In this way it the impact of the work of the scientist and his or her influence is made visible. One of the advantages of the MNCS metrics is that its normalization is calculated on the basis of entire Web of Science database.

3.7 Motivation for MNCS and alternatives considered

The CWTS in Leiden has offered to help in the calculation of the Mean Normalized Citation Score of the publications of the scientists. The CWTS has the skill and the resources to make such calculations as the metrics are based on the entirety of the academic field available in the Web of Science and thus the importance of a scientists work in the respective field. The impact of a single citation is given higher value in subject areas where citations are less likely, and vice versa. The MNCS does take into account field citation behaviors and is not a so to speak 'hard-cut' metric but a ratio score that varies per field. For this reason the MNCS seems to be the best metric to use to assess the impact of the scientists work. The field bias correction calculation is based on the citation in the entire scientific field. Because the normalization is based on the total of Web of Science publications it seems to be the most valid way to correct for field bias. The Ranking of the universities and the individual score are based on the same database and expressed in the same indicator. This makes this metric ideal for researching the relation between individual and institute quality.

To assess the quality of the individual, the MNCS scores of their publications were combined as an average to express their individual quality. Per author all published documents have been attempted to be found through checking the Scopus and Web of Science bibliometric database. In order for the CWTS Leiden to do the calculations a list of all the Digital Object Identifiers (DOI) of the authors had to be supplied. For some authors it was harder to find their publications, particularly the more social sciences. Some research areas of science are less covered in the Web of Science or are harder to trace in the Web of Science. For these authors I relied on what I could find on their personal websites, resumes, staff pages, and what I could already find in the bibliometric databases. For the publications I could find, I used CrossRef.org. CrossRef is an official DOI Registration Agency of the International DOI Foundation. Unfortunately not all the DOIs of all the 2300 documents could be found. Also it should be noted that all documents in which the scientist was named as author were used. It quickly became apparent that some research areas of science were better represented in the bibliometric database then others. For instance the first professor from the database was a professor of Finance and all his publications including DOIs were easily found. Whereas the second author was professor of Law and was significantly less covered in the database and not all documents could be identified according to DOIs. For scientists that hardly came back from the bibliometric data, I did more desk research to find their work. In this case there is a sense of bias for the effort of finding data for research areas that are less covered but I thought it to be a sensible contribution to make an extra effort for the less covered research areas. In the result section it becomes visible which research areas are less suitable for bibliometric analysis.

3.8 Authors disciplinary research areas

The author's disciplinary research areas have been determined using the HOOP classification of scientific research areas (HOOP stand for *Hoger Onderwijs en Onderzoek Plan (*Higher Education and Research Plan), the periodic policy of the Minister of Education (OCW) which is also the categorisation used by the Dutch Central Bureau for Statistics (CBS). It distinguishes between ten categories (Agriculture, Engineering, Health, Economics, Law, Behaviour and Society, Language and Culture, and a Divers category). The faculty where the professor was appointed was used to determine the scientific field of the migrating scientist. The HOOP area classification is a classification which is used in Dutch policy making and therefor it was selected as a suitable means to classify.

3.9 Bibliometric Statistics and Analysis

The relation between the individual quality of the migrating professor (expressed professors' individual average Mean Normalized Citation Score) and the institutional quality (expressed in the Pearson's R correlation of the institute quality according to Leiden Ranking) was express through calculation the correlation an individuals and his prior institutes MNCS. Because the average MNCS score over the period 2009-2012 could theoretically have a value of zero, it is a ratio variable. Because we are dealing with an interval and a ratio variable, a Pearson's *r* correlation test is used to determine the significance of their relation. SPSS was used to perform the analysis and the generation of descriptive statistics. The CWTS Leiden was so friendly as to perform the calculation of the individual bibliometric MNCS statistics based on data from the Web of Science.

4 Results

4.1 Introduction

Data analysis shows that 39 individuals were, prior to their appointment as professor in the Netherlands, affiliated to a university abroad. A full overview of the sample with information about university of origin and destination; the rankings of the foreign and Dutch university; and the country and city of the university of origin can be found in Appendix A. Although much of the information for this sample is derived from public sources the names of the scientists will not be mentioned for privacy reasons. They have each been assigned an anonymising ID.

On a yearly basis 275 individuals are newly appointed as professor in the Netherlands and of these on average 115 persons came from the job market outside the Netherlands (over the period 2003-2011, see Appendix B). Of these 275 persons 125 were previously working as associate professor, 10 as assistant professor and 25 were operating in other academic functions before coming to Dutch academia (de Goede et al., 2013). For the year 2013, the number of people coming from a foreign university is 34. If we would take the number of 34 to be average, and also include the migrants from non-universities, then 17.5 percent of all the newly appointed professors abroad.

Section 4.2 presents the additional results of descriptive analysis of the sample of migrant professors: their country of origin, the university of origin and destination and the distribution per area. These results provide an answer to the first part of the research question. Section 4.3 presents the results of the analysis concerning the quality of individual and institute and provides an answer to the second part of the research question.

4.2 Characteristics of the migrants professors

<u>Country of Origin</u>

The results of the descriptive statistics of the country of prior affiliation (see Table 1) show that most of the migrants come from the United States and United Kingdom (56.4%). Both are English-speaking countries, holding a number of top universities. Only two individuals came from countries which are considered non-Western: Burkina Faso and Taiwan. Neighbouring countries (UK not included) only represent a small proportion of the migrants (17.9%).

Tabel 2. Country of prior affiliation

	Frequency	Percent	Cumulative Percent
US	11	28,2	28,2
UK	11	28,2	56,4
Germany	5	12,8	69,2
Italy	4	10,3	79,5
Austria	2	5,1	84,6
Belgium	2	5,1	89,7
Ireland	2	5,1	94,9
Burkina Faso	1	2,6	97,4
Taiwan	1	2,6	100,0
Total	39	100,0	

The expectation that in the Netherlands, being a top research nation, migrants from other top research nations are appointed is confirmed and can be explained from the stratification of migration. Most scientific migrants come from nations that have top science systems.

University of Origin

The scientists that came from foreign universities were affiliated at universities visible in the figure 1. below and a full description of from and to migration can be found in appendix C in which the universities of origin and destination are listed.

Figure 1. Prior university locations

The four individuals came from a non-university came mostly from research institutes: one from the International Water Management Institute and was working in Burkina Faso, one from the Max Planck Institute for Research on Collective Goods in Bonn, Germany, one from the European University Institute in Florence, Italy and one from Max-Planck-Institute of Biochemistry in Martinsried, Germany.

University of Destination

Table 2 shows the distribution of migrating professors over Dutch universities. From the 39 scientists that came to the Netherlands, 18 became affiliated to a university in the city of Amsterdam of which the University of Amsterdam accounted for 38.5% of the total number of migrant scientists, and together with the VU Amsterdam, they account for almost half of all migrant professors in the Netherlands. One reason that could explain this skewness in distribution could be university size. A bigger university would attract more foreign staff then a smaller one. To put things into perspective, the university personal data is added in Appendix D.

Table 2. Destination University Distribution

		Frequency	Percent	Cumulative Percent
Valid	University of Amsterdam	15	38,5	38,5
	University of Groningen	5	12,8	51,3
	Wageningen University and Research Centre	4	10,3	61,5
	VU University Amsterdam	3	7,7	69,2
	Erasmus University Rotterdam	2	5,1	74,4
	Leiden University	2	5,1	79,5
	Radboud University Nijmegen	2	5,1	84,6
	Technische Universiteit Eindhoven	2	5,1	89,7
	Tilburg University	2	5,1	94,9
	Utrecht University	2	5,1	100,0
	Total	39	100,0	

One reason that could explain this skewness in distribution could be university size. A bigger university would attract more foreign staff then a smaller one. To put things into perspective, the university personal data is added in Appendix D. These data show that university size both in terms of total staff size and in more specifically -professors staff size, does not explain the large differences in migration distribution across the Netherlands. If the percentage of non-Dutch nationality individuals (WOPI-data) is taken as an indicator for internationalization, it does not help to explain the majority of migrants moving to Amsterdam. It should be noted the skewedness of the results could be explained by the fact that this sample accounts for little more than a year period. Migration over a longer period could show a less skewed distribution of migratory scientists across Dutch universities.
Another reason for the skewness of the distribution found could be that one university is more internationally orientated then the other. The WOPI university staff data shows however that the University of Amsterdam is not more internationalized than other Dutch universities (based on nationality). Perhaps a university reorganization or policy adjustment could help explain the skewed distribution or the simple fact that the sample was focused on a too brief time period and therefor a too small sample. The results found concur with the fact that knowledge workers prefer to reside in more metropolitan areas (as was suggested by Raspe et al. (2014)).

A possible explanation could be the attractiveness of living in the city of Amsterdam. A recent research by the Netherlands Environmental Assessment Agency (PBL) shows that Amsterdam is attractive for foreign knowledge workers. Correcting for sector, presence of foreign and international companies the odds that a foreign knowledge worker will work in Amsterdam is still almost 300 percent higher than the Dutch average (Raspe et al., 2014). The agency speaks of the Amsterdam effect to describe the fact that foreign knowledge workers like to work in the Amsterdam agglomeration. 35% of all foreign knowledge workers in the Netherlands works in Amsterdam. The University of Amsterdam itself can also be considered an international orientated university; as for example English instead of Dutch is spoken at increasingly higher administrative and management levels. As foreign knowledge workers are attracted to internationally orientated regions, this could explain the skewed distribution of the migrant professors.

Scientific Migrants per Research Area

The results show that most of the migrant professors are active in the research areas Language and Culture; Law; and Nature. Surprisingly, the research area Language and Culture represented the biggest group of migrant whereas this area can be considered highly contextualized. Also the research area Law accounted for a big part of the migrants, while one would expect that the area of law is mostly bound nationally because of national law. Perhaps the phenomena of globalization and internationalization lead to international and European law and thus more mobile law researchers.

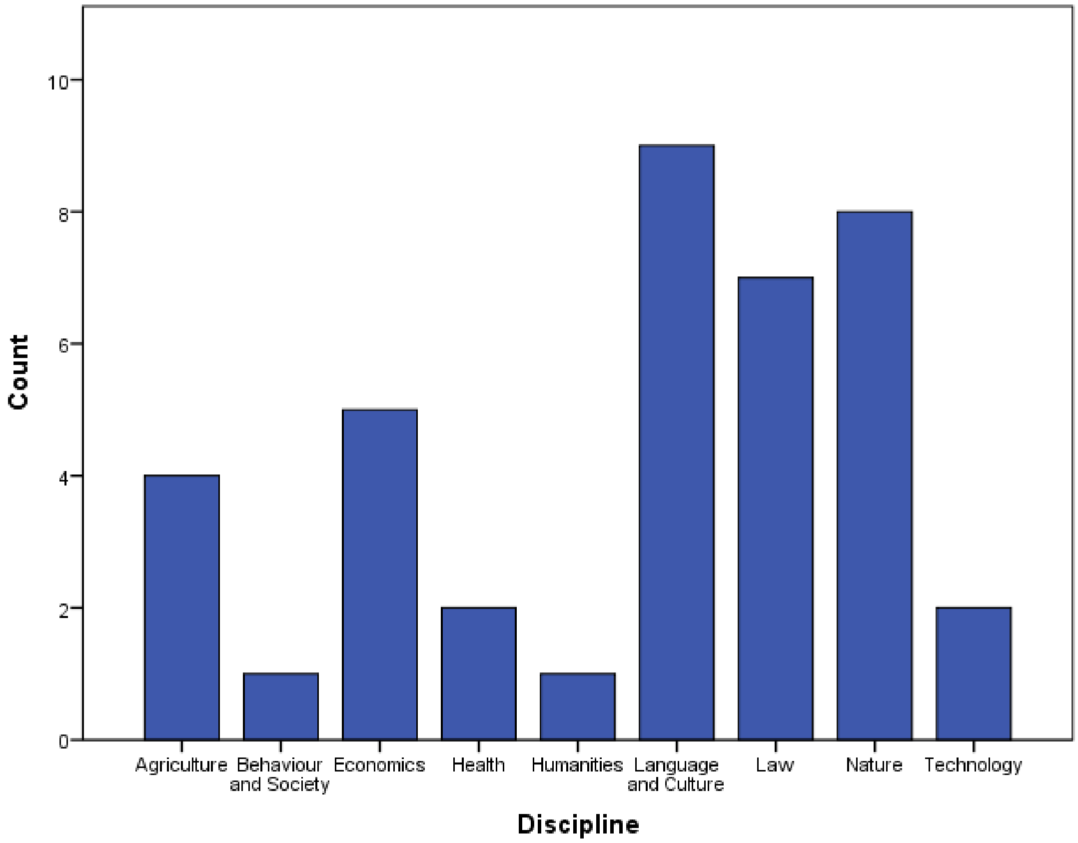


Figure 2. Bar diagram distribution per HOOP research area

4.3 Individual and university quality

<u>University Quality comparison</u>

A comparison of the rankings per MNCS of the Dutch universities and the foreign origin universities is presented in the box plot below (Figure 3). There is clearly a broader distribution of the MNCS ranking of the foreign universities as compared to the MNCS ranking of the Dutch universities. Dutch universities are less spread then the foreign universities the professors have migrated from. This is not surprising as all Dutch universities perform well and can all be considered sub top. It should be noted that all 13 Dutch universities are in the top 750 of the 2014 CWTS Leiden Ranking. The foreign universities give a different picture, as their ranking seems to be more spread or for some universities are not included at all.

Figure 3. University MNCS Ranking Distribution Density Plot

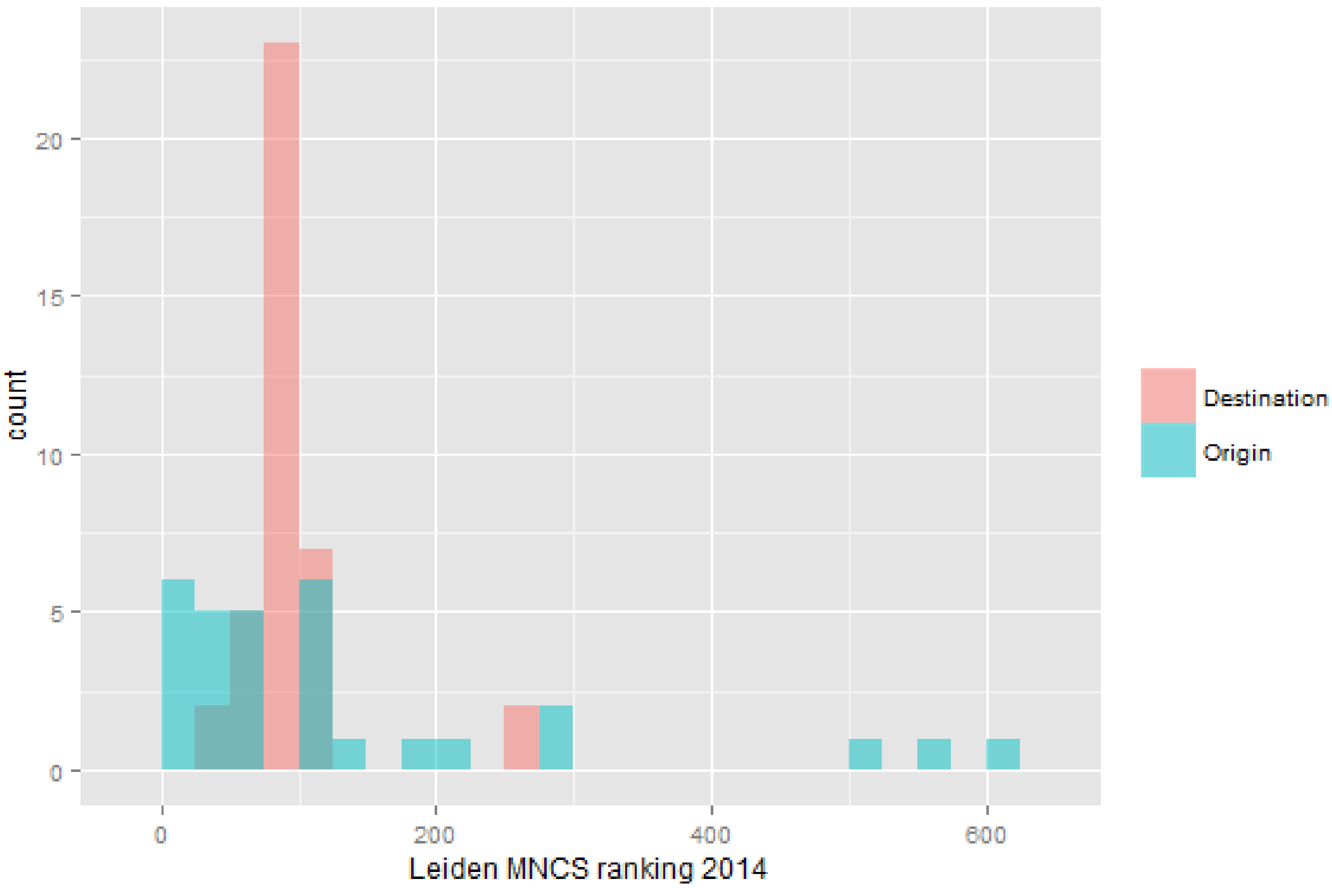
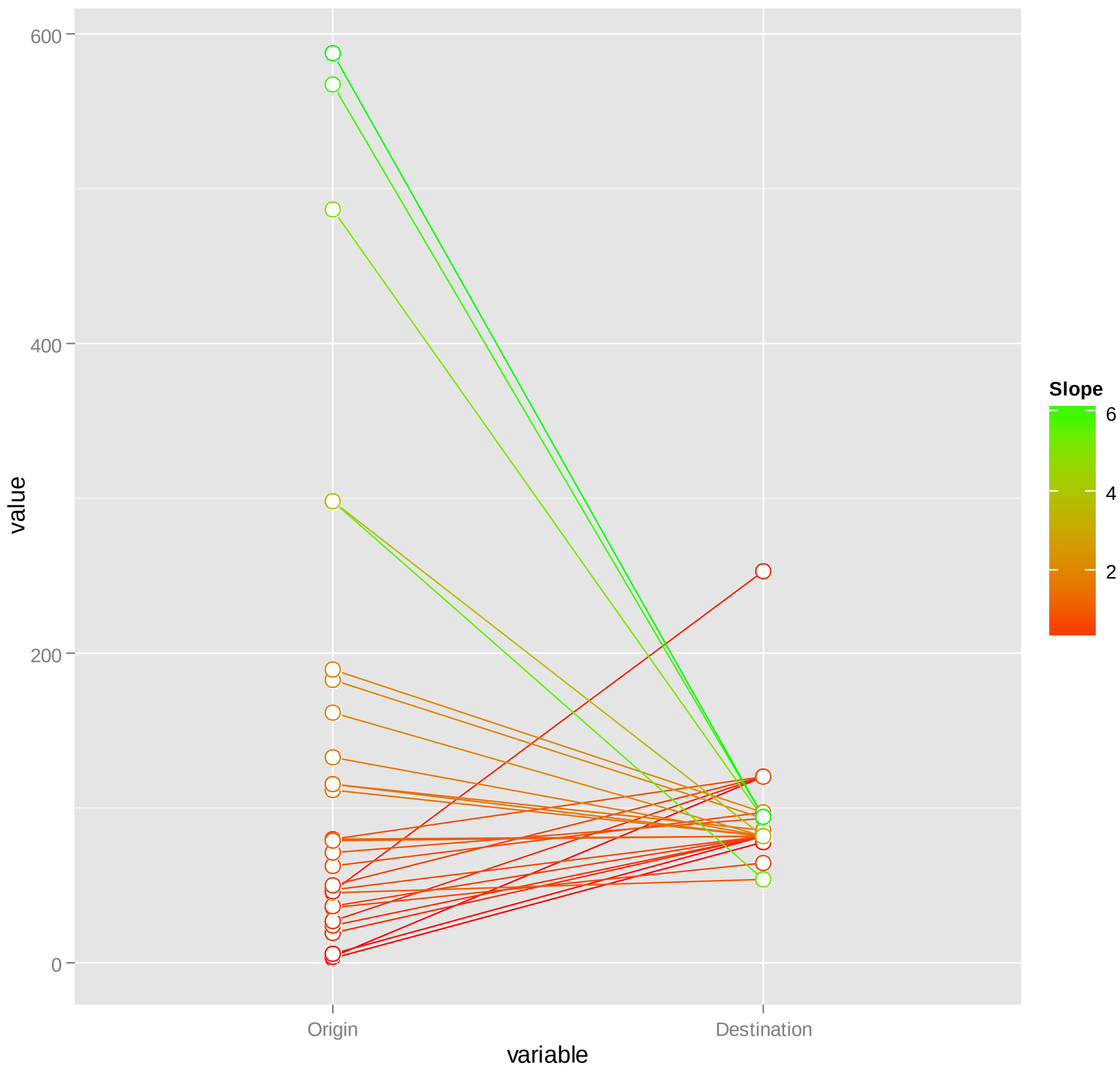


Figure 4. Origin and Destination Ranking movement



The mean ranking for the Dutch universities the scientists migrated to is 90.7 with a standard deviation of 45.7 (see Table 3). The mean ranking for foreign universities is 134 with a standard deviation of 161.6, and clearly more spread then the Dutch University distribution. This becomes more apparent in the density plot below. Out of the total 39, four individuals were not priory affiliated to a university when they came to the Netherlands (specification are given in Section 4.2). Five individuals came from universities that were not represented in the ranking. The fact that these origin universities were not found in the ranking could be because they didn't make it into the top of 750 universities or didn't fit the criteria of the ranking. If they are excluded because they did not make the ranking, this implies the mean and standard deviation would be even higher. Either way, when we compare the distribution of Dutch university rankings and the rankings of the universities of origin we observe that in terms of stratification, there is some overlap in quality. Nevertheless, there are also quite some origin universities that rank above or below de Dutch rankings.

Table 3. University Quality Comparison

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Prior Foreign University MNCS Ranking	30	2	617	134,40	161,623
Dutch Destination University MNCS Ranking	39	36	265	90,67	45,737
Valid N (listwise)	30				

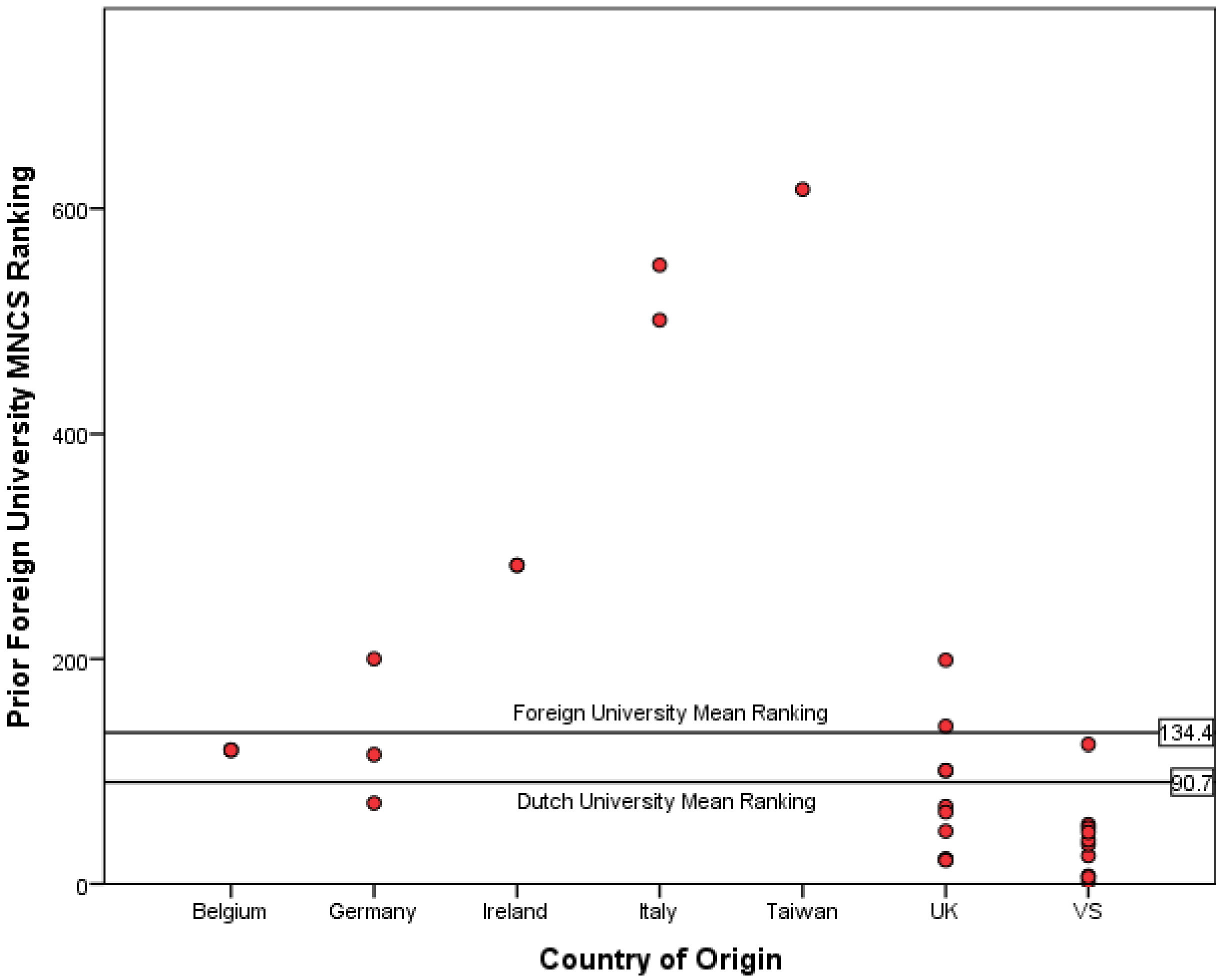
If migration is stratified, scientists move from and to universities of the same quality (Deville, 2014). To what degree this can be confirmed by the results of our research is debatable. The Netherlands is considered a top research country, but from the ranking performance it can be concluded that it is a sub top as most universities rank between the top 50 and 150. However, some footnotes to this conclusion need to be made. All Dutch universities perform well in terms of ranking, making the Netherlands a very healthy and competitive science system. The Netherland does not have a lot of universities in the top 10 or top 20. These places are almost exclusive reserved for the well-known United States universities. In Figure 4 we see the ranking of the university the migrant came from compared to the ranking of the university he or she went to. Most individuals came from a university that ranking within the top 200 and moved to a Dutch university which ranks from 50 to 150 in the Ranking.

Foreign University Quality distribution per Country or Origin

The more prestigious science systems (the United States and United Kingdom) do not only provide the most migrants, but also migrants from the best ranking institutes. This result - that the most advanced science systems provide for the individuals from the highest ranking institutes - comes as no surprise

In Figure 5 below the distribution of university ranking of the university of origin is presented per country. Added is the average ranking of the universities of origin and Dutch university of destination. It shows that the university rankings from the UK and US are mostly below the Dutch average.

Figure 5. University Ranking Distribution per Country



Appendix E provides a full overview of the foreign and Dutch university rankings according to MNCS listed per country. It can be concluded from these data that the scientists coming from universities from the UK and the US, come from higher ranking universities (Mean: 78.60 and 38.20). Scientists from other nations tend to come from universities that rank higher or do not rank at all.

Quality of the individual migrant professors

In collaboration with the CWTS the following bibliometric data was disclosed. Of the total 2273 publications of the sample of 39 professors 73% (1647) had a DOI. Out of the 1647 documents with a DOI, 56% (927) could be found in the Web of Science. Of this sample 721 were published in the period prior to 2013. Of the total sample 32% could be identified with a DOI and could be found in the Web of Science bibliometric database prior to 2013. This means that of the 32% of the total sample of publications was able to identified with a DOI and could be found in the Web of Science bibliometric database.

Table 4. Bibliometric coverage

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
P total publications	39	5,0	264,0	57,077	59,1894
P with DOI	35	1,0	166,0	26,486	37,5824
p in WoS	39	,000	144,000	18,86538	31,021843
P with DOI in Web of Science	35	,00	144,00	21,0214	32,07673
Percentage of total P with DOI	39	0,00%	82,20%	33,5488%	25,62147%
Coverage P Wos DOI in total P with DOI	35	0,00%	100,00%	71,9845%	24,70432%
Coverage total P and WoS DOI P	39	0,00%	66,31%	25,0474%	20,70129%
Valid N (listwise)	35				

Not all migrant scientists were covered equally in the database. Some areas of science were better covered then others. In total there were four persons of who there were publications to be found according to the method used. A full overview of the Bibliometric coverage of scientists per research discipline can be found in the Appendix G and H. The research disciplines Humanities (4.2%); Language and Culture (12%); Law (4.8%) and Technology (7.2%) are poorly represented in the bibliometric data.

Correlation Analysis

To determine to what degree the university quality servers as a proxy for the quality of the individual the correlation between the universities MNCS and individuals scientists is calculated.
Not all scientist were fully represented in the bibliometric data, as expected. In order to exempt the individuals that were underrepresented in the data, a threshold of 25% is set. All individuals whose work was not represented for at least 25% in the data were not included in the correlation analysis. The results of the correlation analysis are shown in the table 4.

Table 5. Individual and University Quality Correlation

		Foreign University Leiden Ranking 2014 position sorted by University MNCS	Individual Mean Normalized Citation Score
Foreign University Leiden Ranking 2014 position sorted by University MNCS	Pearson Correlation	1	,702**
	Sig. (2-tailed)		,005
	N	14	14
Individual Mean Normalized Citation Score	Pearson Correlation	,702**	1
	Sig. (2-tailed)	,005	
	N	14	19

**. Correlation is significant at the 0.01 level (2-tailed).

Out of the total sample of 39, 14 met the 25% coverage criteria and were fit for analysis. The results show that if a person comes from a university which has a higher university MNCS he or she is very likely to have a higher MNCS. Hereby confirming the correlation between the quality of the university one migrates from and the quality of the individual migrant. Even though the sample existed of only 14 individuals the results were still highly significant (0,005).

5 Discussion

5.1 On the new approach used

Since a new method was developed and used in this research, it is important to assess the method on its value as a research method for the analysis of migration. The new method was a combination of desk research to trace the full population of migration in combination with bibliometrics

Using desk research through resumes, LinkedIn pages, university staff pages and personal pages to trace migration of newly appointed professors in the Netherlands proved to be very useful. There were little conflicting data on the migrant professors and for most individuals migration could easily be confirmed of disconfirmed. Nowadays, work-related social networking and advertisement is becoming more and more of a necessity. It can be expected that for younger individuals this method would be even more fruitful and less time consuming as there will be more information on them on the Internet. Because the research focused on a relative short period of one year and three months, it should be taken into account that this can provide a skewed picture of migration. Nonetheless, it does provide for a total overview of migration to the Netherlands during that period. New in this research was that the indicator for mapping migration was not based on country of residence at 18 (as was done in previous research Franzoni, 2012) but on the change of affiliation. It also should be noted that this research has focused on migration of scientists with the highest obtainable degree in academia, professors. We should be careful in extrapolating these results to all scientific migration, most notably because migration occurs less and plays different role in later career and life. And also because the likelihood of not being mobile recently increases over age and being married and having children also decreases the likelihood of mobility (Børing, 2015).

Data availability was a limiting factor in this research design. After careful considerations the mean normalized citation score (MNCS) was selected as a means to measure quality for both the university and the individual. However, not all universities were covered in the ranking. Also there were limitations concerning the publications of the individuals; finding all publications of one author and subsequently trying to find their publications through the use of DOIs in Web of Science proved to be a method that did not work for all disciplines of science. Professors, who can be considered to represent the academic elite, were on some occasions not represented in the bibliometric databases. Especially in the areas Language and Culture; Law; Technology and Humanities they were particularly unrepresented; even after an extra effort was made (in case of the Humanities area) in terms of time invested to find publications and the DOIs of the publications (as the more social sciences are often unrepresented). Individuals in these scientific area are still unfit for bibliometric analysis in 2015. On the other hand, fields such as Health, Economics and Agriculture were much better covered and are fit for use by bibliometric analysis. The above mentioned limitations narrowed the sample for the correlation analysis.

It was found out which fields are suitable for bibliometric analysis and that the method of data collection and bibliometric analysis are viable for research purpose. Replicating the research method can be easily done when the DANS data and bibliometric data are accessible. This means that replicating the research with a bigger sample is feasible and the relation between individual and university, as well as stratification can be more deeply analysed using the more represented fields in science.

As earlier stated the operationalization of quality was via narrow approach, and the areas at the social, humanistic side of science do not lend themselves to be expressed in this manner. As we used the bibliometric approach, no conclusions can be drawn on the quality on these areas of science because they have a publication and citation tradition, but also coverage that does not fit the demands of bibliometric analysis. Gaining an author’s entire list of publications was not always possible. Also in some areas it is more usual that scientists publish a book and do this only once every few years, whereas in other areas an author can have multiple publications per month. The professor with one of the highest mean normalized citation score in the sample had taught history at Oxford, Cambridge and Leiden, all prestigious universities in this field. It should come to no surprise that this individual came out as a high quality scientists. But when looking more closely bibliometric data show that of the 24 publications of this professor, five were found to have a DOI, of which only one could be found in the Web of Science and for which a MNCS could be calculated. This one publication was then cited a total of three times and with field correction this led to a score of 9.41, which was on the highest. Undoubtedly, this individual is a prestigious figure in his field, but with such coverage statistics and field citation behavior it is difficult to argue to what degree the mean normalized citation score calculated reflects the individual’s scientific quality. The bibliometric method is not suitable for analysis of the social sciences and humanities. In fields with considerable numbers of publications per author and citations, and a considerable coverage, this method leads to results that are a good representation of the quality of an individual’s work. It provides a useful method for analysing scientific quality. To conclude: bibliometrics analysis works but not for all fields of science.

5.2 On the found migration patterns

The UK and US provide for most newly appointed professors in the Netherlands, during the period October 2012 - January 2014. Scientists from these two countries are also the individuals that come from the highest-ranking universities. It seems the Netherlands imports quite some talent from these two science systems. Dutch policy makers and university management should continue to invest in maintaining these relations outside the Netherlands. But the most important investment should be done in its own Science System. As knowledge and innovations often find their origin in science, and innovation is a source for competitive advantage, it is important for a national innovation systems to invest in a healthy competitive science system. Quality is concentrated in high-ranking institutes and international competition is increasing and so are investments in terms of scientific research and development, whereas in the Netherlands expenditure on universities is stable and investment in R&D is even declining. The Netherlands should continue to invest in its science system in order to maintain a competitive economy. If the Dutch Innovation System wishes to maintain its leading edge, it should do so by continuing in investing in its science base. Given, the countries who spend the most on R&D do have to do a lot of catching up to the more westernized countries. But a country that has expensive labor and a great amount of social security and wishes to remain so, should invest in maintaining to be on the cutting edge of science.

Theory supposes that scientists in standardized research fields would be more mobile than in more contextual fields as anthropology (Jöns, 2007; Ackers, 2013). The results show that Language and Culture are well represented in the sample of migrants (9), follow by Nature (8) and Law (7). The degree of standardisation does not help to explain the pattern of migration to the Netherlands. Nature (8) can be considered highly standardized where Language and Culture are not.

Based on these results it could be concluded that the degree of standardisation of a field should not be considered a barrier to migration, low degree of standardisation in a research field can also be considered an opportunity to move to a new location. A physicist can study data from the large hadron collider everywhere in the world but if a cultural anthropologist wishes to do comparative research will have to move to another location to study another local culture. With this I mean that the degree of standardization in a research area does not have to be a barrier to migration, it can also be a reason to move.

It seems that the degree of standardisation of the research does not explain the migration pattern to the Netherlands. This is confirmed by a recent EU survey that showed that respondents with the highest educational attainment in the natural sciences or the humanities having the highest incidence of mobility followed by agricultural sciences, medical and health sciences, social sciences and engineering and technology (Børing et al., 2015). In this sample too, the behavior and society; and technology research areas are among the least mobile groups, humanities isn't but this could very well be due to the HOOP research area classification that has been used in this research. As Language and Culture are part of the humanities, the results of this research very well duplicate what Børing 's (2015) found using an extensive survey.

Foreign knowledge workers prefer to live in metropolitan areas where there are more international job perspectives but also because these areas have facilities that fit their lifestyle in which cultural facilities and living environments are important (Raspe et al., 2014). Traditional country benefits seem to play less of a role, but a regions characteristic are more important to highly educated migrants (OECD, 2009). As Glaeser et al. (2001) wrote: 'If cities are to remain strong, they must attract workers on the basis of quality of life as well as on the basis of higher wages.' This research has focused on scientific migrants whose skewness university distribution can well be explained by the attractiveness of the Amsterdam region in terms of its cultural and international environment. Scientific migrants, like other knowledge workers - or perhaps even more so -, seem to base their migration decision also on their future living and working environment. The fact that the University of Amsterdam has attracted so many migrants could be explained by the fact that, as the city of Amsterdam, is internationally orientated, and thus more attractive for foreigners also mean that they are able to choose from a bigger selection pool, making it possible to select from a selection that has more (foreign) talent. If policy makers want to attract and retain talent, they should do so by investing in the quality of their institute; by internationalizing their institute; and to take the living environment into consideration. Universities that are located far from such metropolitan regions could consider opening faculties in more metropolitan regions. Leiden University's new international The Hague Campus can be seen as an example of how a small university in a non-metropolitan area can adjust to attract talent maintain its quality in the future.

5.3 Suggestions for further research

It would be interesting to see what has motived the individuals to move to the Netherlands. If we look at the scientists coming from the highest ranking university, MIT, his academic career has started in the Netherlands with a PhD in Delft. Now a prestigious individual in his field, he has come back to work in Dutch academia. Perhaps this could imply that this individual wishes to see his or her grandchildren grow up, or retire in his country of birth, as personal or family factors seem to be the most important factors influencing a decision to return home (Franzoni et al. 2012). Some qualitative follow up research on these individuals' motivations to move to the Netherlands could provide insights that in turn could lead to policy adjustments to attract and retain talented scientists better. Answering question such as; what does this migration mean in the context of the individuals career? Or did more personal, family consideration play a role in the migration? Would aid in the understanding of the consideration these individuals had made to come to the Netherlands could provide insights that in turn could lead to policy adjustments to attract and retain talented scientists better.

Another interesting question is what explains the individuals that came from the lesser universities. What can we tell about these individuals? Are they as Probst (2013) suggests the individuals that through their talent have escaped the lower class universities? Does, through the migration to a new university, their current university reflect their talent? Studying these 'high risers' could provide interesting insights among other things; the lag of recognition. Some time can pass before an author’s publication reaches the scientific community and gets recognized. Knowing this could provide for insight of the causality of quality development.

In this research the institute and individual level were under comparison, but not all departments of a university are of the same. It would be valuable to research the interplay between quality of the individuals, and the institute, and migration on a more micro level. This research has shown that some fields are better covered then other in terms of bibliometric data. Knowing this, a research which focus on for example life sciences departments could provide for valuable insights and confirm if these effects are also measurable on micro level.

6 Conclusions

6.1 Data Collection and Research Method

Finding migration through taking new appointment data and verifying migration through desk research is a valuable method to isolate the migrants. The advantage of this method is that it theoretically provides for the total population of migrants. There is sufficient data available in bibliographic databases and public sources to distinguish the migrants in the newly appointed professors and build a sample of the total migration to the Netherlands. Of all quality indicators commonly used, the mean normalized citation score of the CWTS Leiden is the best indicator to express quality, as it justifies for different citation behaviours per field; is based the entire Reuters Web of Science and can be used to express quality of a single publication, the quality of an individual's work, the quality of department, faculty, university, or even a nation. Judging individuals in terms through the use of bibliometric analysis is however not suitable for all research areas. Individuals in the research area of humanities; language and culture; and law are unsuitable for analysis. Authors in the research areas Behaviour and Social Sciences, Economics, Health are better suited for bibliometric analysis.

6.2 Patterns in migration to the Netherlands

The population of individuals that were prior foreign affiliation before they got a professors position at a Dutch university consisted of 39 individuals. Dutch academia is fairly internationalized as on average 17.5% of new professors in Dutch academia are appointed from abroad. Most of these individuals come from UK and the US. The individuals coming from the highest ranking institutes also came from these countries. Dutch academia is able to attract individuals coming from the most prestigious universities in the world, such as MIT (2), Harvard (3), Stanford (5), hereby profiting from migration. Most migrants in the Language and Culture, Nature and Law research areas. The degree of standardization in these research areas does not seem to explain which group of migrants is the biggest. The University of Amsterdam attracted by far the most migrants (15 out 39 total), this is most likely explained by the degree of internationalization of the university, the international orientation of the region and the attractiveness of the city itself. If universities wish to attract foreign talent they should strive for quality as talent is attracted to quality, be internationally orientated as this lowers the barriers for migration, and orientate for a metropolitan environment as knowledge workers find this important. Dutch Science policy should aim at helping universities to achieve these goals and hereby strengthen the Netherlands' National Innovation System and provide for competitive advantage.

6.3 The university as a proxy for quality

There was a highly significant (0.005) correlation (0,702) found between the quality of the university and the quality of the individual scientists, even though the sample was limited. The quality of the university and the individual are thus closely related. The migration from and to also suggests that talented individuals move from high quality university to high quality university. Quality is concentrated in high ranking institutes and talented individuals, who in sum define the quality of the institute, move between high ranking institutes. The selection mechanism on the side of the individual scientists and the institutes ensure that when migrant do move to another institutes, they move to an institute which correlates to their individual quality.

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8 Appendix

Appendix A: The sample

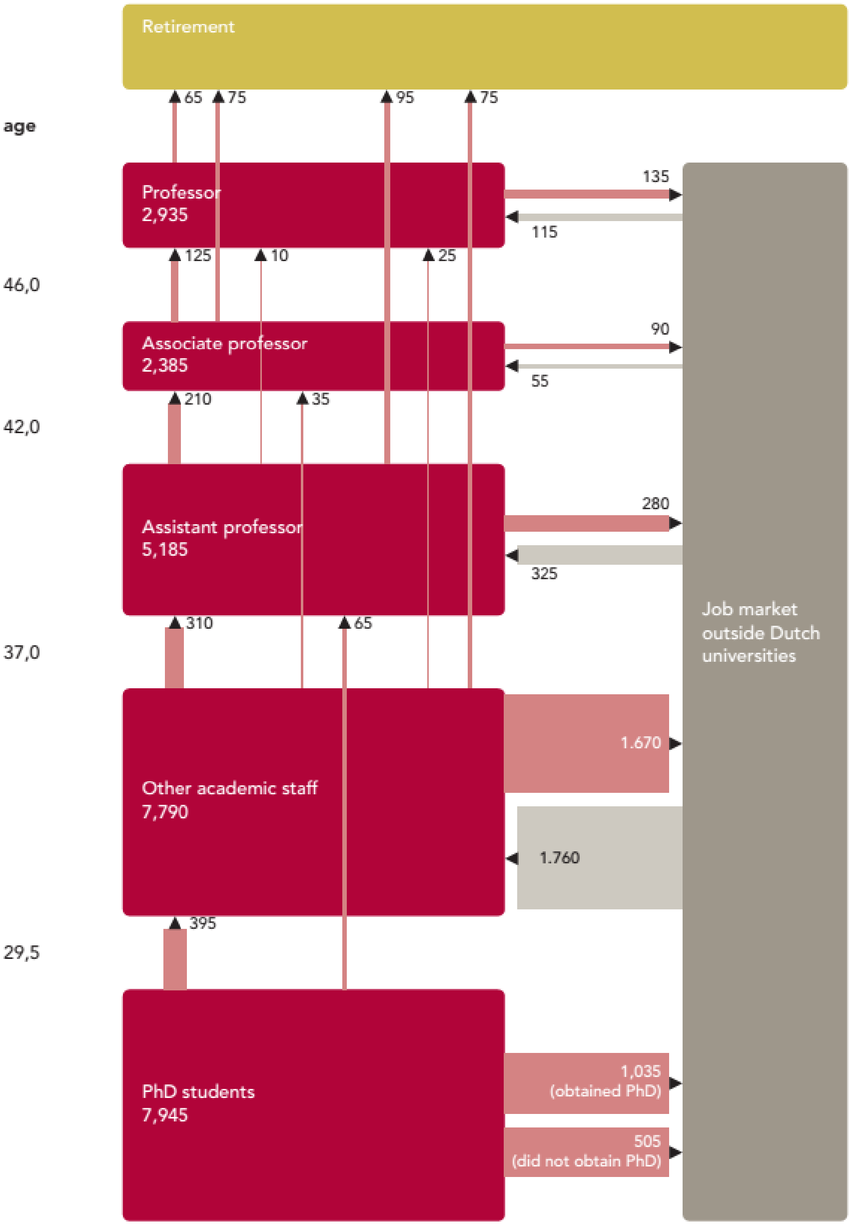
University = 1, Other = 0	University	Foreign University Leiden Ranking 2013	City	Land	institute	Dutch Institute Leiden Ranking 2013
1	New York University	28	New York, NY United States	VS	VU University Amsterdam	83
1	Cambridge Univeristy	24	Cambridge, United Kingdom	UK	University of Amsterdam	103
1	Johann Wolfgang Goethe-University	126	Frankfurt am Main, Germany	Duitsland	Radboud University Nijmegen	114
1	Harvard university	5	Cambridge, United States	VS	University of Groningen	139
1	Royal Holloway,University of London	NA	Surrey, United Kingdom	UK	University of Groningen	139
1	KU Leuven	116	Leuven, Belgium	België	University of Amsterdam	103
1	University of Teramo	Not in Ranking	Teramo, Italy	Italië	University of Amsterdam	103
1	Oxford	30	Oxford, UK	UK	University of Amsterdam	103
1	University of Aberdeen	91	Aberdeen, Schotland	Schotland	University of Groningen	139
1	University of Memphis	Not in Ranking	Memphis, Tennessee, United States	VS	Tilburg University	NA
1	University College Dublin	281	Dublin, Republic of Ireland	Ierland	Leiden University	58
1	Columbia University	19	New York City, New York, United States	VS	University of Groningen	139
1	Georgia Institute of Technology	34	Atlanta, Georgia, United States	VS	University of Groningen	139
0	Not a University	Not a University	Martinsried, Germany	Duitsland	Utrecht University	64
1	Indiana University - Bloomington	69	Bloomington, Indiana, United States	VS	University of Amsterdam	103
1	Cambridge Univeristy	24	Cambridge,United Kingdom	UK	University of Amsterdam	103
1	Munich University	110	Munich, Germany & Berlin, Germany	Duitsland	University of Amsterdam	103
1	University of California- Irvine	44	Irvine, California, United States	VS	University of Amsterdam	103
1	Carnegie Mellon University	21	Pittsburgh, Pennsylvania, United States	VS	Tilburg University	NA
1	University College	281	Dublin, Republic of	Ierland	University of	103

	Dublin		Ireland		Amsterdam	
1	Massachusetts Institute of Technology	1	Cambridge, Massachusetts, United States	VS	Utrecht University	64
1	Icahn School of Medicine at Mount Sinai	31	New York, NY, United States	VS	University of Amsterdam	103
1	Stanford	3	Stanford, California, United States & Chevy Chase (CDP), Maryland, United States	VS	University of Amsterdam	103
1	University of Naples Federico II	428	Naples, Italy	Italië	Wageningen University and Research centre	78
1	KU Leuven	116	Leuven, Belgium	België	Erasmus University Rotterdam	96
0	Not a University	Not a University	Erfurt, Germany	Duitsland	Erasmus University Rotterdam	96
1	University of Edinburgh	84	Edinburgh, Schotland	Schotland	Radboud University Nijmegen	114
1	Paris-Lodron University Salzburg	Not in Ranking	Salzburg, Ostria	Oostenrijk	VU University Amsterdam	83
1	King's College London	56	London, England	UK	Leiden University	58
1	University of London	NA	London, England	UK	Leiden University	58
1	National Taiwan University of Science and Technology	377	Taipei, Taiwan	Taiwan	Technische Universiteit Eindhoven	94
1	University of Siena	448	Siena, Italy	Italië	Technische Universiteit Eindhoven	94
1	Cardiff university	246	Cardiff, Wales, UK	UK	Wageningen University and Research centre	78
0	Not a University	Not a University	Ouagadougou, Burkina Faso	Burkina Faso	Wageningen University and Research centre	78
1	University of Aberdeen	91	Aberdeen, Schotland	Schotland	University of Amsterdam	103
1	University of York	107	Heslington, England, UK	Uk	University of Amsterdam	103

1	University of Manchester	193	Manchester, UK	Uk	University of Amsterdam	103
1	Österreichische Akademie der Wissenschaften	Not in Ranking	Innsbruck, Austria	Oostenrijk	University of Amsterdam	103
0	Not a University	Not a University	Florence, Italy	Italië	VU University Amsterdam	83
1	Technische Universität München.	77	Munchen, Germany	Duitsland	Wageningen University and Research centre	78
36		118,7				98
		80,5				103

Appendix B: Most significant job market mobility

Figure 3 Most significant job market mobility, yearly averages of number of people (period spanning 2003-2011)[3]



Source: VSNU (WOPI; PhD student data), CBS (MUP); figure by Rathenau Instituut

Rathenau Instituut

3 Please note – this infographic is a simplified representation of the data available. Values are based on the average of nine consecutive years of data. Net in- and out-flows of personnel are not equal, due to the infographic not including personnel stepping to 'lower' functions, and the infographic does not include support and management personnel. These data are available.

Appendix C: Migration from and to University per Country,

Case Summaries[a]

				Prior Foreign University	Prior Foreign University MNCS Ranking	Prior Foreign University MNCS	Dutch Destination University	Dutch Destination University MNCS Ranking	Dutch DestinationPrior Foreign University MNCS Ranking
Land	Austria	1		Österreichische Akademie der Wissenschaften	NA	NA	University of Amsterdam	76	1,27
		2		Paris-Lodron University Salzburg	NA	NA	VU University Amsterdam	66	1,30
		Total	N	2			2	2	2
			Mean					71,00	1,2850
			Std. Deviation					7,071	,02121
	Belgium	1		KU Leuven	119	1,20	Erasmus University Rotterdam	84	1,26
		2		KU Leuven	119	1,20	University of Amsterdam	76	1,27
		Total	N	2	2	2	2	2	2
			Mean		119,00	1,2000		80,00	1,2650
			Std. Deviation		,000	,00000		5,657	,00707
	Burkina Faso	1		Not a University	NA	NA	Wageningen University and Research centre	88	1,25
		Total	N	1			1	1	1
			Mean					88,00	1,2500

			Std. Deviation					NA	NA
	Germany	1		Technische Universität München.	72	1,29	Wageningen University and Research centre	88	1,25
		2		Munich University	115	1,20	University of Amsterdam	76	1,27
		3		Johann Wolfgang Goethe-University	200	1,10	Radboud University Nijmegen	114	1,21
		4		Not a University	NA	NA	Erasmus University Rotterdam	84	1,26
		5		Not a University	NA	NA	Utrecht University	36	1,41
		Total	N	5	3	3	5	5	5
			Mean		129,00	1,1967		79,60	1,2800
			Std. Deviation		65,138	,09504		28,228	,07616
	Ireland	1		University College Dublin	283	1,02	Leiden University	51	1,34
		2		University College Dublin	283	1,02	University of Amsterdam	76	1,27
		Total	N	2	2	2	2	2	2
			Mean		283,00	1,0200		63,50	1,3050
			Std. Deviation		,000	,00000		17,678	,04950
	Italy	1		University of Naples Federico II	501	,85	Wageningen University and Research centre	88	1,25

		2		University of Siena	550	,80	Technische Universiteit Eindhoven	83	1,26
		3		Not a University	NA	NA	VU University Amsterdam	66	1,30
		4		University of Teramo	NA	NA	University of Amsterdam	76	1,27
		Total	N	4	2	2	4	4	4
			Mean		525,50	,8250		78,25	1,2700
			Std. Deviation		34,648	,03536		9,535	,02160
	Taiwan	1		National Taiwan University of Science and Technology	617	,74	Technische Universiteit Eindhoven	83	1,26
		Total	N	1	1	1	1	1	1
			Mean		617,00	,7400		83,00	1,2600
			Std. Deviation		NA	NA		NA	NA
	UK	1		Cambridge University	22	1,55	University of Amsterdam	76	1,27
		2		Cambridge University	22	1,55	University of Amsterdam	76	1,27
		3		Oxford University	21	1,55	University of Amsterdam	76	1,27
		4		King's College London	47	1,36	Leiden University	51	1,34
		5		University of Edinburgh	64	1,30	Radboud University Nijmegen	114	1,21

		6		University of Aberdeen	101	1,23	University of Amsterdam	76	1,27
		7		University of Aberdeen	101	1,23	University of Groningen	116	1,20
		8		University of York	69	1,30	University of Amsterdam	76	1,27
		9		University of Manchester	140	1,17	University of Amsterdam	76	1,27
		10		Cardiff University	199	1,10	Wageningen University and Research centre	88	1,25
		11		Royal Holloway,University of London	NA	NA	University of Groningen	116	1,20
		Total	N	11	10	10	11	11	11
			Mean		78,60	1,3340		85,55	1,2564
			Std. Deviation		58,021	,16541		21,002	,04081
	VS	1		Massachusetts Institute of Technology	2	2,05	Utrecht University	36	1,41
		2		Harvard university	6	1,88	University of Groningen	116	1,20
		3		Stanford University	7	1,86	University of Amsterdam	76	1,27
		4		Columbia University	25	1,51	University of Groningen	116	1,20

		5		New York University	35	1,42	VU University Amsterdam	66	1,30
		6		Icahn School of Medicine at Mount Sinai	39	1,40	University of Amsterdam	76	1,27
		7		University of California- Irvine	46	1,37	University of Amsterdam	76	1,27
		8		Carnegie Mellon University	50	1,35	Tilburg University	265	1,04
		9		Georgia Institute of Technology	53	1,33	University of Groningen	116	1,20
		10		Indiana University - Bloomington	124	1,20	University of Amsterdam	76	1,27
		11		University of Memphis	NA	NA	Tilburg University	265	1,04
		Total	N	11	10	10	11	11	11
			Mean		38,70	1,5370		116,73	1,2245
			Std. Deviation		35,409	,28628		77,263	,10875
	Total	N		39	30	30	39	39	39
		Mean			134,40	1,3043		90,67	1,2562
		Std. Deviation			161,623	,29650		45,737	,06953

a. Limited to first 100 cases.

Appendix D: 2013 Full Time Employment and Nationality in Dutch Universities *

2013 Full Time Employment and Nationality in Dutch Universities *						
	Total university Staff			Professors only		
University	FTE	Percentage of universities total	Percentage non-Dutch Nationality	FTE	Percentage of universities total	Percentage non-Dutch Nationality
Leiden University	3419	7,8	20.3	230	8,7	14,3
Utrecht University	4967	11,3	14.5	283	10,7	10,9
Groningen University	3921	8,9	20.9	271	10,3	14,8
Erasmus University Rotterdam	2142	4,9	19.5	130	4,9	15,4
University of Maastricht	3209	7,3	25.2	143	5,4	22,8
University of Amsterdam	4385	10,0	19.5	276	10,4	14,4
VU University of Amsterdam	3747	8,5	15.7	256	9,7	12,1
Radboud University Nijmegen	3336	7,6	16.4	221	8,4	14,7
Tilburg University	1583	3,6	20.8	176	6,7	18,2
Delft University	4532	10,3	28.5	228	8,6	22,8
Eindhoven University of Technology	2768	6,3	34.8	141	5,4	16,7
University of Twente	2689	6,1	23.3	149	5,7	14,3
Wageningen University	2618	6,0	20.2	103	3,9	13,6
Open University	573	1,3	8.5	32	1,2	6,9
Grand Total	43889	100		2639	100	

Table 3. taken from University Staff Information System (WOPI)

Appendix E: MNCS Foreign and destination university + Individuals MNCS

Case Summaries[a]

				Foreign University Leiden Ranking 2014 By MNCS	Foreign University Leiden Ranking 2014_ MNCS	Dutch Institute Leiden Ranking 2014by MNCS	Dutch Institute Leiden Ranking 2014_ MNCS	MNCS
Land	Austria	1		NA	NA	76	1,27	6,409832
		2		NA	NA	66	1,30	,000000
		Total	Mean			71,00	1,2850	3,20491600
			Std. Deviation			7,071	,02121	4,532435673
			N			2	2	2
	Belgium	1		119	1,20	84	1,26	1,270880
		2		119	1,20	76	1,27	,000000
		Total	Mean	119,00	1,2000	80,00	1,2650	,63544000
			Std. Deviation	,000	,00000	5,657	,00707	,898647866
			N	2	2	2	2	2
	Burkina Faso	1		NA	NA	88	1,25	2,129968
		Total	Mean			88,00	1,2500	2,12996800
			Std. Deviation			NA	NA	NA
			N			1	1	1
	Germany	1		72	1,29	88	1,25	,992425
		2		115	1,20	76	1,27	1,523856
		3		200	1,10	114	1,21	1,881338
		4		NA	NA	84	1,26	3,057147
		5		NA	NA	36	1,41	2,491052
		Total	Mean	129,00	1,1967	79,60	1,2800	1,98916360
			Std. Deviation	65,138	,09504	28,228	,07616	,808409839
			N	3	3	5	5	5
	Ireland	1		283	1,02	51	1,34	1,775438
		2		283	1,02	76	1,27	,474859
		Total	Mean	283,00	1,0200	63,50	1,3050	1,12514850
			Std. Deviation	,000	,00000	17,678	,04950	,919648230
			N	2	2	2	2	2
	Italy	1		501	,85	88	1,25	2,084854
		2		550	,80	83	1,26	,453729
		3		NA	NA	66	1,30	,316290
		4		NA	NA	76	1,27	NA
		Total	Mean	525,50	,8250	78,25	1,2700	,95162433

			Std. Deviation	34,648	,03536	9,535	,02160	,983808659
			N	2	2	4	4	3
	Taiwan	1		617	,74	83	1,26	,727660
		Total	Mean	617,00	,7400	83,00	1,2600	,72766000
			Std. Deviation	NA	NA	NA	NA	NA
			N	1	1	1	1	1
	UK	1		22	1,55	76	1,27	1,156916
		2		22	1,55	76	1,27	NA
		3		21	1,55	76	1,27	9,413597
		4		47	1,36	51	1,34	,536300
		5		64	1,30	114	1,21	NA
		6		101	1,23	76	1,27	2,763034
		7		101	1,23	116	1,20	2,088912
		8		69	1,30	76	1,27	NA
		9		140	1,17	76	1,27	,411883
		10		199	1,10	88	1,25	1,511193
		11		NA	NA	116	1,20	6,785272
		Total	Mean	78,60	1,3340	85,55	1,2564	3,08338838
			Std. Deviation	58,021	,16541	21,002	,04081	3,266163937
			N	10	10	11	11	8
	VS	1		2	2,05	36	1,41	5,579800
		2		6	1,88	116	1,20	1,689257
		3		7	1,86	76	1,27	5,925820
		4		25	1,51	116	1,20	,000000
		5		35	1,42	66	1,30	3,803278
		6		39	1,40	76	1,27	2,878814
		7		46	1,37	76	1,27	,451406
		8		50	1,35	265	1,04	1,461576
		9		53	1,33	116	1,20	1,408364
		10		124	1,20	76	1,27	2,426749
		11		NA	NA	265	1,04	1,368499
		Total	Mean	38,70	1,5370	116,73	1,2245	2,45396027
			Std. Deviation	35,409	,28628	77,263	,10875	1,941644238
			N	10	10	11	11	11
	Total	Mean		134,40	1,3043	90,67	1,2562	2,20714280
		Std. Deviation		161,623	,29650	45,737	,06953	2,185296679
		N		30	30	39	39	35

a. Limited to first 100 cases.

Appendix F: Scientists Individual Bibliometric Statistics

ID	publications in Web of Science	Total Citation Score	Mean Citation Score	Mean Normalized Citation Score	Mean Normalized Journal Score	Percentage top 10% cited	Percentage Uncited	Percentage self-cited	Initial coverage
PRS 1330840	6,00	17,00	2,83	2,76	2,18	33%	17%	15%	28%
PRS 1301018	1,00	0,00	0,00	0,00	1,69	0%	100%	NULL	3%
PRS 1327899	2,00	10,00	5,00	1,16	2,14	0%	0%	9%	17%
PRS 1329039	82,00	3295,00	40,18	1,88	1,37	22%	2%	20%	97%
PRS 1330098	1,00	0,00	0,00	0,00	0,96	0%	100%	NULL	44%
PRS 1330841	0,00	#VALUE!	NULL	NULL	NULL	NULL	NULL	NULL	NULL
PRS 1330673	4,00	30,00	7,50	0,73	1,46	25%	50%	12%	45%
PRS 1316421	54,00	1216,00	22,52	1,27	1,64	18%	2%	23%	97%
PRS 1330432	6,00	7,00	1,17	0,41	0,90	0%	50%	50%	12%
PRS 1330563	15,00	236,00	15,73	2,13	1,09	23%	13%	8%	37%
PRS 1330631	1,00	1,00	1,00	0,54	0,85	0%	0%	0%	0%
PRS 1277295	8,00	125,00	15,63	2,43	1,14	25%	13%	1%	17%
PRS	9,00	97,00	10,78	3,06	1,30	17%	22%	7%	66%

125 743 9									
PRS 132 729 5	7,25	41,00	5,66	1,51	0,90	14%	17%	13%	46%
PRS 133 042 7	144,00	3261,0 0	22,65	2,08	1,49	27%	3%	15%	89%
PRS 133 030 6	2,00	2,00	1,00	0,32	0,62	0%	50%	33%	23%
PRS 132 717 7	1,00	3,00	3,00	9,41	1,05	100%	0%	0%	10%
PRS 128 832 6	1,00	3,00	3,00	2,09	10,62	17%	0%	57%	72%
PRS 132 902 4	3,00	3,00	1,00	1,52	0,75	33%	33%	0%	13%
PRS 125 700 5	5,00	162,00	32,40	6,79	1,90	60%	0%	2%	10%
PRS 132 903 3	19,00	214,00	11,26	1,37	1,01	24%	21%	16%	59%
PRS 133 063 5	3,00	5,00	1,67	0,45	1,50	0%	33%	58%	16%
PRS 132 940 5	9,00	120,00	13,33	3,80	2,01	22%	11%	11%	67%
PRS 132 833 4	78,25	2846,2 5	36,37	2,88	2,20	41%	1%	21%	96%
PRS 133 049 2	67,00	9715,0 0	145,00	5,93	2,62	62%	0%	4%	97%
PRS 133 067 6	5,00	20,00	4,00	0,47	1,16	0%	20%	17%	59%
PRS	76,25	7714,7	101,18	5,58	4,80	61%	1%	6%	97%

126 837 6		5							
PRS 132 963 5	23,00	629,00	27,35	1,69	1,52	13%	4%	9%	83%
PRS 133 031 3	31,00	1298,0 0	41,87	2,49	1,83	36%	3%	19%	93%
PRS 133 022 4	19,00	1340,0 0	70,53	6,41	2,46	92%	0%	7%	92%
PRS 132 365 2	6,00	33,00	5,50	1,78	1,17	33%	0%	13%	44%
PRS 132 916 5	13,00	171,00	13,15	1,41	1,12	12%	8%	25%	76%
PRS 132 991 2	5,00	64,00	12,80	1,46	2,88	20%	0%	6%	82%
PRS 133 087 4	7,00	18,00	2,57	0,45	1,76	0%	29%	5%	32%
PRS 133 008 9	22,00	153,00	6,95	0,99	1,04	8%	14%	14%	41%

Appendix G: Bibliometric Coverage per Research area

Case Summaries[a]

		Total publication (P)	Publications with DOI	Coverage of Total Publications with DOI	Publications with DOI found in Web of Science	Percentage of total publications found in the Web op Science	Coverage of total publications with DOI in Web of Science (of P)	Coverage of total publications with DOI in Web of Science compared (of P)
Agriculture	N	4	4	4	4	4	4	4
	Mean	98,750	57,750	53,0141%	47,0625	47,06250	70,8989%	38,0867%
Behaviour and Social Sciences	N	1	1	1	1	1	1	1
	Mean	12,000	7,000	58,3333%	6,0000	6,00000	85,7143%	50,0000%
Economics	N	5	5	5	5	5	5	5
	Mean	16,600	9,000	57,4357%	6,6000	6,60000	77,8413%	41,7258%
Health	N	2	2	2	2	2	2	2
	Mean	125,000	98,000	78,6017%	77,2500	77,25000	78,8452%	62,0394%
Humanitites	N	1	1	1	1	1	1	1
	Mean	24,000	5,000	20,8333%	1,0000	1,00000	20,0000%	4,1667%
Language and Culture	N	9	8	9	8	9	8	9
	Mean	26,222	5,625	18,6069%	3,2500	2,88889	57,5631%	12,0045%
Law	N	7	4	7	4	7	4	7
	Mean	36,429	7,750	8,0180%	4,5000	2,57143	69,9020%	4,8402%
Natural Sciences	N	8	8	8	8	8	8	8
	Mean	107,750	44,625	41,2979%	37,7500	37,75000	86,6423%	35,1456%
Engineering	N	2	2	2	2	2	2	2
	Mean	54,500	5,000	9,4139%	3,5000	3,50000	75,0000%	7,2711%
Total	N	39	35	39	35	39	35	39

	Mean	57,077	26,486	33,5488%	21,0214	18,86538	71,9845%	25,0474%

a. Limited to first 100 cases.

Appendix H: Bibliometric coverage of scientists per research area

Case Summaries[a]

				Total publications	Publications with DOI	Coverage of Total Publications with DOI	Publications with DOI found in Web of Science	Percentage of total publications foudn in the Web op Science	Coverage of total publications with DOI in Web of Science compared to found with DO	Coverage of total publications with DOI in Web of Science compared to total publications
Discipline	Agriculture	1		264,0	166,0	62,88%	144,00	144,000	86,75%	54,55%
		2		61,0	29,0	47,54%	22,00	22,000	75,86%	36,07%
		3		43,0	23,0	53,49%	15,00	15,000	65,22%	34,88%
		4		27,0	13,0	48,15%	7,25	7,250	55,77%	26,85%
		Total	N	4	4	4	4	4	4	4
			Mean	98,750	57,750	53,0141%	47,0625	47,06250	70,8989%	38,0867%
	Behaviour and Society	1		12,0	7,0	58,33%	6,00	6,000	85,71%	50,00%
		Total	N	1	1	1	1	1	1	1
			Mean	12,000	7,000	58,3333%	6,0000	6,00000	85,7143%	50,0000%
	Economics	1		39,0	18,0	46,15%	13,00	13,000	72,22%	33,33%
		2		14,0	10,0	71,43%	9,00	9,000	90,00%	64,29%
		3		11,0	9,0	81,82%	5,00	5,000	55,56%	45,45%
		4		10,0	1,0	10,00%	1,00	1,000	100,00%	10,00%
		5		9,0	7,0	77,78%	5,00	5,000	71,43%	55,56%
		Total	N	5	5	5	5	5	5	5
			Mean	16,600	9,000	57,4357%	6,6000	6,60000	77,8413%	41,7258%
	Health	1		132,0	99,0	75,00%	76,25	76,250	77,02%	57,77%
		2		118,0	97,0	82,20%	78,25	78,250	80,67%	66,31%

	Total	N	2	2	2	2	2	2	2
		Mean	125,000	98,000	78,6017%	77,2500	77,25000	78,8452%	62,0394%
Humanities	1		24,0	5,0	20,83%	1,00	1,000	20,00%	4,17%
	Total	N	1	1	1	1	1	1	1
		Mean	24,000	5,000	20,8333%	1,0000	1,00000	20,0000%	4,1667%
Language and Culture	1		56,0	9,0	16,07%	1,00	1,000	11,11%	1,79%
	2		48,0	11,0	22,92%	8,00	8,000	72,73%	16,67%
	3		31,0	9,0	29,03%	6,00	6,000	66,67%	19,35%
	4		26,0	1,0	3,85%	,00	,000	0,00%	0,00%
	5		23,0	5,0	21,74%	3,00	3,000	60,00%	13,04%
	6		17,0	5,0	29,41%	5,00	5,000	100,00%	29,41%
	7		14,0	0	0,00%	0	,000	0	0,00%
	8		12,0	4,0	33,33%	2,00	2,000	50,00%	16,67%
	9		9,0	1,0	11,11%	1,00	1,000	100,00%	11,11%
	Total	N	9	8	9	8	9	8	9
		Mean	26,222	5,625	18,6069%	3,2500	2,88889	57,5631%	12,0045%
Law	1		83,0	10,0	12,05%	6,00	6,000	60,00%	7,23%
	2		52,0	17,0	32,69%	9,00	9,000	52,94%	17,31%
	3		49,0	3,0	6,12%	2,00	2,000	66,67%	4,08%
	4		33,0	0	0,00%	0	,000	0	0,00%
	5		19,0	1,0	5,26%	1,00	1,000	100,00%	5,26%
	6		14,0	0	0,00%	0	,000	0	0,00%
	7		5,0	0	0,00%	0	,000	0	0,00%
	Total	N	7	4	7	4	7	4	7
		Mean	36,429	7,750	8,0180%	4,5000	2,57143	69,9020%	4,8402%
Nature	1		231,0	81,0	35,06%	67,00	67,000	82,72%	29,00%
	2		158,0	92,0	58,23%	82,00	82,000	89,13%	51,90%
	3		143,0	67,0	46,85%	54,00	54,000	80,60%	37,76%
	4		87,0	7,0	8,05%	7,00	7,000	100,00%	8,05%
	5		73,0	41,0	56,16%	31,00	31,000	75,61%	42,47%
	6		68,0	23,0	33,82%	19,00	19,000	82,61%	27,94%
	7		61,0	25,0	40,98%	23,00	23,000	92,00%	37,70%
	8		41,0	21,0	51,22%	19,00	19,000	90,48%	46,34%
	Tot	N	8	8	8	8	8	8	8

	al	Mean	107,750	44,625	41,2979%	37,7500	37,75000	86,6423%	35,1456%
Technology	1		70,0	6,0	8,57%	3,00	3,000	50,00%	4,29%
	2		39,0	4,0	10,26%	4,00	4,000	100,00%	10,26%
	Total	N	2	2	2	2	2	2	2
		Mean	54,500	5,000	9,4139%	3,5000	3,50000	75,0000%	7,2711%
Total	N		39	35	39	35	39	35	39
	Mean		57,077	26,486	33,5488%	21,0214	18,86538	71,9845%	25,0474%

a. Limited to first 100 cases.