



## On the importance of studying abroad among postdocs – an analysis of postdoc fellowships in Denmark<sup>1</sup>

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### Introduction

Previous studies suggest that knowledge production from different research culture could benefit research outcomes (e.g. Barjak & Robinson, 2008; Tang & Shapira, 2012; Abbasi & Jaafari, 2013), which would imply that having a research stay abroad is an important determinant of researchers' future academic performance. Motivated by this, a number of countries have programs that either allow or are directly targeted at international postdoc fellowships. Among these is the Danish Council for Independent Research (DFR), which has recently launched a program offering two year international postdoc fellowships to early career researchers (DFR, 2017). However, the option of studying abroad has long been available for DFR postdoc fellowships, with many choosing to do research at an international research environment.

The existing literature has found that postdoctoral stays abroad have a positive effect on researchers' participation in international cooperation after the stay abroad (Martinez et al. 2016; Wooley et al. 2008). However, for the outgoing researcher's scientific production and career progression, the picture is less clear. Franzoni et al. (2013) concludes that migrant researchers have higher productivity. In contrast, no effect on productivity is found for participants in the American NSF International Research Fellowship Program (IRFP), where postdocs study abroad for 9-24 months (Martinez et al. 2016). For Spain, the results suggest that studying abroad can slow career progress for outgoing researchers, while resistance and commitment to the same institution can promote career advancement (Cruz-Castro and Sanz-Menéndez 2010).

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<sup>1</sup> This paper is a modified version of Bloch et al. (2016) (which is in Danish). The initial analysis was commissioned by the Danish Council for Independent Research.

The purpose of this paper is to examine the importance of longer stays abroad for postdoctoral fellows funded by the DFF within the natural sciences. DFF postdoc grants within the Natural Sciences provide a good comparative basis, since a relatively large share of fellowships have been used for research stays abroad. The analysis compares career paths and research performance for post-docs with and without a stay abroad. We look at the sectoral mobility (whether the postdoc remained in the university sector after the grant), career advancement and a number of aspects related to research performance such as productivity, citation impact, journal impact, international cooperation and international cooperation.

The analysis includes postdoctoral scholarships financed by the DFF in Natural Sciences in the period 2001-2009, where we examine outcomes 6-8 years after the stay abroad. The sample includes two types of postdocs, individually funded postdoc fellowships (individual postdocs) and postdoctoral grants that are embedded in larger project grants (embedded postdocs). The analysis draws on a dataset constructed from multiple sources: funding data from DFF, register data (incl. migration) from Statistics Denmark, and publication and citation data from an enhanced version of the Web of Science database, developed and maintained by the Center for Science and Technology Studies (CWTS) at Leiden University.

**Table 1. Descriptive statistics** Gross sample consists of a total of 256 postdocs, of which 111 have had a longer period abroad (at least 22 months when the stay commences within two years after the grant reception), 107 short / no stay (maximum 2 months) and 38 medium stay abroad (three to 21 months. These are not included in the analysis.). There are a total of 109 embedded and 147 individual postdocs. Among the embedded postdocs are a group of international researchers who entered to Denmark during or after the grant and have since left Denmark again. For these, their 'study abroad' is actually their stay in Denmark. Therefore we have decided to remove all foreign postdocs who have traveled to Denmark during their postdoc and have not lived in Denmark since 2011; a total of 28 postdoctoral fellows. The remaining sample consists of 193 postdocs. The table shows the distribution of the sample by stay abroad, year of grant receipt and postdoctoral type.

	Short or no stay abroad (max. 2 months)	Longer stay abroad (min. 22 months)	Total
Individual postdoc	57	58	115
Embedded postdoc	64	14	78
	Short or no stay abroad	Longer stay abroad	Total
2001	10	5	15
2002	4	7	11
2003	10	7	17
2004	7	5	12
2005	15	4	19
2006	10	8	18
2007	18	13	31
2008	27	11	38
2009	20	12	32
Total	121	72	193

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There may be differences in the characteristics of the two postdoctoral types, where embedded postdocs clearly are part of a larger project, while individual postdocs can have a more independent course (though individual postdocs may actually be part of a larger group's work). There are also differences with respect to internationalization, where a larger part (about half) of the individual post-docs went abroad during their fellowship, while the majority of embedded postdocs took place in Denmark (about 80%).

In other countries, there are also measures that specifically support international postdoc fellowships. The Swedish Research Council gives postdoc grants for 18 to 36 months, where a minimum of two thirds of the fellowship must take place abroad. The instrument is aimed at young researchers, where the applicant must have obtained his Ph.D. within two years of the application deadline. In Switzerland there are two instrument, s Early Postdoc Mobility and Advanced Postdoc Mobility, where the former is for young researchers under 2 years after PhD, and the latter is for a little more experienced researchers, under 5 years after PhD. There are also schemes where the return phase is mandatory. The German DAAD (Deutscher Akademischer Austauschdienst) and the Flemish FWO (Fonds Wetenschappelijk Onderzoek) have arrangements where two-thirds of their postdoc must be abroad, while the last third is a mandatory return at the national host institution. Both are co-funded by the EU's Marie Skłodowska-Curie program.

## Sector change and retention in academia

The vast majority of postdocs are employed in the academic sector when they receive the grant, but already after two years there is a significant percentage who either change sector or are employed abroad<sup>2</sup>.

The patterns are different for the two groups. Among postdocs without a longer stay abroad, a higher share remains in the Danish academic sector after the postdoc period, and at the same time a higher proportion of postdocs switch to the business sector. Among postdocs with a prolonged stay abroad a relatively larger share remain abroad and in the wider public sector (which also includes international organizations).

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<sup>2</sup> The sectors comprising the NACE2007-branch codes:

- Academic sector: 861,000 (higher education), from 854,100 to 854,200 (hospitals), 841200 (health administration, education etc.).

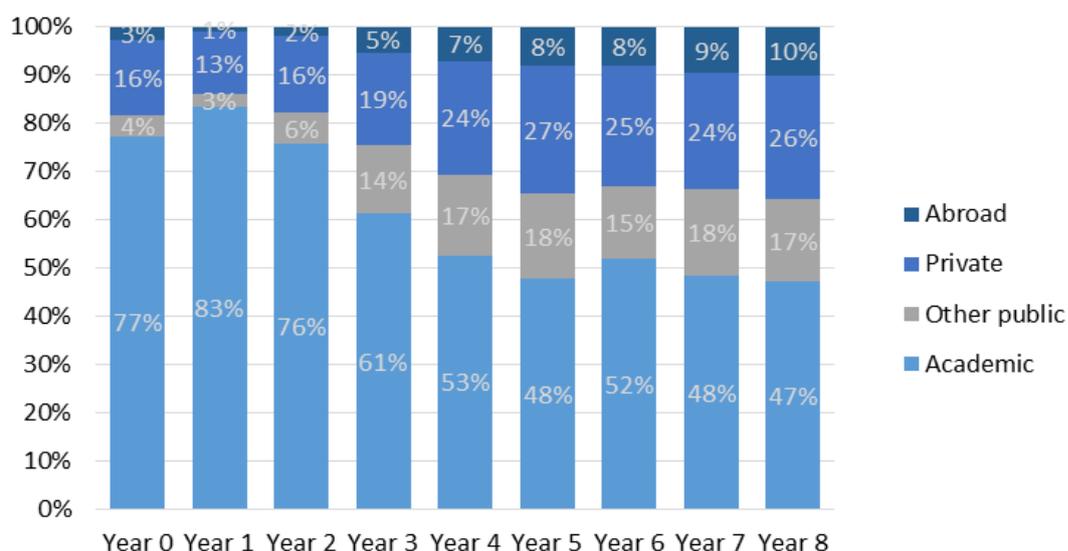
- Private sector: 11000-829900, from 910,000 to 989,999.

- Other public sector: 830000-909999 (excl. 861000, 854100, 854200, 841200), 999999 (international organizations)

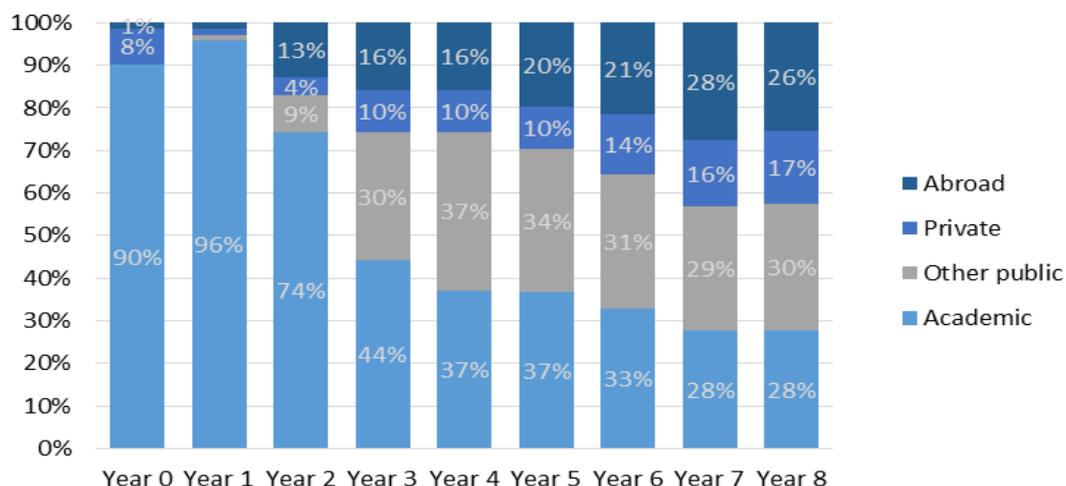
It is assumed that postdocs related to "841200 (management of health, education etc..)" are working in the academic sector, where the sector code corresponds to the funding institution.

**Figures 1 and 2.** The figures show the percentage distribution of postdocs across sector of employment for short or no stay and longer stay abroad. Time is measured in relation to the year of postdoc grant receipt. Academic, Private and Other general are sectors in Denmark. Postdocs who reside abroad but who are employed by an institution in Denmark are classified in relation to the Danish sector. "Abroad" includes postdocs where sector is known from registry data and where migration data shows that they reside abroad. Note that year 8 only includes grants up to 2007 and year 7 only to 2008.

**Figure 1. Short or no stay abroad**



**Figure 2. Longer stay abroad**



Looking only at the postdocs who are employed in Denmark, the proportion who are still employed in the academic sector three years after the grant receipt are greater among postdocs with short or no stay abroad. However, it is probably true that many postdocs abroad are employed by a foreign university. Assuming that postdocs that are abroad and have publication activity are employed in the academic sector (and postdocs without publication activity are not employed in the academic sector), differences are much smaller between postdocs with and without a longer stay abroad. The results are generally the same, if we use year of PhD degree as reference year instead of the year for the grant received.

**Table 2. Academic sector as main occupation.** The table shows the percentage of postdocs with the academic sector as their primary occupation. The percentages are shown both for 3 years and 5 years after grant reception. The results are calculated both among post-docs the employment sector is known via the register data (i.e., excl. Postdocs abroad or inactive), and with the inclusion of post-docs abroad (where it is assumed that the post-docs abroad with publication activity of the current year or three subsequent years employed in the academic sector, while postdocs abroad and without publication activity is not in the academic sector).

	Short or no stay abroad	Longer stay abroad
3 years after grant receipt (excl. Abroad)	64.8 %	52.5 %
3 years after grant receipt (incl. Abroad)	64.0 %	58.6 %
5 years after grant receipt (excl. Abroad)	51.9 %	45.6 %
5 years after grant receipt (incl. Abroad)	51.3 %	49.3 %

## Academic career advancement

A relatively small share of the postdocs earned a permanent position as an associate professor or professor (or equivalent position) within the first 3 years after grant receipt. The percentage is, however, twice as high among post-docs without a stay abroad, 12% vs. 6% for the postdocs with a longer stay abroad. Shares rise sharply for both groups, where respectively 34% and 23% of postdocs with short or no stay and with longer stay abroad have received tenure after five years. However, it seems that the variation in doctoral experience (years since PhD) among postdocs affects these results as there is almost no difference in shares when they are based on years since PhD.

**Table 3. Permanent academic position.** The table shows the percentage of post-docs permanent academic employment. The percentages are shown both for 3 years and 5 years after grant reception and for 4 years and 6 years after completion of PhD. There were a total of 107 postdocs wholly or partly employed by a Danish university three years after the grant reception and 93 five years after. Measured in relation to the year of completion of PhD, there were 99 postdocs wholly or partly employed by a Danish university four years after the grant reception and 83 six years after.

	Short or no stay abroad	Longer stay abroad
3 years after grant receipt	12.0 %	6.3 %
4 years after PhD	14.0 %	14.3 %
5 years after grant receipt	34.3 %	23.1 %
6 years after PhD	31.3 %	28.6 %

## Publication activity

Publication activity can typically be measured in several ways, for example by the number of publications and the number of fractional publications (where the number is fractioned with respect to the number of authors).

The average publication activity has increased over time for both postdoctoral groups. In the period from three years before the grant reception to six years after, the average number of

articles increased from 1.38 to 2.18 for postdocs with longer stays abroad and from 0.93 to 1.73 for short / no stay. The average number of fractional articles is significantly lower than the number of all articles, reflecting the fact that many articles have several co-authors. Also measured in fractional articles are publication activity higher among postdocs with longer stays abroad.

**Table 6. Number full count and fractioned journal articles before and after grant receipt.** The table shows the average number of articles and fractioned articles for postdocs by stay abroad. The period before includes the six years before grant receipt (incl. grant year), while the period after includes the six years after the grant.

	Short or no stay abroad	Longer stay abroad
Number articles <b>before</b> grant receipt	6.69	8.76
Number articles <b>after</b> grant receipt	10.62	12.28
Fractioned articles <b>before</b> grant receipt	0.24	0.27
Fractioned articles <b>after</b> grant receipt	0.18	0.21

## Citation impact

For the analysis of citation impact, we used Citation Normalized Mean Score (MNCS<sup>3</sup>) the Journal Normalized Mean Score (MNJS<sup>4</sup>). Citation impact is high among both groups, but are not increasing throughout the process from before to after the grant. For both postdocs with and without a prolonged stay abroad citation impact around the beginning of the grant. Citation impact is generally higher among postdocs with short / no stay, both in the periods before and after the grant.

**Table 4. Citation and journal impact before and after grant receipt.** The table shows MNCS and MNJS for post-docs with and without longer stays abroad. The period before the six years before allocation (incl. grant year), while the period following the six years after the grant.

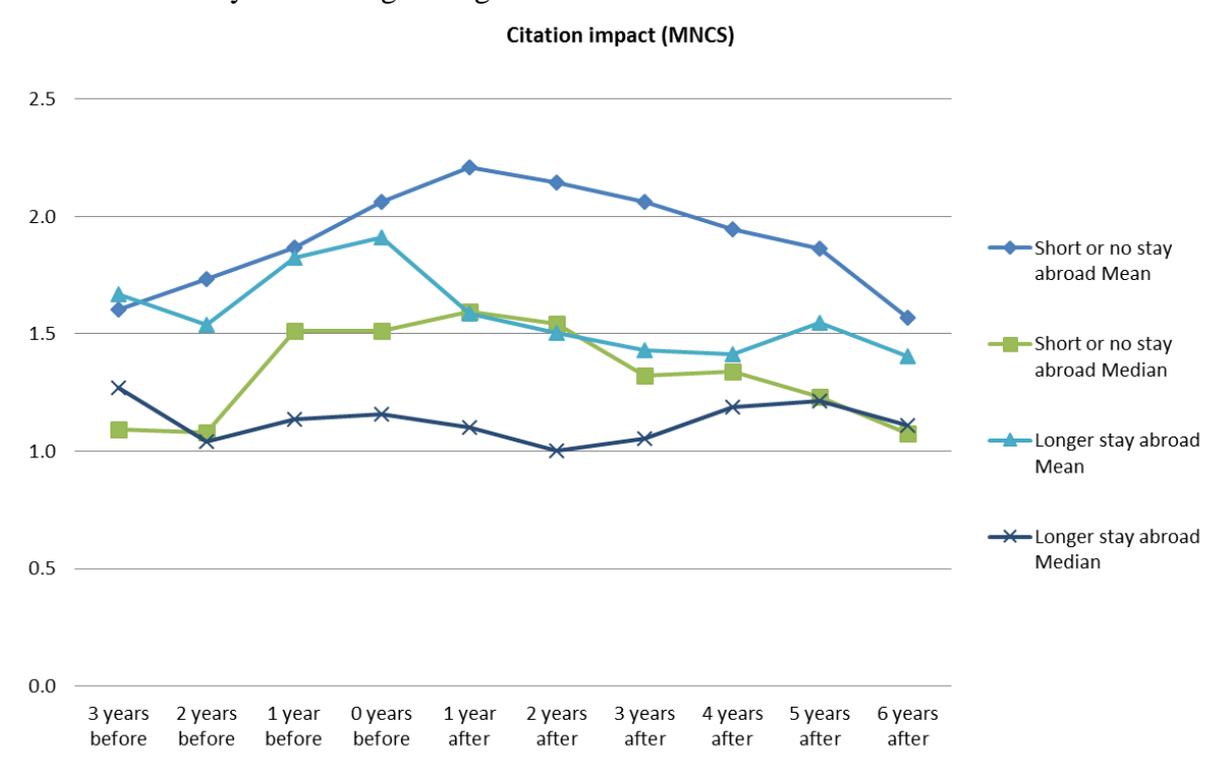
	Short or no stay abroad	Longer stay abroad
Citation impact (MNCS) <b>before</b> grant receipt	1.84	1.72
Citation impact (MNCS) <b>after</b> grant receipt	2.06	1.61
Journal impact (MNJS) <b>before</b> grant receipt	1.44	1.37
Journal impact (MNJS) <b>after</b> grant receipt	1.62	1.58

<sup>3</sup> Mean Normalized Citation Score is the average field normalized citation score, excluding self-citations. If MNCs is greater than 1, this means that the groups cited publications frequently than an "average publication" within the subject areas, wherein the radicals are active release. The analysis uses a three-year citation window, i.e., all bibliometric indicators calculated on the number of citations received in the same year as the publication is released, and the following two years.

<sup>4</sup> Mean Normalized Journal Score. The average field normalized citation score for journals, exclusive self-citations. Relative journal indicator that shows the groups international journal publishing profile. If MNJS is greater than 1, it means that citation frequency of the journals in which the articles have published exceeds frequency for all publications within the subject areas in which these journals belong.

On the other hand, there is almost no difference in the journal impact of postdocs with and without longer stay abroad; i.e. both groups have published in journals with approximately the same impact.

**Figure 3.** The figure shows both the median and average citation impact (MNCs) over time, for the period from three years before grant reception to 6 years after. In the figure, MNCS is calculated as a 4 year 'moving average'.



### International and inter-institutional collaboration

In the period before the grant involved about 40% of the articles from both postdoctoral groups collaboration with researchers abroad. This proportion has increased in the period after the grant of both groups. However, the proportion of international cooperation highest among postdocs with short / no stay, 55%, while the figure is 49% for postdocs with extended stays.

Inter-institutional cooperation includes both international cooperation and collaboration across the Danish universities. Over two-thirds of the articles involving inter-agency cooperation, where the proportion is again highest among postdocs with short / no stay.

**Table 5. Share of articles with International and inter-institutional collaboration before and after grant receipt.** The table shows the percentage of articles with international collaboration and inter-agency collaboration for postdocs with and without longer stays abroad. The period before the six years before allocation (incl. Grant year), while the period following the six years after the grant.

	Short or no stay abroad	Longer stay abroad
International collaboration <b>before</b> grant receipt	44.3 %	40.5 %
International collaboration <b>after</b> grant receipt	55.0 %	49.0 %
Inter-institutional collaboration <b>before</b> grant receipt	62.5 %	57.6 %
Inter-institutional collaboration <b>after</b> grant receipt	74.5 %	66.6 %

## Conclusion

In this paper we have examined career paths, sector mobility and performance among DFF postdoc fellowships with and without a longer stay abroad. Postdocs with a prolonged stay abroad (minimum 22 months) are compared with postdocs with no or a very short stay abroad (maximum 2 months) during their postdoctoral program.

Overall, we find that both postdocs with and without prolonged stay abroad have fairly high research performance during and after the grant from the DFF. However, the results provide little indication that postdocs with extended stays abroad outperform postdocs with short or no stay abroad. This is also the case for international collaboration, where we find that postdocs with longer stays abroad actually have a lower share of articles with international collaboration than for postdocs with short or no stay abroad.

Productivity, measured either in terms of counts or fractional articles, is highest among postdocs with a prolonged stay abroad, while the average citation impact is highest for postdocs with little or no stay abroad. When it is based on doctoral age instead of grant receipt, there is little difference among the two postdoc groups in the share that achieves tenure as associate professor or professor.

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