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# Stay rates of foreign PhD graduates in the Netherlands

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## Summary

The effects of foreign PhD graduates on the Dutch economy as a whole and on public finances in particular depends on whether and for how long foreigners stay in the country after receiving their PhD degree from a Dutch university. We analyze the stay rates of foreign PhD graduates in the Netherlands over a 10-year period after their graduation. We use rich administrative data containing information on different demographic characteristics and migration events of individuals who are employed as PhD candidates by Dutch universities. We find that the stay rate of foreign PhD graduates in the Netherlands 10 years after graduation is 32 percent. In comparison to the US, this stay rate is substantially lower. We additionally find that women have a 28 percent lower probability of leaving the Netherlands than men. Foreign PhD graduates in technical studies are more likely to stay in the Netherlands compared to those who received their PhD in other disciplines. PhD graduates who originate from less developed countries are more likely to stay than foreign PhD graduates from developed countries. The most popular destinations among foreign PhD graduates who leave the Netherlands are Germany, the U.S., and the U.K.

# Contents

Summary—2

1 Introduction—4

2 Trends in doctoral mobility—5

3 Previous literature on stay rates of doctoral graduates—8

3.1 Actual stay rates in the U.S.—8

3.2 Intention to stay in the Netherlands—9

3.3 Actual stay rates of foreign students and labor migrants in the Netherlands—9

4 Data—10

4.1 Data sources—10

4.2 Descriptive statistics—14

5 Empirical approach—16

6 Stay rates of PhD students in the Netherlands—17

6.1 Baseline estimates—17

6.2 Heterogeneity in the stay rates of foreign PhD graduates—18

6.3 Cox proportional hazard model estimates—22

6.4 Additional analyses and sensitivity checks—23

7 Conclusion and discussion—26

References—28

# 1 Introduction

The number of PhD graduates in the Netherlands has risen sharply over the last decades: from around 2.000 graduates in 1990 to 4.500 in 2013. This development can also be seen in other Western countries (Eurostat, 2014). It has given rise to a debate on the value of a PhD diploma and the broader impact of PhD graduates on the economy. The role of foreign PhD students is crucial for this debate. The growth in PhD candidates employed by Dutch universities since 2006 can be fully attributed to the growth in foreign candidates.<sup>1</sup> The effects of the foreign PhD graduates on the Dutch economy depends, next to their direct effect on production and knowledge creation, strongly on whether these individuals stay after their graduation in the Netherlands. Despite its importance, very little is known about the stay rate of foreign PhD graduates. In this study, we estimate stay rates of foreign PhD graduates over the first ten years after graduation.

The empirical evidence on the economic effects of foreign PhD graduates on the host country is limited. In general, economic theory suggests that immigration of high-skilled workers has positive economic effects (Borjas, 1999; Roodenburg et al, 2003). When foreigners possess skills that are complementary to those of natives, it is likely that natives will benefit from the immigration influx in terms of higher productivity and wages. Although the impact on the economy is generally positive, high-skilled migration might also impose a negative effect on the labor market position of natives in specific sectors (see Kerr, 2013). For the U.S., Borjas (2006) finds empirical evidence that the inflow of foreign PhD doctorates has depressed wages of native postdocs.

From the perspective of public finances, the costs of training a PhD candidate can be seen as an investment by the government. This investment is then paid back after graduation through taxes during graduates' working lives. Especially in the Netherlands, where about half of the PhD students are treated as employees of the university, the initial public investment costs are substantial. Similar to other highly educated groups, PhD graduates have high individual returns and they are generally net contributors to government finances over the lifecycle (Van der Steeg et al., 2014; Van Elk, 2012). The largest public returns are estimated for highly performing foreign individuals who enter the Netherlands in age from the middle 20s and early 30s (Roodenburg et al., 2003). Obviously, the extent to which high-skilled foreign migrants affect public budgets depends crucially on whether they remain in the Netherlands and for how long.

There is remarkably little empirical evidence on stay rates of foreign PhD graduates in the Netherlands. Existing studies are limited to analyses of survey data on the intention of foreign PhD graduates to stay, and not on actual stay rates (Sonneveld et al., 2010; Maas et al., 2014). Self-reported intention to stay is less informative than data on actual stay, since intentions can differ from actual decisions. In addition, intention to stay does not provide

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<sup>1</sup> Throughout the text we use 'PhD students' and 'PhD candidates' as synonyms to refer to those who are involved in a PhD program. We use 'PhD graduates' and 'doctorate holders' as synonyms to refer to those who have obtained a PhD degree.

information on the duration of stay. International research on actual stay rates of PhD graduates is also limited, focusing almost solely on the U.S. (e.g. Baker and Finn, 2003; Finn, 2014). Given the large differences between the higher education system and labor market of the U.S. and that of European countries, evidence from the U.S. is only of limited relevance for the Netherlands.

An important reason for the scarce knowledge on stay rates of foreign PhD graduates in the European countries is the lack of good data. In the Netherlands, no central registration of all PhD graduates exists. Recent survey studies from the Netherlands have tried to fill the knowledge gap on the stay rates of foreign PhD graduates (Sonneveld et al., 2010; Maas et al., 2014). However, the design of these surveys leads to an undersampling of foreign PhD graduates and a bias towards those graduates who stay in the Netherlands.

In this study, we therefore make use of administrative employment data for all PhD candidates employed by Dutch universities. We are able to identify individuals who completed their PhD contract as an employee of a Dutch university. We link these data to administrative data on migration. We analyze the stay rates of PhD graduates using survival models. Such models account for the fact that we only observe migration status over a limited period of time after PhD graduation and that this time period can differ across observations. In particular, we use the Kaplan-Meier survival model to assess the stay rate of foreign PhD graduates over a 10-year period. We compare this stay rate to that of Dutch PhD graduates, and we also estimate the stay rates for different demographic groups. In addition, we use the Cox proportional hazard model to estimate whether differences in the stay rates across different groups are statistically significant. We find that after 10 years, 32 percent of foreign PhD graduates still reside in the Netherlands. We also find that the stay rates vary across different groups. The stay rates are higher for women, graduates in technical studies, and for graduates originating from less developed countries.

This study consists of six parts. In Section 2, we discuss trends in doctoral mobility both from an international and a Dutch perspective. In Section 3, we outline previous literature on the stay rates of PhD graduates. Section 4 presents the data and Section 5 explains the empirical approach that we use in this study. Section 6 presents the results with respect to the stay rates of PhD graduates in the Netherlands and across different subgroups. Several additional analyses and sensitivity checks are applied and shown in this section. Finally, we discuss our findings in Section 7.

## 2 Trends in doctoral mobility

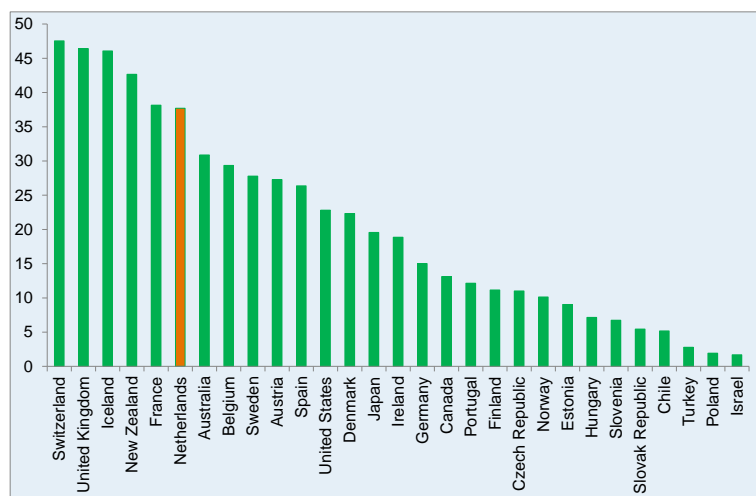
### **Doctoral mobility from the international perspective**

Both the increasing role of PhD students in academia as contributors to education and research, and the internationalization of the PhD position (e.g. focus on global research, recognition of academic degrees from other countries, and mobility of PhD graduates) are worldwide trends. Likely causes for these trends are the raising importance of teamwork

and international collaboration within academia (Black and Stephan, 2008) and the convergence of academic institutions towards a single (US) standard (Borghans and Cörvers, 2010). For the EU, part of the internationalization can be related to specific policies. The unification of higher education degrees after the Bologna declaration in 1999 has, for example, fostered the international mobility of students and researchers within Europe (Curaj et al., 2012).

EU countries and the U.S. have experienced a substantial increase in the total number of PhD students in the period 2006-2011: from around 510 thousands to around 749 thousands in EU-28 and from around 376 to around 492 in the U.S. (Eurostat, 2014). The share of foreigners among PhD graduates has increased in most OECD countries in the period between 2006 and 2011, especially in countries of the European Union (OECD, 2009; OECD, 2014). The share of foreign PhD graduates in the average EU country was 15 percent in 2006 compared to 21 percent in 2011. At the same time, the share of foreign PhD graduates from U.S. universities has decreased from 28 percent in 2006 to 23 percent in 2011 (OECD, 2009; OECD, 2014). This development is likely caused by the increased international competition of universities around the world (Clotfelter, 2010). Many universities in Europe and Asia have experienced various reforms during the last decades which enabled them to become major players in the global higher education market. The percentage of foreigners among doctoral graduates in OECD countries for 2011 is presented in Figure 2.1. The Netherlands is in the third place among EU countries with the highest share of foreign PhD students, after the United Kingdom and France.

**Figure 2.1 Foreigners among doctoral graduates (%)**



Note: Reference year is 2011.  
Source: OECD (2014).

### Doctoral mobility in the Netherlands

A number of reasons might explain the relative attractiveness of the Netherlands among foreign PhD students. Dutch universities are placed relatively high in worldwide university rankings (e.g. the Shanghai Ranking).<sup>2</sup> Universities are internationally oriented, and English

<sup>2</sup> For more details, see <http://www.shanghairanking.com/>

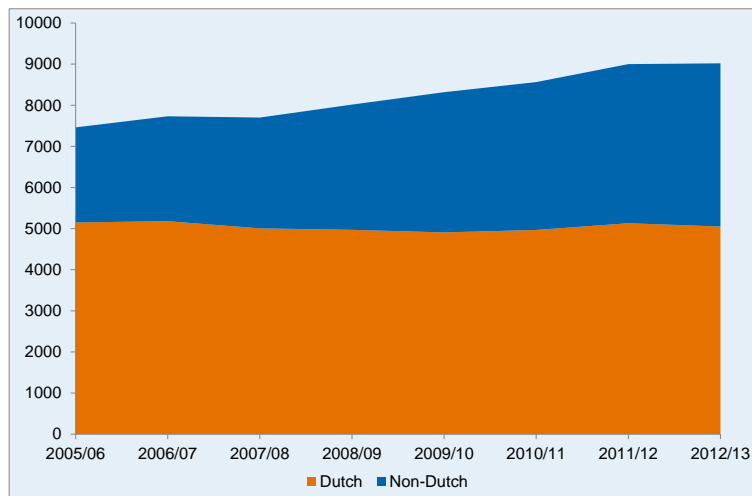


serves as a *lingua franca* in educational and research programs. There are also different policies aimed at attracting foreign PhD students and encouraging doctoral students to stay in the Netherlands after they completed their PhD study. For example, foreign PhD candidates and PhD graduates are eligible to apply for a 30 percent rule, which provides them with a tax free allowance amounting to 30 percent of their salary during the first ten years of living in the Netherlands.<sup>3</sup>

An important part of the attractiveness of a PhD track in the Netherlands is the position of the PhD student as an employee.<sup>4</sup> About half of PhD students in the Netherlands are official university employees with the pertaining benefits such as wages and social security options (VSNU, 2008). Another half are external PhD student who are employed elsewhere.<sup>5</sup> The annual income of PhD candidates employed by Dutch universities is twice as large as the annual salaries and stipends of the PhD candidates in the average EU country (MORE2, 2013), whereas the gross annual earnings of doctorate holders are among the highest in the world (Auriol et al., 2013).

Figure 2.2 shows that the total number of PhD students employed by Dutch universities has been steadily increasing. This increase is exclusively due to the growing number of foreign PhD students, as the number of Dutch PhD students has remained constant. In 2005, the share of foreign PhD students (2,313) employed by Dutch universities was on average 31 percent, whereas in 2013 this share reached 44 percent (3,969).

**Figure 2.2 PhD students employed in Dutch universities by the end of each calendar year**



Source: VSNU/WOPI, 2013.

<sup>3</sup> For more details, see [http://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/privé/internationaal/werken\\_wonen/tijdelijk\\_in\\_een\\_ander\\_land\\_werken/u\\_komt\\_in\\_nederland\\_werken/30\\_procent\\_regeling/](http://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/privé/internationaal/werken_wonen/tijdelijk_in_een_ander_land_werken/u_komt_in_nederland_werken/30_procent_regeling/)

<sup>4</sup> This is not the case in the U.S. and many other countries where PhD candidates have a status of students and next to their PhD project can be employed as research assistants and lecturers.

<sup>5</sup> For more details on types of PhD students, see VSNU (2008).

## 3 Previous literature on stay rates of doctoral graduates

International empirical evidence on the stay rates of foreign PhD graduates is limited. There are also no studies that estimate actual stay rates of PhD graduates for the Netherlands. We refer to three types of studies to gain a first insight in the stay rates of PhD graduates: studies on actual stay rates of foreign PhD graduates in the U.S., survey studies on the intention of foreign PhD graduates to stay in the Netherlands, and Dutch studies on actual stay rates of other types of immigrants. We focus our discussion on the overall long-term stay rates of PhD graduates and on heterogeneity in these stay rates.

### 3.1 Actual stay rates in the U.S.

Studies on the actual stay rates exist mainly for the U.S. Baker and Finn (2003) estimate the actual stay rates of foreign PhD graduates in the U.S. over a 5-year period after receiving a doctoral degree. They use tax data from earnings reported to the Social Security Administration on foreign citizens who obtained a PhD degree in 1994-1995 and find that the average stay rates of doctoral holders across all disciplines after five years is 51 percent.<sup>6</sup> Finn (2014) uses the same data to estimate stay rates of PhD graduates, but for individuals who have received their PhD degree in 2006. He finds that after a 5-year period, 66 percent and after a 10-year period 62 percent of foreign doctorate holders on temporary visas stay in the U.S.<sup>7</sup> This underlies that the stay rates for different cohorts of PhD students can vary over time.

Furthermore, Finn (2014) compares stay rates across fields. He finds that doctoral holders in agricultural sciences, economics, and social sciences have substantially lower stay rates than those in engineering and other science disciplines. This difference can be related to higher availability of postdoctoral positions and employment opportunities outside of academia in science and engineering fields (Johnson and Regets, 1998; Burrelli, 2004; Kim et al., 2011).<sup>8</sup> Grogger and Hanson (2013) show that foreign PhD graduates in science and engineering are more likely to stay in the U.S. if economic conditions there are better compared to the economic conditions in the home country. This also holds for the field of economics and management, but not for other non-science-and-engineering fields. Furthermore, Grogger and Hanson (2013) find that foreign PhD graduates in science and engineering with a stronger ability level are more likely to stay.<sup>9</sup>

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<sup>6</sup> Most foreign PhD students have temporary resident permit for the duration of their PhD study.

<sup>7</sup> Information about PhD graduates on permanent visas is of less interest here, because such foreigners are similar to natives in their residence status. Hence, they cannot be compared to the typical foreign PhD graduate in the Netherlands.

<sup>8</sup> Johnson and Regets (1998) show that most foreign PhD graduates in biological science accept a postdoctoral position after graduation, while the vast majority of foreign PhD graduates in computer engineering choose to work in the private sector.

<sup>9</sup> Ability is measured by success in obtaining graduate fellowships or scholarships, the quality of the university and/or the academic department awarding the PhD degree, and the education level of the parents. Ability is not a statistically significant predictor of the decision to stay among PhD graduates in the fields not related to science and engineering.

In addition to differences in stay rates of PhD graduates across disciplines, there is heterogeneity across demographic groups. Finn (2014) finds that women have slightly higher stay rates than men. This can be due to the existence of more degree-relevant opportunities for women in the U.S. compared to the graduates' home countries (Psacharopoulos, 2006; Grogger and Hanson, 2013). Stay rates vary greatly depending on country of citizenship. Doctoral holders from China and India have the highest stay rate. These findings are largely consistent with those of Kim et al. (2011), that are based on the analysis of the annual U.S. Survey of Earned Doctorates over several decades.

### 3.2 Intention to stay in the Netherlands

Findings from the U.S. cannot be generalized to the Netherlands or other European countries. The status of American universities, as well as the labor market and migration policies differ considerably from those in Europe. Existing evidence for the Netherlands is based on self-reported intention to stay. Sonneveld et al. (2010) use data from a survey of recent doctoral graduates at four universities in the Netherlands (Delft University of Technology, Erasmus University Rotterdam, Utrecht University and Wageningen University). They report that 37 percent of foreign PhD respondents are willing to stay in the Netherlands after obtaining their PhD degree and 43 percent want to leave the Netherlands, while the rest of respondents (20 percent) are indecisive. Maas et al. (2014) explore data from 'Career of Doctoral Holders Survey 2014' and conclude that only a small share of foreign and Dutch doctoral holders who reside in the Netherlands (after receiving their PhD degree from Dutch university) indicate their concrete plans to leave the country.<sup>10</sup> However, this study is likely to misrepresent the general stay rate because it is conducted among those PhD graduates who remained in the Netherlands.

Since intention-to-stay can differ from actual stay rates, we compare the Dutch estimates with intention-to-stay in the U.S. Intention-to-stay rates are higher in the U.S.: around 79 percent of foreign PhD students (on temporary visas) are willing to stay in the country after graduation (National Science Foundation, 2010; Finn, 2014). Finn (2014) concludes that data on intentions to stay are a good predictor of actual stay rates of foreign PhD holders in the US, but only for short-term stay rates, namely one year after graduation.

### 3.3 Actual stay rates of foreign students and labor migrants in the Netherlands

Given the limitations of intention to stay as a measure for actual stay of foreign PhD graduates, we also consider research on actual stay rates for different types of immigrants, in particular for undergraduate foreign students and labor migrants (Bijwaard, 2010; Bijwaard and Wang, 2013). Bijwaard (2010) uses administrative data from the Netherlands to analyze migration dynamics. He finds that the stayer probability in the Netherlands for a reference

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<sup>10</sup> 61% of foreign doctoral holders indicated that they are willing to stay in the Netherlands, 4% indicated their intentions to leave, whereas 36% were indecisive.

group represented by young unmarried men from EU countries, is 24 percent for the average labor migrant and 19 percent for the average student migrant after an 8-year period.<sup>11</sup> Depending on the country of origin and marital status, this probability varies from 12 to 44 percent for student migrants (the average probability is 26 percent), and from 16 to 51 percent for labor migrants (the average probability is 32 percent). Foreign women (labor and student immigrants) have a higher probability to stay in the Netherlands than men.

Furthermore, Bijwaard (2010) finds that the probability to stay in the Netherlands for labor and student migrants from China and Turkey is twice as high as for the corresponding reference group. The stay rates for labor and student migrants from non-EU European countries are also high, but slightly lower than for migrants from China or Turkey. Bijwaard and Wang (2013) show that the long term stay rates are the lowest among foreign students from developed countries (the U.S., Canada, Japan, Australia, Singapore, and the EU-15 member states), which are on average estimated to be about 31 percent over a 9-year period. Stay rates for the same period are the highest among foreign students from less developed countries, estimated to be about 37 percent, and individuals from Suriname and Netherlands Antilles, estimated to be about 50 percent.

To summarize, the existing U.S. and Dutch studies suggest that long-term stay rates differ across countries, discipline and gender. In particular, stay rates are higher for women and for PhD graduates in science and engineering (in the U.S.). Evidence from existing Dutch and U.S. studies suggests that immigrants from less developed countries are more likely to stay than immigrants from developed countries.

## 4 Data

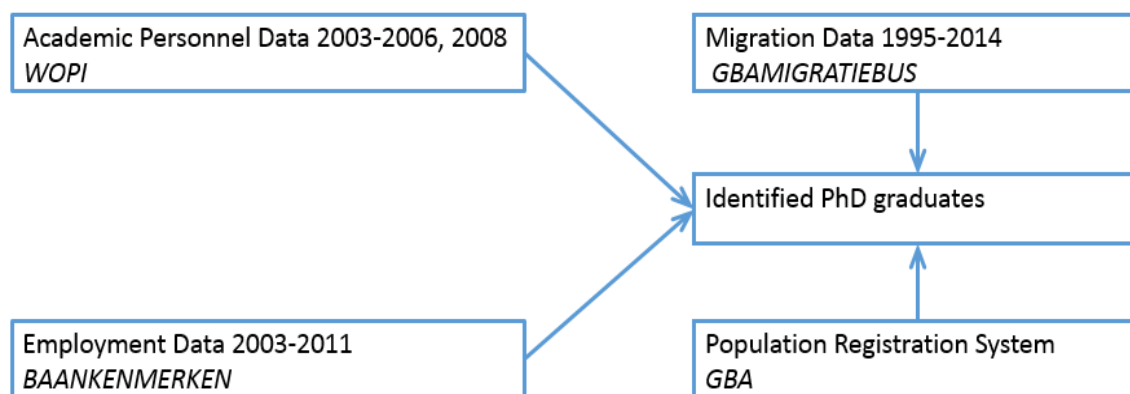
### 4.1 Data sources

To estimate stay rates of foreign PhD graduates, we exploit several administrative data sources that contain information on PhD candidates, their personal and employment characteristics, and migration events. The database of Statistics Netherlands allows us to link these data on an individual level, using anonymized identifiers. In Figure 4.1 we provide an overview of the data linking process. Table 4.1 shows the linking process and resulting sample size in four steps. In the first step, we identify PhD students who are officially employed by Dutch universities. In the second step, we use additional administrative employment data to identify the start and the end date of the PhD contracts. In the third step, we identify PhD graduates on the basis of their PhD contracts and the end date of these contracts. In the last step, we identify the migration status of these PhD graduates using administrative data on migration.

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<sup>11</sup> The group excludes new EU members (in 2002) and Germany, Belgium, the U.K. and France.

**Figure 4.1 Data linking process**



**Table 4.1 Identification of the sample presented in steps**

Steps	Data and identification	No. obs.
1	WOPI-2003	7019
	WOPI-2004	7482
	WOPI-2005	7780
	WOPI-2006	7806
	WOPI-2008	8094
	Merged unique observations	16736
2	Linking the WOPI and BAANKENMERKEN data together	
	Identification of PhD contracts in the BAANKENMERKEN data (PhD contracts for 775 observations are not identified in the BAANKENMERKEN data)	15961
3	Identification of PhD observations with completed PhD contract (4617 observations are excluded because PhD contract continues in 2012)	11344
	PhD duration restriction applied: 2.5 < 'PhD contract' < 6.5 years (1115 observations with PhD contract lasting for less than 2.5 years; 379 observations with PhD contract lasting for more than 6.5 years)	9850
	Linking observations to the GBAMIGRATIEBUS data and the GBA data (Excluding 627 foreigners who arrived in the Netherlands earlier than 5 years before the start of their PhD contract) PhD students excluding those who have emigrated from the Netherlands earlier than 4 months before the end of their PhD contract	9223
4		9091

### Step 1: Identifying university employees who are enrolled in a PhD track

There is no central register of PhD students in the Netherlands that allows for identification of PhD graduates on an individual level. Therefore, we identify PhD students based on employment data of Dutch universities. In the interpretation of the results, it is of importance to recognize that our analysis refers to this specific group only. About half of all PhD candidates in the Netherlands are employed by universities as PhD students. The other half consists mainly of external PhD students employed by another public or private institution.<sup>12</sup>

<sup>12</sup> In 2008, 45% of all candidates were employed by universities, and 48% were external PhD students. A small share of PhD candidates was funded on a scholarship (5.5%) or linked to the university as an internal or dual PhD student (1.5%). Internal PhD students are employed by university in a position of researcher and at the same time they are involved in a PhD project there. Dual PhD students also have an appointment at the university and, in addition, they work elsewhere. For more details on these PhD types, see VSNU (2008).

The primary information on PhD students employed by universities comes from the Academic Personnel Data (WOPI). These data are collected and provided by the Association of Universities in the Netherlands (VSNU). The data contain information on all academic personnel in Dutch universities, excluding academic hospitals.

The WOPI data provide information on the employment contract dates, academic function, field of research and affiliation of each academic employee per 31st of December of a given year. We use five WOPI waves for years from 2003 to 2006, and 2008.<sup>13</sup> From information on function scale, we identify individuals who are employed by Dutch universities in the scale “PhD student”. We delete observations with a missing start date of the PhD contract. This results in a sample with 16,736 unique observations (see Table 4.1).

### **Step 2: Identifying start and end date of PhD contracts**

We link observations from our identified sample to administrative data on job characteristics (“BAANKENMERKEN”) collected and registered on an annual basis by Statistics Netherlands (CBS) for the years 2003-2011. We use the BAANKENMERKEN data to obtain information on the start and the end date of the PhD contract for PhD student observations. The WOPI data also contain information on the start date of the PhD contract, but details on the end date of the PhD contract are often missing. Moreover, PhD students can extend or terminate their PhD contract, which cannot be directly observed in the WOPI data.

To match PhD contracts from the WOPI data to the BAANKENMERKEN data, we use information on the start date of these contracts. The start date of the PhD contract from the WOPI data and the start date of the employment contract from the BAANKENMERKEN do not match exactly (by day) for around one third of observations. The average mismatch between the start contract dates is 1.5 month. If the start dates of the contracts (in the WOPI and BAANKENMERKEN data) for the same individual differ by a maximum of one year, we consider such observations as valid for our analyses. For 775 observations, we cannot identify their PhD contract in the BAANKENMERKEN data because they have either more than one contract (i.e. affiliation) or the starting date of the contract between the WOPI data and the BAANKENMERKEN data differ by more than one year. We exclude these observations from the sample. This results in a sample of 15,961 (see Table 4.1).

To test the sensitivity of our results to the data selection criteria, we later perform a separate analysis on the 10,633 observations for which the starting dates of PhD contract in the WOPI data and BAANKENMERKEN are identical (see Section 6.4).

### **Step 3: Identification of PhD students with completed PhD contract.**

We study stay rates of PhD students whose PhD contract is finished. The end of PhD is a crucial period when individuals have to make a choice regarding their follow-up job and a country of employment.

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<sup>13</sup> The data for 2007 were not available for our research. This is not likely to cause any bias in our findings because we link the WOPI data to other administrative data sources (i.e. employment data).

PhD observations from our sample because these PhD students still have a running PhD contract by the end of 2011. Hence, for this group we do not observe when the contracts are finished (since the BAANKENMERKEN data are limited to the end of 2011). The most common length for a PhD contract in the Netherlands is four years. We restrict our sample to PhD students whose PhD contract lasts for more than 2.5 years (this excludes 1,115 observations) and for less than 6.5 years (this excludes 379 observations). This is because PhD students who dropped out of the PhD track (it is likely among those PhD students whose contract is shorter than 2.5 years) or those who have an irregularly long PhD track (i.e. longer than 6.5 years) can obscure our results.<sup>14</sup> This leaves a sample of 9,850 observations (see Table 4.1). The identified observations serve as a proxy for the average PhD graduate. As a sensitivity check, we repeat the analysis for a more restricted sample of PhD graduates whose PhD contract has lasted between four and four and a half years, which is the most typical duration of a PhD contract (see Section 6.4).

#### **Step 4: Identifying migration dynamics of PhD graduates**

To identify immigration and emigration events of PhD graduates, we link our sample to administrative data on migration (“GBAMIGRATIEBUS”) and to the data from the Dutch municipality register (GBA). The GBA data provide information on demographic characteristics of individuals, such as information on the country of birth, date of birth and gender. From the migration data, we observe immigration and emigration dates.

In our main analysis, we consider foreign-born individuals who arrived in the Netherlands up to five years prior to their PhD contract. This includes individuals who initially arrived in the Netherlands to do a bachelor or masters study. International citizens who arrive in the Netherlands are obliged to register in the local municipalities upon their arrival. As we observe in the data, the process of registration can take several months. Therefore, we identify foreign PhD graduates as individuals who arrived in the Netherlands within five years before the start of their PhD contract *or* who are registered in the migration data within four months after the start date of their PhD contract.<sup>15</sup> Our sample at this point consists of 9,223 PhD graduates (see Table 4.1). As additional analyses, we identify foreign PhD students who arrived in the Netherlands within one year before the start of their PhD contract and those who arrived any time before their PhD contract (see Section 6.4).

Emigration events of foreign and Dutch PhD graduates are also identified from the GBAMIGRATIEBUS data. We consider PhD graduates as emigrants if they have emigrated from the Netherlands after the end date of their PhD contract or within four months before its end. The four month period is based on the distribution of the data, which suggests that some PhD students emigrate before termination of their PhD contract. We drop the 142 individuals who emigrate earlier than four months before the end of their contract, because it is likely that these PhD students have dropped out from their study. The final sample

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<sup>14</sup> We also note that the group of PhD students who are employed during 6.5 and more years is different from those PhD students in our main sample with respect to their contract: substantially more PhD students in the first group do not have a full time PhD contract.

<sup>15</sup> All time periods are measured using information on the day level. There are no foreign PhD students registered as those who arrive in the Netherlands after a four-month period unless they were mobile students after the start of their PhD contract.

consists of 9,081 PhD graduates (see Table 4.1), 2,950 of those are foreign PhD graduates and 6,131 are Dutch.

We can observe emigration events until the end of 2013. This means that for the cohort of PhD graduates whose PhD contract has finished in 2003, we observe emigration status during 10 years. For each consecutive cohort, the observation period is one year shorter. Although the dates of emigration events are available from the GBAMIGRATIEBUS data, some migrants do not officially report that they leave the Netherlands. The local authorities annually register the emigration events of these individual through ‘administrative removal’ on the date when it is assessed that the individual has already left the country. Administrative removal in our data accounts for 13 percent of all emigration events (see Section 5 for more details on this issue).

## 4.2 Descriptive statistics

Table 4.2 presents the years of the start and the end of the PhD contract for observations in our sample. The start date varies from 1998 to 2008 and the end date varies from 2003 to 2011.

**Table 4.2** Years of the start and the end of PhD contract

Start			End		
	Mean	Percent		Mean	Percent
1998	44	0.48	2003	76	0.84
1999	330	3.63	2004	942	10.36
2000	906	9.97	2005	1159	12.75
2001	1110	12.21	2006	1296	14.26
2002	1247	13.72	2007	1032	11.35
2003	967	10.64	2008	1000	11.00
2004	1163	12.79	2009	1158	12.74
2005	1178	12.96	2010	1225	13.47
2006	1168	12.85	2011	1203	13.23
2007	831	9.14			
2008	147	1.62			
No. of observations	9091				

Table 4.3 further presents descriptive statistics for foreign and Dutch PhD graduates. Foreign PhD students at the start of their PhD track are on average 26.5 years old and Dutch PhD students are on average 25 years old (this difference is statistically significant). 40 percent of both Dutch and foreign PhD graduates in the data are women. The average duration of a PhD study is about 52 months for foreign PhD graduates and 54 months for Dutch PhD graduates (this difference is statistically significant). Most foreign PhD graduates originate from Asia, Eastern European (non-EU) countries and EU countries. The largest shares of foreign PhD graduates were born in China (12%), Germany (8%), former Soviet Union (7%), India (6%) and Italy (6%), Romania (5%), Poland (5%), France (3%) and Spain (3%). For both Dutch and foreign PhD graduates, the most popular disciplines are technical studies and natural



sciences.<sup>16</sup> Table 4.4 presents the share of foreign PhD students per discipline. Foreign PhD graduates are overrepresented in technical studies (49%) and economics (45%), and underrepresented in social sciences (15%), health sciences (16%) and law (16%).

**Table 4.3 Descriptive characteristics**

	Foreign PhD graduates		Dutch PhD graduates	
	Mean	Std	Mean	Std
Age at the start of PhD study	26.54	(3.08)	25.20	(2.98)
Female	0.40	(0.49)	0.40	(0.49)
Duration of PhD study (in months)	51.83	(8.23)	54.09	(8.60)
<b>Discipline:</b>				
Technical studies	0.44		0.22	
Natural sciences	0.26		0.26	
Economics	0.07		0.04	
Agriculture	0.06		0.08	
Languages/Cultural studies	0.05		0.09	
Law	0.02		0.04	
Health sciences	0.05		0.13	
Social sciences	0.05		0.14	
<b>Region of birth:</b>				
Asia	0.33			
-China	0.12			
-India	0.06			
-Other	0.15			
Eastern Europe (Non-EU)	0.25			
-Soviet Union	0.07			
-Other	0.18			
EU countries	0.40			
-Germany	0.08			
-Italy	0.06			
-Romania	0.05			
-Poland	0.05			
-France	0.03			
-Spain	0.03			
-Other	0.11			
South America	0.04			
Africa	0.04			
North America	0.03			
Australia and New Zealand	0.01			
Rest of the world	0.01			
No. of observations	2950		6141	

**Table 4.4 The share of foreign PhD graduates per discipline**

Discipline	Share
Technical studies	0.49
Economics	0.45
Natural sciences	0.32
Agriculture	0.25
Languages/Cultural studies	0.21
Law	0.16
Health sciences	0.16
Social sciences	0.15
No. of observations	9091

<sup>16</sup> We note that our data exclude PhD graduates in academic hospitals. This explains the relatively low fractions of PhD students in health sciences.

## 5 Empirical approach

We estimate the probability that foreign PhD graduates remain in the Netherlands using survival analysis. Survival models are commonly applied in empirical studies to assess time to the occurrence of an event of interest. Survival models estimate a particular outcome as a function of the time an individual has been at risk. We estimate the probability of emigration from the Netherlands as a function of the time since the end of the PhD contract. An advantage of survival models compared to ordinary regression models or mean comparison is that they account for the fact that we only observe migration status over a limited period of time after PhD graduation and that this time period can differ between observations (right censoring).

We use two models in our analysis. We first estimate the survival function (the probability that someone is still in the Netherlands  $t$  years after his graduation) using the Kaplan-Meier (K-M) model (Kaplan and Meier, 1958). The advantage of the K-M model is that it takes right censoring into account. The model is non-parametric: we do not need to assume a particular functional form of the survival function.<sup>17</sup> We use the K-M model to illustrate the survival function for all foreign PhD graduates, and to compare it to the survival function of native PhD graduates. We also use it to describe heterogeneity in survival rates between men and women, country of origin, and field of study.

The second method we use is the Cox proportional hazard (CPH) model (Cox, 1972). In contrast to the Kaplan-Meier model, this model is semi-parametric, but it allows us to investigate the statistical significance of differences in the probability of migration between subgroups. In the CPH model, the hazard (the probability that an individual who has not emigrated from the Netherlands before time  $t$  will emigrate after  $t$ ) is defined as a combination of a baseline hazard ( $\lambda_0$ ), only depending on  $t$  and a scale factor  $\phi$ , only depending on subgroup characteristics ( $x$ ), or

$$\lambda(t|x) = \lambda_0(t)\phi(x).$$

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<sup>17</sup> The Kaplan-Meier survival function is specified as  $\hat{S}(t) = \prod_{j|t_j \leq t} \left( \frac{n_j - d_j}{n_j} \right)$ , where  $t$  and  $t_j$  denote discrete

emigration times of PhD graduates,  $n_j$  the number of PhD graduates at risk of emigration (if they have not emigrated yet or been censored) observed just before time  $t_j$  and  $d_j$  the number of PhD graduates emigrating at time  $t_j$ . In our case,  $t$  and  $t_j$  are measured in days. We use the approach of Kalbfleisch and Prentice (2002) to calculate 95% confidence bounds for  $\hat{S}(t)$ .

An important assumption is that the proportional difference in hazard between subgroups is constant over time. An advantage of the CPH model is that we do not have to specify a functional form for the baseline hazard in order to estimate the proportional differences in the hazard rate between groups (see Cameron and Trivedi, 2005). We do have to specify the scale factor:  $\phi(x) = \exp(x\beta)$ . The reported coefficients can then be directly interpreted as the proportional difference in hazard between the relevant subgroup and the reference group.

There are three issues that we have to consider regarding the estimation of the survival function. First, a considerable number of PhD graduates migrate before the end date of the PhD contract. For individuals leaving less than four months before the end of the PhD contract we set the date of emigration at  $t=0$ . Second, for 13 percent of the leavers we do not observe the actual emigration date, but an “administrative removal” date. This is a case of left censoring, since we only observe that an individual has left the country somewhere between his graduation and the administrative removal date. In parametric survival models, left censoring can be controlled for (see Cleves et al., 2004; Bijwaard et al., 2014). Since we rely on non- and semi-parametric models we treat the administrative removal date as the actual date of emigration.<sup>18</sup> In addition, since we are interested in presenting long term stay rates in years, this is a minor issue. Third, we use the first emigration after PhD graduation as the outcome variable. A potential concern for the analysis might be that some of the emigrated PhD graduates return to the Netherlands. We address this issue in Section 6.4.

## 6 Stay rates of PhD students in the Netherlands

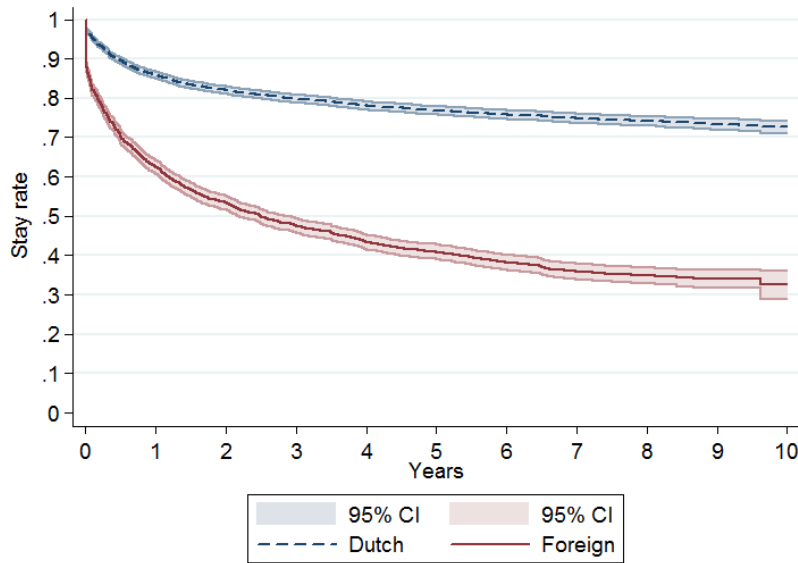
### 6.1 Baseline estimates

Figure 6.1 presents the Kaplan-Meier survival curves for foreign and Dutch PhD graduates. The figure shows that a substantial part of PhD graduates emigrates before the end date of their PhD contract or shortly after. One year after the end of PhD contract around 62.4 percent of foreign PhD graduates and 85.8 percent of Dutch PhD graduates are still in the Netherlands. In the further years, the survival curves continue to decrease, but less rapidly compared to the first year. Five years after the graduation 40.8 percent of foreign PhD graduates remain in the Netherlands. Ten years after the end date of the PhD contract around 32.4 percent of foreign PhD graduates remain in the Netherlands. With regards to Dutch PhD graduates, 76.9 percent stay after five years, and 72.7 percent stay over the period of 10 years.

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<sup>18</sup> Dropping observations for which we observe “administrative removal” instead of the actual emigration date would lead to underestimation of the stay rates.

**Figure 6.1** Kaplan-Meier stay rates of foreign and Dutch PhD graduates



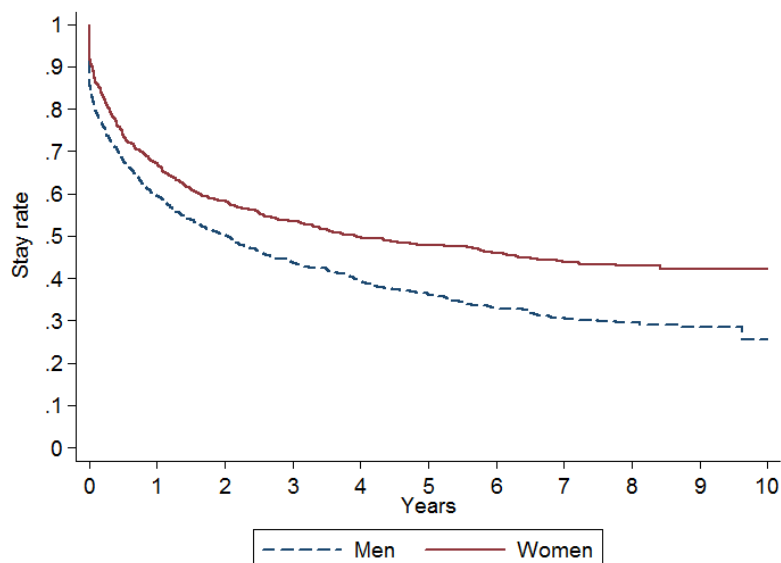
## 6.2 Heterogeneity in the stay rates of foreign PhD graduates

The stay rates may depend on specific characteristics such as gender, country of origin and discipline. We proceed by estimating the stay rates for different subgroups.

### Stay rates for men and women

Figure 6.2 presents the Kaplan-Meier curves for foreign PhD graduates by gender. In the first half year of the follow-up period both men and women have similar stay rates patterns. However, the survival curves differ consistently in the later period, with the higher stay rates for women. After the ten-year period the stay rate for women is around 42.2 percent and the stay rate for men around 25.6 percent.

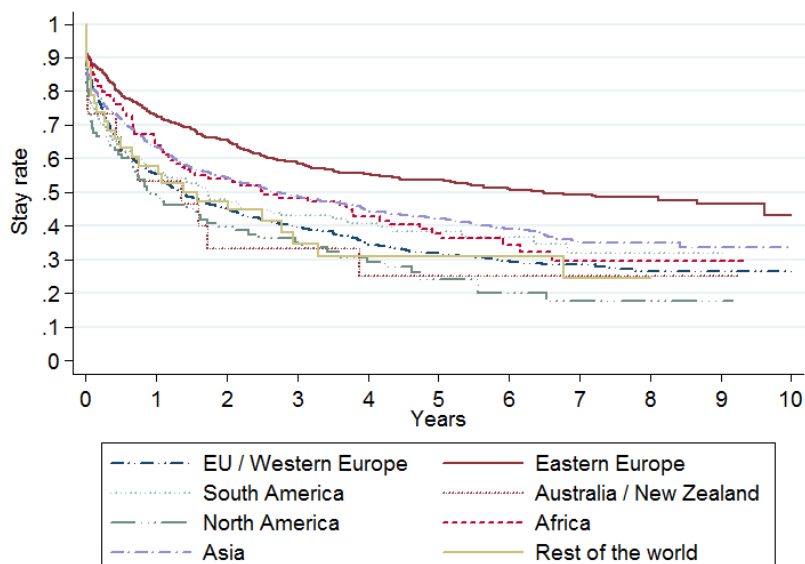
**Figure 6.2 Kaplan-Meier stay rates of foreign PhD graduates by gender**



**Stay rates by region and country of origin**

We group all countries into eight geographic categories: Eastern Europe (non-EU), EU countries and Western European countries which are not in the EU (Norway, Monaco, San Marino, Lichtenstein, Switzerland and Iceland), North America, South America, Africa, Asia, Australia and New Zealand; and the rest of the world. Figure 6.3 shows that foreign PhD graduates born in Eastern Europe are more likely to stay in the Netherlands during the whole follow-up period, compared to PhD graduates born in other countries.

**Figure 6.3 Kaplan-Meier stay rates of foreign PhD graduates by region of origin**



The stay rate of Eastern European PhD graduates at the end of the ten-year period is around 43.2 percent. The stay rate of Asian PhD graduates at this point in time is just below 33.8 percent. The stay rates of PhD graduates from the EU is 32.1 percent. The estimated stay rate is lowest for PhD graduates from North American countries (17.7 percent).

Table 6.1 presents stay rates of foreign PhD graduates for the most common countries of origin in the sample. In the data we observe foreign PhD graduates usually during 10 years (Panel A, Table 6.1). Some groups of foreign PhD graduates we observe for a shorter period, namely for nine (Panel B, Table 6.1) and eight years (Panel C, Table 6.1), because these foreign PhD students graduate in 2004 and 2005 or leave the Netherlands earlier than 2013. We find that Iranian PhD graduates are the most likely stay in the Netherlands (62%) after 10 years compared to other nationalities. They are followed by PhD graduates originating from the former Yugoslavia, Romania and the former Soviet Union: above half of these PhD graduates stay in the Netherlands after 10 years. Around 43 percent of the Chinese PhD graduates stay in the Netherlands after 10 years. The lowest probability to stay in the Netherlands is observed for PhD graduates from the U.S. (11.6% after 8 years). PhD graduates from Germany and Belgium are also unlikely to stay in the Netherlands: only around one-fifth of these PhD graduates stay in the Netherlands after 10 years.

**Table 6.1 Long term stay rates of foreign PhD graduates**

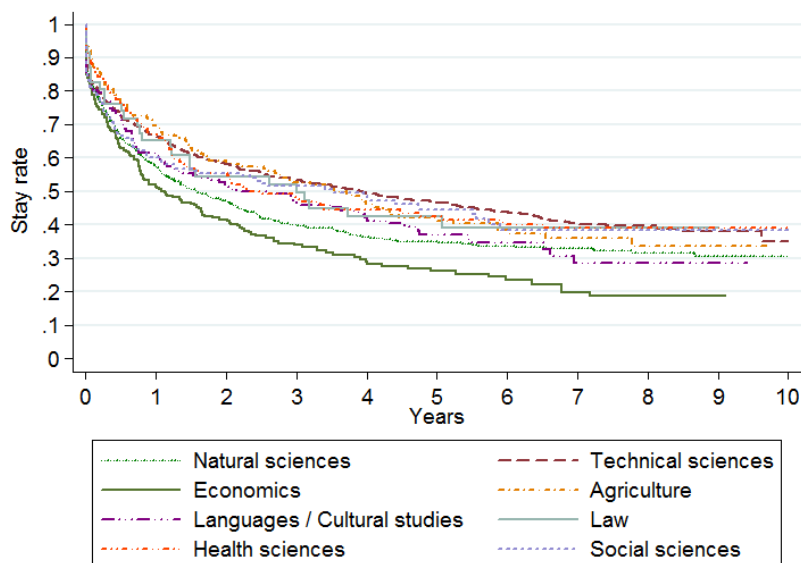
Country of origin	No. observations	Stay rates, %
<b>Panel A</b>		<b>After 10 years</b>
Iran	67	62.0
Former Yugoslavia	113	52.3
Romania	134	51.2
Former Soviet Union	219	50.5
China	352	42.7
Portugal	49	40.6
Poland	134	36.2
Italy	165	33.8
Spain	94	28.9
Belgium	47	21.7
Germany	227	20.1
<b>Panel B</b>		<b>After 9 years</b>
Bulgaria	45	50.0
Turkey	106	35.7
India	173	31.2
Indonesia	81	29.9
<b>Panel C</b>		<b>After 8 years</b>
Colombia	46	38.1
France	92	27.6
US	41	11.6

Note: The standard errors of the reported stay rates are relatively small.

### Stay rates by discipline

Figure 6.4 shows stay rates by discipline. It appears that PhD graduates in Technical Studies, Social Sciences, Law and Health Sciences are more likely to stay in the Netherlands in the long-run compared to foreign PhD graduates in other sciences. Foreign PhD graduates in Economics are most likely to leave the Netherlands.

**Figure 6.4** Kaplan-Meier stay rates of foreign PhD graduates by discipline



### Country of destination

We also assess the destination country of foreign and Dutch PhD graduates. Of all foreign PhD graduates who left the Netherlands within ten years, around half of PhD graduates (48%) returned to their home country and another half went somewhere else. Table 6.2 presents the most popular destination countries (3% of emigration and higher) among emigrated Dutch and emigrated foreign PhD graduates. The highest share of Dutch PhD graduates emigrate to the United States (22%) and the highest share of foreign PhD graduates go to Germany (15%). Other common destinations of Dutch PhD graduates are the U.K. (17%), Germany (13%) and Switzerland (5%). Among foreign PhD graduates other popular destinations are the U.S. (11%), the U.K. (7%), China (6%) and France (5%). This partly occurs because foreign PhD graduates are returning to the countries of origin. In parentheses in (column 4) we present the numbers of emigrated foreign PhD graduates who return to their home country. If we exclude PhD-returnees, the highest number of foreign PhD graduates emigrate to the U.S. (9.6%). Germany is the second most popular destination among foreign PhD graduates who are not returning home (8.5%), followed by the U.K. (6.7%).

We also check what share of emigrated PhD graduates stays in the EU. Half of all emigrated Dutch PhD graduates go to other EU countries. Around 43 percent of all emigrated foreign PhD graduates go to other EU countries (this also includes PhD graduates who are returnees). This share is lower among emigrated non-EU PhD students, which is estimated to be 22.4 percent and it is substantially higher for emigrated Eastern European (non-EU) PhD graduates, which is around 57.6 percent.

**Table 6.2 Destination countries of Dutch and foreign PhD graduates**

County of destination	Dutch PhD graduates		Foreign PhD graduates	
	No.	%	No.	%
<b>The U.S.</b>	313	22.0	154	10.8
(of which U.S. citizens)			(17)	
<b>The U.K.</b>	241	17.0	106	7.4
(of which U.K. citizens)			(<10)	
<b>Germany</b>	190	13.4	215	15.0
(of which German citizens)			(95)	
<b>Switzerland</b>	89	6.3	55	3.8
(of which Swiss citizens)			(<10)	
<b>Belgium</b>	73	5.1	60	4.2
(of which Belgium citizens)			(11)	
<b>France</b>	53	3.7	76	5.3
(of which French citizens)			(25)	
<b>Italy</b>			65	4.5
(of which Italian citizens)			(53)	
<b>China</b>			83	5.8
(of which Chinese citizens)			(79)	
<b>India</b>			44	3.1
(of which Indian citizens)			(43)	
<b>Spain</b>			56	3.9
(of which Spanish citizens)			(36)	
<b>Canada</b>	61	4.3		
<b>Sweden</b>	49	3.4		
<b>Australia</b>	61	4.3		
<b>Other countries</b>	291	20.5	517	36.2
<b>Total emigrated, No.</b>	1421	100	1431	100

Note: This table presents information on emigrated PhD graduates only if destination country is known and only for the most popular destination countries (3% of emigration and higher for emigrated Dutch PhD graduates and, separately, for emigrated foreign PhD graduates).

### 6.3 Cox proportional hazard model estimates

To assess whether the differences between subgroups are statistically significant, we use the Cox proportional hazard model. We use this model to estimate relative differences in the probability of emigration between foreign PhD graduates of different age, gender, origin and discipline. Table 6.3 reports the results. The covariates related to the origin of foreign PhD students are presented as binary variables and refer to the eight geographic categories. These categories exclude the eight most common countries of origin. The latter are separately added into the regression. The reference group represents German graduates with a PhD in Technical Studies. The reported hazard ratio is the ratio of the hazard rate in the relevant subgroup compared to the reference group. A ratio that is lower than one should be interpreted as a lower probability of emigration and a ratio that is higher than one as a higher probability of emigration.

Foreign female PhD graduates have a 28 percent lower chance to emigrate from the Netherlands than foreign male PhD graduates. Foreign PhD graduates from Eastern Europe and China have a respectively 44 and 49 percent lower chance to emigrate compared to German PhD graduates. Foreign PhD graduates from other countries are also more likely to stay in the Netherlands compared to German PhD graduates (though the coefficients are not



statistically significant for foreign PhD graduates from Australia and New Zealand, Poland, and countries from North America and rest of the world). Foreign PhD graduates in Economics, Natural Sciences and Language and Cultural Sciences have a statistically significantly higher chance to emigrate than PhD graduates in Technical Sciences.

**Table 6.3 Estimates from Cox proportional hazard model**

	Hazard Ratio	Std. Err.
Female	0.718***	(0.038)
Age	0.963***	(0.008)
<b>Origin</b>		
Eastern Europe	0.558***	(0.059)
Former Soviet Union	0.623***	(0.089)
North America	0.917	(0.127)
South America	0.788*	(0.104)
Africa	0.685***	(0.095)
China	0.514***	(0.054)
India	0.732***	(0.088)
Rest of Asia	0.719***	(0.066)
Australia and New Zealand	0.880	(0.273)
Italy	0.748**	(0.090)
France	0.610***	(0.092)
Spain	0.686***	(0.100)
Romania	0.708**	(0.114)
Poland	0.982	(0.147)
Rest of EU and Western Europe	0.772***	(0.072)
Rest of the world	0.821	(0.171)
<b>Disciplines</b>		
Economics	1.748***	(0.156)
Natural sciences	1.336***	(0.080)
Languages/Cultural studies	1.246*	(0.143)
Health sciences	1.188	(0.140)
Agriculture	1.099	(0.121)
Law	1.121	(0.222)
Social sciences	1.099	(0.133)
Number of observations	2950	

Note: The reference category for discipline is 'Technical studies'. The reference category for the country variable is Germany.

## 6.4 Additional analyses and sensitivity checks

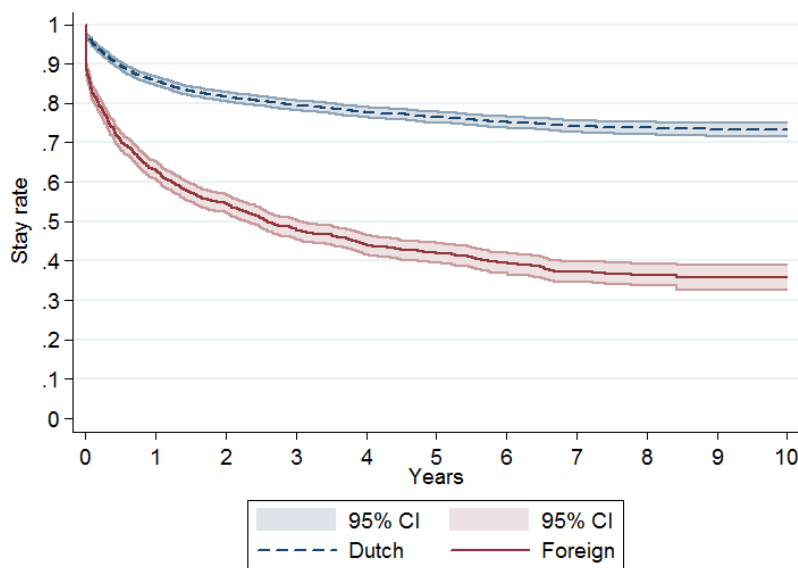
In this section, we provide sensitivity checks for our sample identification and we conduct additional analyses for modified samples which are constructed by using various restriction criteria. First of all, we use a subsample of PhD graduates whose PhD contracts are identified in the employment data using exact timing of the contract start. This identification enables us to examine whether identification of PhD contracts in the employment data by allowing for not exact timing (up to one year difference in the start date) does not impose a bias. Secondly, we repeat our main analysis for PhD graduates whose PhD contract has lasted from 4 to 4.5 years (the most typical duration of PhD contract) instead of from 2.5 to 6.5 years as in the main analysis. This additional test shows whether duration of the PhD contract has an effect on stay rates of PhD graduates. Thirdly, we restrict our analysis to foreign PhD graduates who have arrived in the Netherlands within one year before the start

of their PhD contract. In the main analysis we focus on PhD graduates who arrived in the Netherlands up to five years before the start of their PhD contract. The latter sample is likely to include those foreigners who initially arrived in the Netherlands for undergraduate studies. Finally, we discuss the role of return migration in estimating the stay rates of PhD graduates.

### Restricted sample according to different identification of PhD contract in the employment data

In the main analysis, our sample includes PhD graduates whose PhD contract was identified in both the WOPI data and the BAANKENMERKEN data, allowing for differences in start dates between both data sets up to one year. Below we provide estimates for a restricted sample of PhD graduates (5,836 observations) whose start date of the PhD contract in the WOPI data is the same as in the BAANKENMERKEN data. Figure 6.5 presents the survival rate for this sample. The results of this check show that the survival curves for both foreign and Dutch PhD graduates are similar to the curves presented in the main analysis (Figure 6.1). In particular, in a 10-year period around 35.8 percent of foreign PhD graduates and 73.3 percent of Dutch graduates stay in the Netherlands, whereas in the main analysis these rates are 32.4 percent and 72.7 percent for foreign and Dutch PhD graduates, respectively.

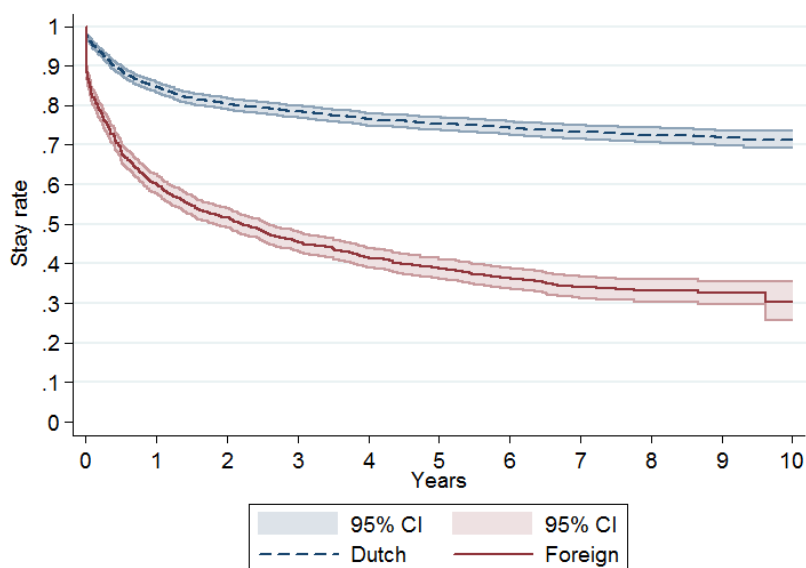
**Figure 6.5** Kaplan-Meier stay rates of PhD graduates, using different identification of PhD contract



### Restricted period of PhD track

We restrict the sample to individuals whose PhD track has lasted between 4 and 4.5 years because this duration of PhD contract is the most common in the Netherlands (above 50% of the sample). The results of this check are presented in Figure 6.6. The stay rates are slightly lower for both foreign PhD graduates (30.5%) and Dutch PhD graduates (71.4%) over a 10-year period than the stay rates estimated for the sample of PhD graduates who had a contract from 2.5 to 6.5 years (32.5% for foreign PhD graduates and 72.7% Dutch PhD graduates), but these differences are marginal.

Figure 6.6 Kaplan-Meier stay rates of PhD graduates with 4-4.5 year PhD track

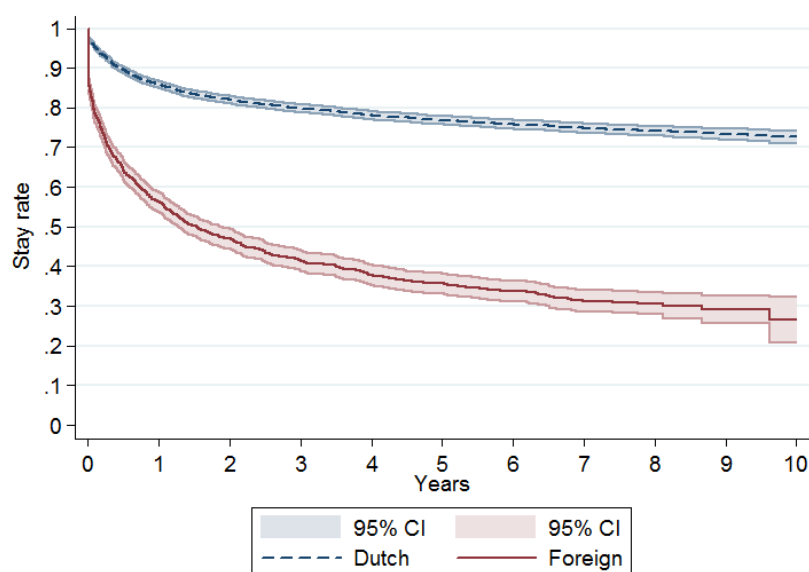


#### Identification of foreign PhD graduates using a more restricted definition

The definition of foreign PhD graduates that we use in our main analysis not only considers foreign individuals that arrived shortly before the start of their PhD study but also those who arrived in the Netherlands for the purpose of obtaining a bachelor or master degree. To see whether the stay rate is different for foreign PhD students who arrived shortly to the Netherlands before their PhD track, we restrict the definition to PhD students who arrived in the Netherlands within one year before the start of their PhD contract. The results are presented in Figure 6.7. The stay rates of newly defined foreign PhD graduates are lower than the stay rates of foreign PhD graduates presented in Figure 6.1 (32.4 % for foreign PhD graduates and 72.7 % Dutch PhD graduates). By the end of the observation period, 26.5 percent of foreign PhD graduates stay in the Netherlands. This result suggests that the probability to stay is larger for those individuals who have already been living in the Netherlands before the start of their PhD study, probably because they could better integrate into Dutch society during a longer period<sup>19</sup>

<sup>19</sup> We have also analyzed the stay rates of PhD graduates who arrived in the Netherlands any time before the start date of their PhD contract. The stay rate for such foreign PhD students is marginally higher (35%).

**Figure 6.7** Kaplan-Meier stay rates of PhD graduates who arrived in the Netherlands within one year before the start of their PhD contract



### Return migration

Our main analyses have been focused on the first emigration of PhD graduates from the Netherlands. It is possible that some of these emigrated PhDs return to the Netherlands within 10 years. To provide more insights into the potential impact of return migration we consider a cohort of emigrated PhD graduates and check whether they return to the Netherlands three, five and nine years after the end date of their PhD contract.<sup>20</sup> The results suggest that 5.5 percent of the emigrated Dutch PhD graduates and 1.9 percent of the emigrated foreign PhD graduates return to the Netherlands within a period of three years after the end of their PhD contract. These rates are somewhat higher for the period of five years: 8.9 percent of emigrated Dutch PhD graduates and 2.4 percent emigrated foreign PhD graduates are coming back to the Netherlands. After an nine-year period, 13.8 percent of emigrated Dutch PhD graduates and 4.1 percent of emigrated foreign PhD graduates return to the Netherlands. The return rates, especially for foreign PhD graduates, are found to be low and therefore return migration is of limited concern here.

## 7 Conclusion and discussion

In this study, we have estimated stay rates of foreign PhD graduates using administrative data. We have found that ten years after graduation, 32 percent of foreign PhD graduates still live in the Netherlands. We have also found substantial differences in the stay rates across demographic groups. In particular, estimated stay rates of PhD graduates are higher for women, for individuals who originate from less developed countries, and for PhD graduates in technical studies.

<sup>20</sup> Our data allow us to observe return migration during a maximum period of nine years.

We can compare our findings to previous research on the stay rates of foreign PhD graduates in the U.S., to findings from Dutch survey studies on the intention of PhD graduates to stay, and to estimates of actual stay rates of labor and student immigrants in the Netherlands. Finn (2014) finds a considerably higher share of foreign PhD graduates (62%) that stay in the U.S. after 10 years compared to our estimates for the Netherlands.<sup>21</sup> The fact that the U.S. is a substantially larger country than the Netherlands, with more universities and thus with more academic career choices, can possibly explain why proportionally more PhD graduates stay in the U.S. Furthermore, this difference might be related to institutional differences in the Dutch education system for doctoral studies, to differences in migration law, and to differences in labor market opportunities. Another explanation can be that the U.S. doctoral programs attract other types of foreign graduate students, with different ability levels and skills, than the doctoral programs in the Netherlands.

The estimated stay rates in this study are in line with the self-reported intention to stay among foreign PhD graduates in four Dutch universities (Sonneveld et al., 2010), and also comparable to those found by Bijwaard (2010) for (non-PhD) labor migrants (32 percent) and for foreign students (26 percent) after the period of nine years.

Our finding that women are more likely to stay than men confirms findings of previous empirical studies (Kim et al., 2011; Finn, 2014). Similar to studies for the U.S. (Finn, 2014; Kim et al., 2011; Grogger and Hanson, 2013), we find that graduates from China have a relatively high likelihood of staying, and that PhD graduates who originate from less developed countries are generally more likely to stay than foreign PhD graduates from developed countries. However, stay rates of PhD students from Western countries appear to be relatively lower in the Netherlands than in the U.S. In line with Bijwaard (2010) and Bijwaard and Wang (2013), we find that immigrants from EU countries are less likely to stay in the Netherlands than immigrants from Eastern Europe. This difference could be related to the costs of mobility within the EU and economic opportunities in the country of origin.

Similar to the patterns in the U.S., we find that graduates in a technical field of study are more likely to stay than graduates in other sciences. This could be explained by different factors, such as working opportunities in the Netherlands for foreign PhD graduates in technical studies, skills of foreign PhD students, and other economic and social factors (see Johnson and Regets, 1998; Kim et al., 2011; Grogger and Hanson, 2013).

Our analyses suggest that stay rates after PhD graduation are related to the duration of stay in the Netherlands before graduation. In particular, we find that PhD students who have arrived in the Netherlands some years before the start of their PhD contract are more likely to stay in the Netherlands in the long-term than those individuals who have arrived within one year before the start of their PhD contract. This is in accordance with previous evidence from Grogger and Hanson (2013), that suggests that the likelihood of staying in the host

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<sup>21</sup> We note that Finn (2014) does not control for the fact that the observed time spells of PhD graduates can be different. Our estimation models take this into account by applying right-censoring. Without right-censoring, the stay rates in the Netherlands are 40% for foreign PhD graduates and 76% for Dutch PhD graduates.

country is higher among foreign PhD graduates who have finished their bachelor degree there.

This study has several limitations. First, we have had to narrow our analysis to PhD students employed by Dutch universities. PhD students in the Netherlands who are not employed by universities (about half of the total PhD population) are a blind spot in the available data, and hence in our analysis. The results of our analyses cannot be generalized to this type of PhD graduates, and also to PhD graduates from academic hospitals. Second, we had to use different restriction criteria to identify the start and end of the PhD track. Additional analyses and sensitivity checks have indicated that our results are robust to different specifications. Third, in our study we have used straightforward survival models, in the full recognition that these models have limitations. More sophisticated models can help to better address left censoring and return migration (see e.g. Bijwaard, 2014). A disadvantage of such models is that they rely heavily on functional form assumptions. Moreover, return migration of foreign PhD graduates appears to be a limited concern for estimating the stay rates in our study.

The identification of stay rates adds to the discussion on the role of foreign PhD graduates in Dutch society. To further assess the impact of the internationalization of PhD graduates for the Netherlands it would be valuable to obtain more insights into the labor market characteristics (e.g. employment and wages) of foreign PhD graduates and into the stay rates of Dutch PhD graduates abroad.

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