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Studying abroad experience and the wages of females

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Abstract
Studying abroad acts as investment in human capital and ideally outweighs associated investment costs due to higher earnings or related non-monetary benefits. We estimate monetary returns to studying abroad for female graduates 1 and 5 years after graduation. The empirical estimates—based on panel data from four graduate cohorts in 1997, 2001, 2005, and 2009—confirm positive returns to studying abroad. Mobile females earn 3.2% higher wages compared to non-mobiles at labor market entry. These initial wage gains tend to improve further over time, resulting in about 4.0% higher earnings for mobile females 5 years after graduation. Detailed consideration of different socio-economic groups reveals that female graduates from non-academic backgrounds and females majoring in social sciences benefit most. Studying abroad, therefore, has positive effects on later income of female graduates.

Keywords International student mobility · Returns to education · Human capital · Wages of females

Introduction

According to UNESCO, international students are those "*who have crossed a national or territorial border for the purpose of education and are now enrolled outside their country of origin*" (UNESCO Institute of Statistics, 2020). Studying abroad takes two main forms: credit mobility and degree mobility. Credit mobility stands for cases when students attend university abroad only for part of their studies to obtain academic credits. Unlike such temporary mobility, degree mobility implies longer stays abroad and obtaining degree in a foreign country. Both types of student mobility have increased in importance over the last decades despite rising numbers of students overall, and study abroad programs have become an integral part of higher education.

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The motivation and expectations associated with studying abroad are manifold. Major objectives are to improve the skills in the field of study, foreign language proficiency, and professional skills (Allen, 2010; King & Ruiz-Gelices, 2003; Kitsantas, 2004; Sánchez et al., 2006). In addition, some students favor cultural exchange and exploring new countries (e.g., Petzold & Moog, 2018; Schroth & McCormack, 2000). The motives for participation in studying abroad also comprise better future job perspectives (Doyle et al., 2010; Toncar et al., 2006). Another reasoning may be less competitive barriers in a foreign country for entering higher education in the specific field (Wiers-Jenssen, 2008). Financial considerations can shape the intentions to study abroad, with students being more motivated to study abroad when some financial aid or scholarship program is available (Netz, 2015; Petzold & Moog, 2018; Toncar et al., 2006). Moreover, intentions to study abroad differ among countries of origin of students. For example, US students are motivated to improve foreign language skills, whereas students from China are particularly interested in liberty (Sánchez et al., 2006). Moreover, there is a mutual exchange of students between countries with similar levels of democracy, meaning that more liberalized countries attract students from other liberalized countries, whereas autocratic countries create a certain type of tunnel of exchange between other countries with similar levels of autocracy (Vögtle & Windzio, 2020) .

Student mobility and study abroad programs may be beneficial in particular for women. Explorations of gender participation in student exchange reveal some notable patterns. Females tend to participate more actively in studying abroad than males (Cordua & Netz, 2022; Hurst, 2019; Salisbury et al., 2010; Van Mol, 2022). For example, they are overrepresented in student exchange programs, such as Erasmus,[1] compared to the share of female students participating in tertiary education (Böttcher et al., 2016). Nevertheless, while the share of women among mobile students in European OECD countries is about 51.8%, there is a considerable heterogeneity across countries from 34.6% in Turkey up to 60.2% in Iceland (as of 2018). Moreover, gender patterns differ in sending and receiving: for example, Germany receives fewer females than males (46.9%), while more German women choose to study abroad (53.9%). Higher female participation may be attributed to higher socioeconomic background, gender-related characteristics, as well as better academic performance and subjects chosen at school with higher propensity to study abroad (Cordua & Netz, 2022; De Winter et al., 2021; Di Pietro, 2022; Hurst, 2019; Salisbury et al., 2010; Van Mol, 2022). Studying abroad thus has a particular emphasis on the acquisition of specific knowledge and skills; its intercultural experience can therefore imply a change in career prospects.

We use information of the German graduate panel datasets provided by the German Center for Higher Education Research and Science Studies (DZHW) for the graduating cohorts 1997, 2001, 2005, and 2009 to empirically analyze whether temporary studying abroad (i.e., credit mobility) is correlated with wage gains for female graduates. In a stylized way, studying abroad represents an investment in human capital. If efficient, its returns—expressed by higher wages, more stable jobs, or jobs in higher paying sectors—will outweigh investment costs. Since women with exchange experiences may be more mobile even within county, they may have a higher probability to get into these jobs. In addition, they may also benefit from other experiences and skills obtained by studying abroad. To analyze, whether this holds in reality (and to quantify the potential impacts),

[1] Erasmus is an organization supporting international mobility among countries on each educational level (Erasmus Plus, 2020).

our first research question asks: How does studying abroad affect wages of females? Since the panels contain detailed information on graduates' study and career information in two waves each (surveyed after 1 year of graduation and after 5 years of graduation), we estimate short-run and medium-run effects using linear regression and propensity score matching estimators to account for issues of self-selection. Moreover, the rich set of information allows consideration of a wide range of accompanying influences in the analysis, i.e., differences in socio-demographic, study, and work-related characteristics. This enables us to analyze a second question: How do effects differ with respect to certain patterns in socio-economic characteristics and/or related to major choice?

Student mobility

Effects of student mobility: a short review of the literature

Today, almost all universities in Germany offer individual exchange programs that typically comprise tuition fee waivers, approval of course credits, and, in some cases, additional benefits (like lump-sum payments, travel grants, living grants and the like). These programs are usually based on cooperation contracts and aim at promoting two-way exchanges, i.e., sending students abroad and receiving students from the host country for one or two semesters. There are also longer-term programs leading to so-called double degrees from both the sending and hosting higher education institutions. Since the late 1970s, more and more countries began to moving their focus from primarily hosting foreign students to promoting studying abroad for own students. International student mobility has become more affordable and less dependent on financial support of parents due to the inauguration of studying abroad scholarship programs.[2] The amount of foreign students enrolled in universities across the world more than doubled within 10 years to about 5.3 million in 2017, with international students (including degree and credit mobility) representing about 5% of all students in OECD countries and about 6% in non-OECD countries (OECD, 2019).

There is a comprehensive literature from different disciplines regarding the impacts of international student mobility (e.g., Netz & Cordua, 2021; Roy et al., 2019; Waibel et al., 2017). Hence, we can provide a selective overview only, trying to strive the findings important for the analysis at hand. Evidence shows that studying abroad increases the employability of graduates (Di Pietro, 2015). Students who studied abroad improve their proficiency in foreign language skills and benefit from experiences with different cultures (King & Ruiz-Gelices, 2003; Roy et al., 2019). Both skills are more widely used among mobile students in comparison with non-mobile (Wiers-Jenssen, 2008). Mobile students tend to become more empathetic towards other cultures and improve their academic performance (Roy et al., 2019). Moreover, studying abroad experience enhances the probability to work abroad (Oosterbeek & Webbink, 2011; Parey & Waldinger, 2011), and mobile students have a higher likelihood to look for job opportunities abroad compared to non-mobile students. In addition, studying abroad leads to jobs with higher chances to have business travels (Wiers-Jenssen, 2008).

[2] For example, the DAAD budget has considerably changed its focus to promoting studying abroad for home students in 1990s, compared to the focus on welcoming foreign students in the 1970s (Baron, 1993).

Regarding monetary returns, the available literature indicates a positive impact associated with studying abroad expressed in higher wages and a smoother transition to the labor market (see, for example, Kratz & Netz, 2018; Iriondo, 2020; Netz & Cordua, 2021; Teichler et al., 2000; Wiers-Jenssen & Try, 2005). In this context, overall positive effects have been decreasing over time with reference to the earlier cohorts of exchange students (Teichler, 2012; Teichler & Janson, 2007). Despite decreasing returns to studying abroad, it is still associated with on average higher monetary returns later in life (Kratz & Netz, 2018; Netz & Grüttner, 2021). Several reasons are emphasized: some authors explain the gains by a higher probability to change jobs more frequently and realizing the associated wage gains, on the one hand, and higher chances of working in large international companies which offer above-average wages, on the other hand (Kratz & Netz, 2018). Improved language skills may be another mediator (Sorrenti, 2017). Nevertheless, there is some ambiguity: while some studies causally attribute higher income to studying abroad (Oosterbeek & Webbink, 2006; Orru, 2014), Messer and Wolter (2007) show that positive relations of higher monetary income lose its significance when controlling for selection of students. Monetary gains also differ depending on type of mobility and on whether mobility takes place during bachelor or master studies. There is evidence on higher monetary returns for mobile bachelor students, but not for mobile master students. However, controlling for self-selection reduces significance of the effects (Van Mol et al., 2021). Furthermore, the type of mobility affects later income as well: while studying abroad is associated with higher monetary returns, such effects do not hold for internships abroad (Van Mol et al., 2021).

Social background and field of study have been shown to be relevant as well (Waibel et al., 2017). The social capital literature argues that social groups possess certain sets of assets (Bourdieu, 1986). Studying abroad has a history of being an exclusive experience for more privileged circles of students. Hence, there may be differences in the outcomes depending on social background. Related to this, studying abroad may act as symbolic capital for some group of students (Hurst, 2019). Decisions may, therefore, follow certain pathways, and there may be differences in access to information conditional on parental background (Coleman, 1990). Previous research on student mobility confirms the role of parental background on several outcomes. Overall, there is a tendency of lower participation in studying abroad for students from non-academic background (Lörz et al., 2016). Gains from studying abroad are higher among students from academic than from non-academic background (Netz & Grüttner, 2021). Studying abroad improves the employment opportunities for students in general; however, this cannot be confirmed for students from low-educated parental background (Di Pietro, 2015). Related to fields of study, effects tend to be mixed. While for some fields positive gains in terms of better employment chances (business administration, see Wiers-Jenssen & Støren, 2021) or higher returns have been found (humanities and economics students, see Netz & Grüttner, 2021), Schmidt and Pardo (2017) do not find any significant gains on wages across various fields considered.

A common finding in a set of recent studies is higher female participation in studying abroad compared to males (Böttcher et al., 2016; Cordua & Netz, 2022; De Winter et al., 2021; Di Pietro, 2022; Hurst, 2019; Salisbury et al., 2010; Van Mol, 2022). Tendencies of higher female participation in studying abroad persist in a number of European countries since the early 2000s (Di Pietro, 2022). However, the gender participation gap in studying abroad becomes smaller when controlling for different factors, such as fields of study and academic performance. Accordingly, over-representation of women in studying abroad is driven mainly by specific fields of study, such as humanities and social sciences, where females represent the majority of students. Another explanation of higher female participation in

studying abroad refers to better academic performance: women tend to have higher achievement scores, and better academic performance correlates with a higher likelihood of studying abroad. Related to that, some authors emphasize that higher participation can be due to gender specific profiles already starting to develop during school age, such as language competences, subjects related to studying abroad, and better educational performance (Cordua & Netz, 2022). Further influencing factors mentioned in the literature are being in a romantic relationship and academic motivation of students. However, both aspects differ in impact between males and females. Female students, e.g., tend to aspire to participate in studying abroad program less if they are in romantic relationships but no such effects are reported for male students. Intrinsic academic motivation, in contrast, has strong positive effects regardless of gender (De Winter et al., 2021). Alternatively, it may be not females per se who tend to study abroad more often than males, but privileged females in particular, i.e., those from higher social class. For them, studying abroad may reflect some kind of symbolic cultural capital of belonging to a certain class (Hurst, 2019).

There are number of studies exploring female participation and reasoning of higher female participation in studying abroad. The female-focused evidence concerning monetary returns to studying abroad is very scarce, however. A rare example is Schmidt and Pardo (2017) who account for gender differences in their empirical analysis. While they find no significant effect for males, females experience significant positive effects only in the case of full-time employment.

Theoretical effects

Following the idea of human capital theory, studying abroad may increase individual productivity through an improvement (of the set) of individual skills. In this sense, we can view education abroad as investment that will pay off later. Ben-Porath (1967) shows that higher earnings can be explained by continuous investment in education (or training) over lifetime. Individuals make an investment in themselves depending on gains and costs of the decision. In line with this, the present value of disposable earnings (W_t, see Eq. 1) will be maximized as the integral over time from the moment the individual enters the labor market until the end of her economic life (T). The maximization problem is subject to the production function, constraints on the available stock of human capital, and the rate of change of the capital stock:

$$W_t = \int_t^T e^{-rv}\left[a_0 K(v) - I(v)\right]dv \tag{1}$$

where W_t is the present value of disposable earnings at time t, r is a constant rate of interest, K is the stock of human capital, a_0 is the rent for the service of a unit of human capital, K, per unit of time, and I denotes the investment costs. According to the model, optimal investment in human capital is achieved when marginal costs of producing human capital equal the demand price of human capital. At a certain point of time, t, the investment allocated to acquiring an additional unit of human capital optimally meets the amount of additional earnings, received from the investment in that additional unit of human capital. In other words, at this time t, the individual reaches the maximum of additional earnings if she invests in her human capital with explicit consideration of the (direct and indirect) costs of investment.

$$I_t = a_0 s_t K_t + P_d D_t \tag{2}$$

Investment costs (I_t, Eq. 2) consist of two parts: opportunity costs and direct costs. The first term on the right-hand side, the opportunity costs, are foregone earnings of the individual due to the time invested in schooling or training. The model assumes that human capital can be traded on a market. Hence, a_0K_t is the maximum services of human capital provided in a market, i.e., the earning capacity of the individual in t, a_0K_t. s_t reflects the proportion of time devoted to produce human capital, i.e., studying or other educational activities. The direct costs, i.e., the second term on the right-hand side, denote costs for human capital development. D_t denotes the quantity "purchased" at time t with P_d denoting the price for D. The investment costs in total need to be minimized subject to some production function.

To determine the value of going abroad, the following thought experiment can be conducted. Holding all other things equal, we compare a student who went abroad compared to her counterfactual situation where she decided not to do so. Of course, the same student will never be observed in both situations at the same time. The population of interest in our case are students in universities and universities of applied sciences. Each individual in the pool of students can decide to go abroad—or not. Given its simplicity, the Ben-Porath (1967) model provides a useful framework to illustrate the theoretical effects. For this purpose, we assume that studying abroad reflects some kind of good among those of human capital traded in a market. If individual v decides to invest in studying abroad, let us denote her human capital by $K\left(v_{SA}\right)$, the associated investment costs by $I(v_{SA})$, leading to a reformulation of disposable earnings from Eq. 1 as follows:

$$W_{tSA} = \int_t^T e^{-rv_{SA}}\left[a_0K\left(v_{SA}\right) - I(v_{SA})\right]dv_{SA} \tag{3}$$

Of course, in the counterfactual situation—when the same individual decides not to study abroad—the disposable income maintains as in Eq. 1. Given our assumptions (the same individual on the same market), the rate of interest (r) and rent on human capital of studying abroad (a_0) stay constant. What changes, are the current disposable earnings. The return of studying abroad is thus the difference of Eqs. 3 and 1, i.e., of the earnings at time t when the individual decides to study abroad and the earnings of the same individual at the same time t in case if she decides not to invest in studying abroad:

$$W_{tSA} - W_t = \int_t^T e^{-rv_{SA}}\left[a_0K\left(v_{SA}\right) - I(v_{SA})\right]dv_{SA} - \int_t^T e^{-rv}\left[a_0K(v) - I(v)\right]dv \tag{4}$$

Equation 4 further shows that the difference mainly depends on whether the difference between gains from investing in studying abroad is higher or lower than the investment costs. We therefore simplify Eq. 4 as follows:

$$\Delta W = \Delta(K - I) = \Delta K - \Delta I \tag{5}$$

Since the investment costs stay the same for the same individual, we could further argue that the difference in wages is directly associated with the value of human capital. This implies that studying abroad itself is the service of human capital, which can be traded. The individual then decides to invest in it—or not—for a limited period of 1 or 2 semesters. Although these semesters should substitute for studying at home, preparation, requirements, formal paper work, and travel arrangements may lead to a prolongation

of the study duration. These opportunity costs therefore denote the hypothetically foregone earnings, which result from the time spent for (organizing and) studying abroad experience. Direct costs would include tuition fees, moving costs, and other hidden costs (such as library card or laboratory equipment). Obviously, in this model framework, the investment is efficient if international mobility leads to a higher wage, which also settles potential higher study costs.

Data sources and selected descriptive statistics

Data sources

For the empirical analysis, we use data from the graduate panels provided by the German Centre for Higher Education Research and Science Studies (*Deutsches Zentrum für Hochschul und Wissenschaftsforschung*; *DZHW*) and the Leibniz Institute for the Social Sciences (*GESIS*).[3] These panel datasets cover information on graduates from German higher education institutions, i.e., universities and universities of applied sciences, for the graduation cohorts of 1997, 2001, 2005, and 2009. Each panel consists of two waves. The first wave is surveyed after 1 year of graduation and provides information on individual's study, career entry, and the early labor market biography. The second wave complements information 5 years after graduation. Besides detailed study information, the datasets comprise a comprehensive set of individual characteristics including socio-demographic characteristics (such as gender, age, parental education, family status) and job characteristics.

The population sampled are all higher education graduates who obtained their degree at a German higher education institution. Sampling uses a cluster approach that considers the distribution of graduates across regions and majors (see Baillet et al. (2017) for detailed information). The approach ensures a representative sample with respect to region and majors of all graduates. The response rates in the first wave vary between 20 and 40%. Panel attrition over 5 years leads to relative response rates in the second wave of around 60–65%. Overall, we have information on 8078 female students (wave 1) or 5907 with complete information (waves 1 and 2).[4]

Characteristics

The data contain self-reported information on graduates' gross monthly income of their current or last job at the time of the interview and detailed information of each job, including working hours per week. Each of the panels offers the opportunity to track whether students went abroad during studies or not, and provide a detailed description of every major, program, and location of university.

For our outcome of interest, we use the available information on wages 1 and 5 years after graduation and hours per week indicated by the graduates for each job location. Based on these data, we calculate hourly wages in prices of 2014 (euro) using the consumer price index provided by the Federal Statistical Office. We symmetrically trim the wage distribution by 2% to avoid biases due to misreporting errors. The main

[3] For more information see https://metadata.fdz.dzhw.eu/en/start. Specific references can be found in Brandt et al. (2018, 2021), Briedis et al. (2021), and Minks et al. (2017).

[4] See Table 4 in the Appendix for further information.

treatment in our analysis is whether the student went abroad or not. Graduates indicate every enrollment in tertiary education and any potential changes of university. Therefore, we could identify mobile students from information on location of university and create a binary dummy variable s*tudy abroad*.[5]

We further select factors systematically affecting wages based on the related literature. We regard age, age squared, parental education, children, and long-term relationships. For *age* and *parental education*, we follow Parey and Waldinger (2011), where *age* refers to the age of graduates when they started their first university education. *Parental education* refers to the highest education level achieved by any of the parents of graduates. We include a *children* dummy, since children have a strong influence on labor market availability, particularly for women. We control for abilities of students in terms of their *final university grade* and *high school grade* obtained to enter higher education institutions. We also include an indicator for holding more than one degree. More specific to the German labor market and its higher education system, we additionally consider an *apprenticeship training* and attending *gymnasium* (i.e., the highest secondary school track granting access to university studies) in our analysis, to proxy for different initial conditions before studying. To observe the variation across different majors, we control for different *fields of study*. Finally, we control for graduating from universities of applied sciences and the length of study in the number of semesters. We restrict the empirical analysis to graduates holding classical diploma degree, magister, or master degrees to avoid potential selection bias caused by graduates from bachelor degree and state regulated examinations.

Selected descriptive statistics

Table 1 presents selected summary statistics on the composition of the two student bodies, i.e., stayers and movers. The results show some heterogeneity across mobile and non-mobile students. Mobile students are on average younger at first enrollment and have a higher socio-economic background (i.e., larger share from academic backgrounds, better grades at high school graduation and university graduation). Regarding the fields of study, students of arts & humanities are overrepresented among mobile students, while the opposite holds for the engineering students, and there are similar shares of mobile and non-mobile students among social and natural sciences.

Regarding the outcomes of interest, the table provides selected figures 1 and 5 years after graduation. Mobile students, on average, have higher wages both at job entry and after tenure of 5 years. Working abroad is three times as likely for mobile students compared to non-mobile students. Regarding employment, there are no strong differences between students with and without studying abroad experience.

[5] The most recent panels of 2005 and 2009 offer more details of studying abroad: graduates report their international experience during studies, including study, language course, or an internship abroad. Kratz and Netz (2018) or Netz and Grüttner (2021) use this information to define a study abroad indicator. Therefore, by the definition, these authors report higher shares of mobile students in their analysis due to the inclusion of the more comprehensive mobility definition. To allow a comparison between our definition and the definition used by Kratz and Netz (2018) or Netz and Grüttner (2021), we have re-estimated the empirical models based on the panels for the 2005 and 2009 cohort applying both definitions. Table 10 in the Appendix shows the corresponding estimation results.

Table 1 Summary statistics

	Abroad	Non-abroad
Age (when starting studies)	20	21
Children	4.2%	8.8%
Long-term relationship	66.5%	72.2%
Academic background	53.2%	32.3%
Final university grade	1.7	1.8
High school grade	1.9	2.2
Length of study (# of semesters)	*10.9*	*10.9*
University of applied sciences	19.3%	41.3%
Gymnasium	89.4%	76.7%
Apprenticeship (before or during uni studies)	5.3%	13.9%
Indicator for more than one degree	16.0%	1.5%
Field of study		
Arts & humanities	30.4%	26.8%
Social sciences	*37.2%*	*37.2%*
Natural sciences	*17.5%*	*16.7%*
Engineering	15.0%	19.3%
Work characteristics after 1 year of graduation		
Wage, euro*	2400.0	2272.4
Wage per hour, euro	15.4	14.8
Currently employed	*98.6%*	*98.2%*
Work abroad	8.8%	3.3%
Observations	767	7311
Work characteristics after 5 years of graduation		
Wage, euro	3458.6	3125.0
Wage per hour, euro	22.7	21.3
Currently employed	*84.5%*	*82.4%*
Work abroad	14.9%	5.4%
Observations	563	5344

Table contains sample means and share of female graduates holding various characteristics. Plain values indicate that mean differences between groups are significant at $p < 0.05$. Not significant mean differences are displayed in *italics*. *Children* indicates if graduate has a child or not. *Long-term relationship* is an indicator on being in long-term relationship or married. *Academic background* indicates if one of the parents holds university degree. *Final university grade* and *high school degree* is range from 1 to 5, where 1 is the highest grade; *university of applied sciences*, *gymnasium*, and *apprenticeship (before or during university studies)* indicate participation in one of these institutions; *indicator for more than one degree* indicates holding more than one degree. *Work abroad* indicates whether the location of last or current job is abroad. **Wages* transformed to comparable prices of year of 2014 in euros. Data source: DZHW graduate panels 1997, 2001, 2005, 2009

Empirical results

Estimation

Based on these data, we estimate the monetary returns to studying abroad for female graduates to answer our first research question. To allow a deeper understanding on underlying patterns—our second research question—we also consider several

subgroups in the following. We distinguish graduates from academic parental background and graduates from non-academic parental background to proxy for differences in initial socio-economic status. Since wages highly depend on professions, we furthermore consider the heterogeneity across majors, i.e., we separately estimate the effects for graduates from (1) arts & humanities, (2) social sciences, (3) natural sciences, and (4) engineering.

To proceed with our analysis, first we estimate the empirical models using the following specification by ordinary least squares:

$$Log\ (Wage)_i = \beta_0 + \beta_1 Study\ Abroad + \beta_2\ Cohort + X_i'\beta + u \tag{6}$$

where log(wage) is the logarithm of the gross hourly wage of female graduates, 1 and 5 years after graduation, respectively. Study abroad is the binary dummy variable indicating the study abroad experience. X denotes the set of further control variables, i.e., socio-demographic characteristics and study-related information. Socio-demographics include age (when starting studies), age squared, parental education, having children, and being in a long-term relationship. The study-related characteristics include fields of study, final university grade, high school grade, length of study (number of semesters), graduating from university of applied sciences, attending gymnasium and apprenticeship (before or during university studies), and holding more than one degree. Moreover, we consider fixed-effects for each graduating cohort in all estimated models. We estimate separate models for outcomes 1 year and 5 years after graduation.

Secondly, we continue our analysis using a propensity score kernel matching estimator for the effects of studying abroad on wages. Propensity score matching ensures to compare mobile students with non-mobile ones based on the estimated propensity score, i.e., the probability of studying abroad. Therefore, the estimates reflect the difference in outcomes of mobile students with comparable non-mobile students (statistical twins) that only differ in not moving but that are identical in all other respects. Matching relies on the assumption of selection on observables—and the common support condition, i.e., the availability of a comparison unit (not studying abroad) for each treated unit (studying abroad). In a first step, we estimate the propensity scores by probit models containing the same set of variables as in the OLS model. In the second step, we apply kernel matching. It weights the propensity scores of all comparison group units to provide a match. For the weighting, an Epanechnikov kernel matching (bandwidth 0.06) is applied. Moreover, we impose a min–max common support condition, i.e., treatment observations whose propensity score is higher than the maximum or less than the minimum propensity score of the comparison group are dropped. Estimation is conducted with Stata psmatch2 (Leuven & Sianesi, 2003, version 2012).

Moreover, we estimate separate models for each subgroup in consideration (i.e., parental background and fields of study) to ensure a high quality of the matches with the potential risk of losing significance due to smaller subsample sizes.

Results of several balancing checks applied on the main sample and on these subsamples before and after matching are given in Table 2. As becomes obvious, there are substantial differences in the single variables between mobile and non-mobile students before matching. The applied matching procedure eliminates these differences in all cases. Moreover, as the pseudo R^2s indicate, after matching the covariates cannot explain the variation in participation probability anymore, i.e., there is no systematic difference in the probability between mobile and non-mobile students left after matching. Matching quality is thus high and we have good reason to assume that is solves issues of self-selection sufficiently.

Table 2 Balancing checks for PSM

	After 1 year of graduation (wave 1)				After 5 years of graduation (wave 2)			
	Number of significant variables		Pseudo R^2		Number of significant variables		Pseudo R^2	
	Before	After	Raw	Matched	Before	After	Raw	Matched
Overall	14/19	0/19	0.149	0.002	13/19	0/19	0.145	0.002
Parental educational background								
Academic	12/17	0/17	0.130	0.002	12/17	0/17	0.119	0.005
Non-academic	12/17	0/17	0.134	0.003	11/17	0/17	0.146	0.004
Field of study								
Arts & humanities	12/16	0/16	0.096	0.002	13/16	0/16	0.098	0.001
Social sciences	13/16	0/16	0.214	0.003	12/16	0/16	0.234	0.006
Natural sciences	10/16	0/16	0.191	0.009	10/16	0/16	0.176	0.012
Engineering	13/16	0/16	0.166	0.004	10/16	0/16	0.148	0.005

Table contains number of significant covariates and pseudo R^2 before and after propensity score matching is implemented (for Table 3)

For this reason, the procedure obtains feasible statistical twins for the analysis, and the PSM estimates below reflect causal effects of studying abroad.

Monetary returns to studying abroad

We now turn to our main results. Table 3 shows the corresponding estimates from linear regression (OLS) and propensity score matching (PSM).[6] The outputs presented are the summary results from a series of separate regressions and PSM analysis on the pooled sample of female graduates 1 and 5 years after graduation and on subsamples divided by parental background and four groups of fields of study.

Studying abroad positively affects the human capital of female graduates in short-run and medium-run and results in higher salaries. On average, women with studying abroad experience have 3.2% higher wages compared to non-mobile females 1 year after graduation. This positive effect increases further with tenure after 5 years of graduation to up to 4.0%. The results of propensity score matching are qualitatively similar to the OLS results, confirming and even emphasizing the positive wage gain for mobile females, with 4.3% higher wages in the short-run compared to their non-mobile counterparts. In the medium-run, however, the PSM estimates show a positive coefficient but become statistically insignificant.

Our results confirm and extend the findings of the related literature. While there are number of studies on the returns from studying abroad, they do not differentiate between genders explicitly and provide evidence on positive effects of studying abroad in general (see, e.g., Kratz & Netz, 2018; Teichler et al., 2000; Van Mol et al., 2021; Wiers-Jenssen & Try, 2005). Our results indicate that these findings may be driven by the effects for women (and do not

[6] Models—for both OLS and PSM analysis—include the same set of variables. We consider socio-demographic characteristics, study related controls, and cohort fixed effects to control for each graduating cohort. Table 5 in the Appendix provides detailed results of the OLS regressions.

Table 3 OLS and PSM results on log gross hourly wages

Dependent variable: *log gross hourly wages*	Wave 1					Wave 2				
	OLS			PSM		OLS			PSM	
	Study abroad	*N*	Adjusted R^2	Diff.	*N*	Study abroad	*N*	Adjusted R^2	Diff.	*N*
Overall	0.032**	8078	0.042	0.043***	8070	0.040**	5907	0.044	0.032	5902
	(0.016)			(0.017)		(0.019)			(0.020)	
Parental educational background										
Academic	−0.000	2769	0.032	0.017	2762	0.035	2016	0.033	0.025	2015
	(0.024)			(0.025)		(0.028)			(0.030)	
Non-academic	0.065***	5309	0.047	0.070***	5304	0.041	3891	0.045	0.019	3889
	(0.021)			(0.023)		(0.025)			(0.028)	
Field of study										
Arts & humanities	−0.012	2191	0.020	−0.001	2191	−0.018	1656	0.031	−0.013	1653
	(0.029)			(0.031)		(0.039)			(0.040)	
Social sciences	0.067***	3007	0.048	0.109***	2986	0.120***	2053	0.071	0.111***	2041
	(0.026)			(0.028)		(0.027)			(0.034)	
Natural sciences	0.014	1352	0.019	0.024	1335	−0.010	1058	0.035	0.007	1047
	(0.040)			(0.042)		(0.047)			(0.048)	
Engineering	0.042	1528	0.046	0.024	1522	0.041	1140	0.042	0.055	1133
	(0.042)			(0.045)		(0.040)			(0.044)	

Significance levels ***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors in parentheses. Table contains information on estimates of regression on log gross hourly wages and propensity score matching results after 1 and 5 years of graduation for female graduates. The first row of estimations presents the results for the full sample; the following rows present results for different subgroups depending on the parental background of graduates and their field of study. Academic parental background refers to graduates with one of the parents holding a university degree or higher; non-academic otherwise. Field of study refers to which field of study individuals graduated their first degree. Models include key independent variable, socio-demographic and study related control variables and control for graduating cohorts. Dependent variable is *log gross hourly wages* of a current or last job respondent has at the time of the survey. *Study abroad* is the binary dummy variable indicating if student spends part of her university career at a foreign university. *Socio-demographic controls* include *age (when starting studies)*, *age squared*, *parental education*, *children*, and *long-term relationships*. *Study related controls* include *field of study*, *final university grade*, *high school grade*, *length of study (number of semesters)*, *university of applied sciences*, *apprenticeship (before or during university studies)*, *gymnasium*, and *holding more than one degree*. *Cohort* is categorical dummy variable to control the graduate panel. *Diff.* refers to treatment effect estimates of wages for females studying abroad. All estimates obtained by propensity score matching consider all variables of the main analysis in the propensity score. Estimation conducted with Stata psmatch2 (Leuven & Sianesi, 2003, version 2012) using kernel matching and system-provided standard errors. Data source for analysis: DZHW graduate panels 1997, 2001, 2005, 2009

hold for males to the same extent).[7] To the best of our knowledge, Schmidt and Pardo (2017) is the only other study that distinguishes effects for males and females. However, the study is limited in several respects: first, it uses data from alumni of one university in the USA only. Secondly, there is some ambiguity in the results concerning the employment of women: they find full-time employed females to benefit from studying abroad, but effects become insignificant when other types of employment are considered. Our study is far more general by incorporating the universe of German universities and universities of applied sciences and the effects of studying abroad on hourly wages of female graduates with consideration of the whole spectrum of employment contracts (including full-time, part-time, and flexible forms) across graduates from 1997, 2001, 2005, and 2009. Moreover, like Kratz and Netz (2018), we also find a less pronounced effect at the early stage of the career, which tends to increase over time. Our results add to this evidence showing that mobile females gain from studying abroad slightly less 1 year after graduation but more in the following years.

The estimated effects at the mean may differ with regard to social origin and field of study. To exemplify the related heterogeneity in monetary returns, Table 3 presents results of detailed analyses for several subgroups. Social origin may considerably affect the career pattern of graduates. It reflects the educational aspirations of parents and the related investments in child's education. An academic background of parents, therefore, proxies for more available tangible and intangible assets, which positively correlate with the probability of studying abroad. The higher share of female mobile students from this background compared to female students from non-academic background reflects this. The corresponding estimation results clearly show studying abroad is associated with higher wages for graduates from non-academic background 1 year after graduation. In this group, the average positive effect of studying abroad results in 6.5% higher wages. Propensity score matching confirms this empirical result showing a difference of 7.0% higher wages. However, as in the main sample, gains from studying abroad are no more significant 5 years after graduation.

A possible explanation for the positive gains from studying abroad for graduates from non-academic backgrounds results from the higher propensity to study abroad among females from privileged social backgrounds. For this group, studying abroad may reflect a common asset of social capital acquired (Hurst, 2019). The acquired human capital may thus be more valuable for graduates from non-academic origin. Importantly, our findings on parental background deviate from the results by Netz and Grüttner (2021) who find higher gains from going abroad during studies for graduates from academic background. Since they do not differentiate between genders, however, their averaging may veil some pronounced underlying gender heterogeneity.

Regarding the results for the different study majors, the coefficient estimates indicate that graduates from the social sciences tend to benefit most from studying abroad, both in the short-run as well as in the medium-run. At labor market entry, studying abroad experience implies 6.7% higher wages, and after 5 years wages are 12.0% higher, compared to their non-moving counterparts. The results from propensity score matching confirm these results in the short-run and show even more pronounced effects with 10.9% higher wages; in the medium-run, effects are still substantial and increase slightly (11.1% after 5 years of graduation). Related to our

[7] We have estimated the effects for male graduates, too. The results of these analyses are given in the Appendix, Tables 6, 7, 8, and 9. On average, there is no gain associated with studying abroad for males, independently of estimation method applied. Furthermore, the analysis considering differences in parental background shows a negative correlation of studying abroad for males from academic background (of − 4.0%) in the short-run but this effect is not confirmed by PSM. In contrast to that, studying abroad is positively associated with higher wages of 6.1% (6.0% PSM) for male graduates from non-academic background in the medium-run. Variation across fields of study shows a positive impact associated for male graduates from natural sciences (4.8%).

findings, Wiers-Jenssen and Støren (2021) report a more positive relation between studying abroad and suitable jobs when majoring in business administration compared to other fields of study. They explain their findings that studying abroad may be valued as a positive signal to potential employers. Our findings add to this by showing strong effects particularly for females in social sciences. The coefficient estimates for the other fields are smaller and statistically not significant. Women from social sciences thus benefit in particular from studying abroad.

Conclusion

Studying abroad has positive effects on the wages of female graduates. We analyzed the effects on hourly wages of female graduates 1 and 5 years after graduation, and the results clearly indicate earnings increases of, on average, between 3.2% (after 1 year) and 4.0% (after 5 years) from studying abroad. These estimated positive effects of studying abroad may be attributed to an improved human capital. The results confirm our theoretical ideas on the improvement of human capital by studying abroad for some time, confirming the idea of Ben-Porath (1967) of continuous investment in training. Evidently, studying abroad has positive impacts on being more aware of different cultures, becoming more cosmopolitan and better in cross-cultural communication, in addition to improved foreign language proficiency (Roy et al., 2019). In line with human capital theory, we can argue that investing in temporary studying abroad leads to an improvement of soft and hard skills of mobile females, strengthening their human capital reflected in higher income. Therefore, further promoting studying abroad among females might have positive effects.

Moreover, we estimated the effects for different socio-economic groups to study potential heterogeneity. Our analysis indicates that studying abroad is particularly valuable for female graduates from non-academic parental background. These results are of particular interest, since higher female participation in studying abroad programs is more likely for those from academic households (Hurst, 2019). For that reason, one may have expected that this group would be benefiting most from studying abroad. However, the positive effects for mobiles from non-academic background imply a substantial gain to human capital. Therefore, promoting studying abroad opportunities and informing about its beneficial effects at an early stage (during studies or even already in high school) can improve the awareness of the programs and therefore the likelihood of participation regardless of social background. Since studying abroad may be seen also as symbolic capital, being more aware of such opportunities among graduates from non-academic background is even more valuable. Further analysis across different fields of study shows that positive gains from studying abroad are profound among social science graduates. Revealed heterogeneity, e.g., with respect to field of study, implies important pathways for further promoting study abroad programs for these groups. We provide evidence of significant monetary returns for female graduates from social sciences but there are no significant effects for the other disciplines considered. To better understand the mechanisms underlying the heterogeneous patterns of monetary returns, further research will be needed, with more detailed consideration of work characteristics. For this purpose, more data on the current labor market situation and the demanded skills in jobs has to be retrieved, potentially by linking survey data with information from administrative records. Our study provides evidence on monetary returns to studying abroad. However, the literature points to several non-monetary effects (which reflect another type of utility gains). Evidence on impacts of these is scarce and so far, to the best of our knowledge, there have been no attempts of a comprehensive analysis, i.e., understanding the interdependency of monetary and non-monetary outcomes. For a conclusive judgment of studying abroad, such an approach will be desired.

Appendix

Table 4 Overview on graduate panel datasets

	Number of observations		
	Wave 1	Wave 2	Response rate of Wave 1*
Graduate panel			
1997	1152	1319	34%
2001	2607	1942	30%
2005	2822	1871	25%
2009	1497	775	20%
Total	8078	5907	

Data obtained from DZHW graduate panels 1997, 2001, 2005, 2009

*Information on response rate of wave 1 obtained from Baillet et al. (2017)

Table 5 OLS results on log gross hourly wages for female graduates

Dependent variable: *log gross hourly wages*	After 1 year of graduation (wave 1)						
	Overall	Academic	Non-academic	Arts & humanities	Social sciences	Natural sciences	Engineering
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Study abroad	0.032**	−0.000	0.065***	−0.012	0.067***	0.014	0.042
	(0.016)	(0.024)	(0.021)	(0.029)	(0.026)	(0.040)	(0.042)
Age (when starting studies)	0.031***	0.030*	0.032***	0.034**	0.048***	0.027	−0.038
	(0.009)	(0.016)	(0.011)	(0.015)	(0.014)	(0.021)	(0.033)
Age squared	−0.000**	−0.000	−0.000*	−0.000	−0.001**	−0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Parental education (ref: high school education)							
Craftsmanship/university of applied sciences	0.018*			0.041*	0.037**	−0.030	−0.019
	(0.010)			(0.021)	(0.016)	(0.027)	(0.023)
University degree or higher	−0.011			0.010	0.000	−0.065**	−0.017
	(0.011)			(0.022)	(0.018)	(0.029)	(0.026)
Children	−0.099***	−0.078**	−0.11***	−0.031	−0.17***	−0.089*	−0.072
	(0.019)	(0.031)	(0.023)	(0.034)	(0.029)	(0.049)	(0.045)
Long-term relationship	0.036***	0.038**	0.035***	0.038**	0.043***	0.061**	−0.0071
	(0.010)	(0.018)	(0.011)	(0.019)	(0.015)	(0.024)	(0.022)
Field of study (ref: arts & humanities)							
Social sciences	0.120***	0.130***	0.110***				
	(0.012)	(0.021)	(0.014)				
Natural sciences	0.130***	0.098***	0.150***				
	(0.014)	(0.023)	(0.017)				
Engineering	0.140***	0.150***	0.140***				
	(0.014)	(0.025)	(0.017)				
University of applied sciences	−0.041***	−0.050**	−0.035***	−0.081***	−0.032**	0.025	−0.069***
	(0.011)	(0.020)	(0.013)	(0.027)	(0.016)	(0.029)	(0.025)

Table 5 (continued)

Indicator for more than one degree	0.000	0.030	−0.031	−0.073	0.050	−0.021	0.029
	(0.028)	(0.040)	(0.038)	(0.048)	(0.041)	(0.092)	(0.072)
Final university grade	−0.040***	−0.038**	−0.041***	−0.045***	−0.019	−0.034	−0.110***
	(0.009)	(0.016)	(0.010)	(0.016)	(0.014)	(0.023)	(0.019)
High school grade	−0.030***	−0.042***	−0.025***	−0.010	−0.067***	−0.040**	0.026
	(0.008)	(0.014)	(0.009)	(0.015)	(0.013)	(0.020)	(0.018)
Length of study (# of semesters)	−0.001	−0.001	−0.001	−0.000	0.004	−0.001	−0.008*
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)	(0.005)
Apprenticeship	0.017	0.050	0.005	−0.008	0.008	0.025	0.051
	(0.016)	(0.033)	(0.018)	(0.037)	(0.023)	(0.039)	(0.038)
Gymnasium	0.029**	0.040	0.027*	0.006	0.065***	−0.009	−0.004
	(0.013)	(0.027)	(0.014)	(0.028)	(0.018)	(0.033)	(0.029)
Cohort (ref: 1997)							
2001	0.021	0.011	0.028*	0.025	0.049**	0.009	−0.028
	(0.013)	(0.024)	(0.016)	(0.027)	(0.023)	(0.032)	(0.027)
2005	−0.061***	−0.062**	−0.061***	−0.052*	−0.032	−0.037	−0.16***
	(0.013)	(0.024)	(0.016)	(0.027)	(0.021)	(0.035)	(0.031)
2009	0.008	0.002	0.013	0.020	0.029	−0.010	−0.045
	(0.015)	(0.027)	(0.018)	(0.028)	(0.023)	(0.040)	(0.040)
Constant	2.18***	2.23***	2.15***	2.10***	1.98***	2.39***	3.43***
	(0.12)	(0.21)	(0.14)	(0.21)	(0.19)	(0.28)	(0.38)
Observations	8078	2769	5309	2191	3007	1352	1528
Adjusted *R*-squared	0.042	0.032	0.047	0.020	0.048	0.019	0.046

Table 5 (continued)

Dependent variable: *log gross hourly wages*	After 5 years of graduation (wave 2)						
	Overall	Academic	Non-academic	Arts & humanities	Social sciences	Natural sciences	Engineering
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Study abroad	0.040**	0.035	0.041	−0.018	0.120***	−0.010	0.041
	(0.019)	(0.028)	(0.025)	(0.039)	(0.027)	(0.047)	(0.040)
Age (when starting studies)	0.038***	0.023	0.046***	0.030	0.050***	−0.007	0.009
	(0.011)	(0.026)	(0.013)	(0.021)	(0.018)	(0.027)	(0.062)
Age squared	−0.001***	−0.000	−0.001***	−0.000	−0.001**	0.000	−0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Parental education (ref: high school education)							
Craftsmanship/university of applied sciences	−0.010			−0.058**	0.023	−0.017	−0.0034
	(0.013)			(0.028)	(0.021)	(0.031)	(0.027)
University degree or higher	−0.005			−0.019	0.008	−0.007	−0.012
	(0.014)			(0.027)	(0.023)	(0.032)	(0.031)
Children	−0.081***	−0.088***	−0.079***	−0.043*	−0.099***	−0.140***	−0.049*
	(0.012)	(0.021)	(0.015)	(0.025)	(0.020)	(0.029)	(0.025)
Long-term relationship	0.029**	0.044*	0.021	−0.004	0.078***	0.043	−0.020
	(0.014)	(0.025)	(0.017)	(0.030)	(0.022)	(0.031)	(0.029)
Field of study (ref: arts & humanities)							
Social sciences	0.110***	0.094***	0.110***				
	(0.015)	(0.026)	(0.019)				
Natural sciences	0.073***	0.057**	0.081***				
	(0.017)	(0.028)	(0.021)				
Engineering	0.096***	0.066**	0.110***				
	(0.017)	(0.029)	(0.022)				
University of applied sciences	−0.099***	−0.140***	−0.083***	−0.120***	−0.110***	−0.040	−0.065**
	(0.014)	(0.025)	(0.017)	(0.037)	(0.021)	(0.033)	(0.030)

Table 5 (continued)

Indicator for more than one degree	0.015	0.009	0.026	−0.007	0.040	0.007	0.035
	(0.030)	(0.038)	(0.046)	(0.049)	(0.049)	(0.10)	(0.067)
Final university grade	−0.031***	0.008	−0.048***	−0.047**	−0.0085	−0.009	−0.100***
	(0.011)	(0.020)	(0.013)	(0.023)	(0.018)	(0.030)	(0.021)
High school grade	−0.053***	−0.039**	−0.059***	−0.070***	−0.043***	−0.078***	−0.009
	(0.010)	(0.018)	(0.012)	(0.020)	(0.017)	(0.023)	(0.022)
Length of study (# of semesters)	−0.000	−0.005	0.002	−0.002	0.002	−0.001	0.007
	(0.003)	(0.005)	(0.003)	(0.004)	(0.006)	(0.005)	(0.007)
Apprenticeship	0.003	−0.011	0.004	−0.064	−0.020	0.048	0.093**
	(0.021)	(0.046)	(0.024)	(0.055)	(0.031)	(0.050)	(0.045)
Gymnasium	0.024	−0.021	0.040**	−0.066	0.053**	0.001	0.053
	(0.017)	(0.035)	(0.019)	(0.041)	(0.024)	(0.043)	(0.035)
Cohort (ref: 1997)							
2001	−0.089***	−0.073***	−0.097***	−0.043	−0.140***	−0.074**	−0.093***
	(0.015)	(0.027)	(0.018)	(0.032)	(0.027)	(0.032)	(0.030)
2005	−0.031**	−0.011	−0.040**	0.079**	−0.110***	−0.022	−0.068**
	(0.015)	(0.027)	(0.018)	(0.031)	(0.024)	(0.036)	(0.033)
2009	−0.075***	−0.065**	−0.077***	−0.031	−0.130***	−0.059	−0.025
	(0.018)	(0.031)	(0.021)	(0.032)	(0.027)	(0.044)	(0.052)
Constant	2.60***	2.84***	2.49***	2.87***	2.44***	3.26***	3.04***
	(0.15)	(0.32)	(0.17)	(0.28)	(0.25)	(0.37)	(0.69)
Observations	5907	2016	3891	1656	2053	1058	1140
Adjusted *R*-squared	0.044	0.033	0.045	0.031	0.071	0.035	0.042

Significance levels ***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors in parentheses. Table contains information on estimates of regression on log gross hourly wages after 1 and 5 years of graduation for female graduates. Overall columns (1) and (8) present the results for the full sample; the following columns present results for different subgroups depending on the parental background of graduates and their field of study. Academic parental background refers to graduates, whose one of the parents holds the university degree or higher; non-academic otherwise. Field of study refers to which field of study individuals graduated their first degree. Dependent variable is *log gross hourly wages* of a current or last job respondent has at the time of the survey. *Study abroad* is the binary dummy variable indicating if student spends part of her university career at a foreign university. *Cohort* is categorical dummy variable to control the graduate panel. Data source for analysis: DZHW graduate panels 1997, 2001, 2005, 2009

Table 6 Summary statistics for male graduates

	Abroad	Non-abroad
Age (when starting studies)	21	22
Children	3.3%	9.3%
Long-term relationship	*60.5%*	*64.3%*
Academic background	48.0%	28.6%
Final university grade	1.7	1.9
High school grade	2.0	2.3
Length of study (# of semesters)	*10.9*	*11.0*
University of applied sciences	17.7%	44.6%
Gymnasium	82.0%	67.8%
Apprenticeship (before or during uni studies)	11.0%	23.2%
Indicator for more than one degree	21.6%	1.2%
Field of study		
Arts & humanities	*9.0%*	*7.9%*
Social sciences	37.0%	27.1%
Natural sciences	27.5%	21.8%
Engineering	26.4%	43.3%
Work characteristics after 1 year of graduation		
Wage, euro*	*2887.1*	*2934.1*
Wage per hour, euro	*17.8*	*17.5*
Currently employed	99.7%	98.6%
Work abroad	11.7%	2.9%
Observations	610	7428
Work characteristics after 5 years of graduation		
Wage, euro	4529.7	4350.3

Table 6 (continued)

	Abroad	Non-abroad
Wage per hour, euro	27.0	25.2
Currently employed	*95.7%*	*96.4%*
Work abroad	14.5%	5.0%
Observations	489	5601

Table contains sample means and share of male graduates holding various characteristics; significant at $p < 0.05$ (in *italics* sample mean is not significant). *Children* indicates if graduate has a child or not. *Long-term relationship* is an indicator on being in long-term relationship or married. *Academic background* indicates if one of the parents of graduates holds university degree. *Final university grade* and *high school degree* is range from 1 to 5, where 1 is the highest grade; *university of applied sciences*, *gymnasium*, and *apprenticeship (before or during uni studies)* indicate participation in one of these institutions; *indicator for more than one degree* indicates holding more than one degree. *Work abroad* indicates whether the location of last or current job is abroad. **Wages* transformed to comparable prices of year of 2014 in euros. Data source: DZHW graduate panels 1997, 2001, 2005, 2009

Table 7 OLS and PSM results on log gross hourly wages for male graduates

Dependent variable: *log gross hourly wages*	Wave 1					Wave 2				
	OLS			PSM		OLS			PSM	
	Study abroad	*N*	Adjusted R^2	Diff.	*N*	Study abroad	*N*	Adjusted R^2	Diff.	*N*
Overall	−0.005	8038	0.042	0.002	8029	0.022	6090	0.088	0.023	6079
	(0.016)			(0.018)		(0.018)			(0.020)	
Parental background										
Academic	−0.040*	2417	0.031	−0.038	2394	−0.031	1760	0.102	0.002	1755
	(0.024)			(0.027)		(0.025)			(0.035)	
Non-academic	0.022	5621	0.049	0.033	5618	0.061**	4330	0.080	0.060**	4324
	(0.022)			(0.023)		(0.025)			(0.029)	
Field of study										
Arts & humanities	−0.033	640	0.029	−0.039	543	−0.040	514	0.054	−0.036	514
	(0.056)			(0.058)		(0.056)			(0.061)	
Social sciences	0.003	2240	0.027	0.018	2233	0.031	1561	0.071	0.050	1550
	(0.028)			(0.031)		(0.037)			(0.042)	
Natural sciences	−0.004	1784	0.010	0.005	1765	0.048*	1417	0.045	0.022	1410
	(0.033)			(0.035)		(0.029)			(0.035)	
Engineering	−0.014	3374	0.033	0.001	3365	0.005	2598	0.096	−0.034	2583
	(0.028)			(0.030)		(0.031)			(0.035)	

Significance levels ***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors in parentheses. Table contains information on estimates of regression on log gross hourly wages and propensity score matching results after 1 and 5 years of graduation for male graduates. The first row of estimations presents the results for the full sample; the following rows present results for different subgroups depending on the parental background of graduates and their field of study. Academic parental background refers to graduates, whose one of the parents holds the university degree or higher; non-academic otherwise. Field of study refers to which field of study individuals graduated their first degree. Models include key independent variable, socio-demographic and study related control variables and control for graduating cohorts. Dependent variable is *log gross hourly wages* of a current or last job respondent has at the time of the survey. *Study abroad* is the binary dummy variable indicating if student spends part of his university career at a foreign university. *Socio-demographic controls* include *age (when starting studies)*, *age squared*, *parental education*, *children*, and *long-term relationships*. *Study related controls* include *field of study*, *final university grade*, *high school grade*, *length of study (number of semesters)*, *university of applied sciences*, *apprenticeship (before or during university studies)*, *gymnasium*, and *holding more than one degree*. *Cohort* is categorical dummy variable to control the graduate panel. *Diff.* refers to treatment effect estimates of wages for males studying abroad. All estimates obtained by propensity score matching considering all variables of the main analysis in the propensity score. Estimation conducted with Stata psmatch2 (Leuven & Sianesi, 2003, version 2012) using kernel matching and system-provided standard errors. Data source for analysis: DZHW graduate panels 1997, 2001, 2005, 2009

Table 8 Balance check for PSM for male graduates

	After 1 year of graduation (wave 1)				After 5 years of graduation (wave 2)			
	Number of significant variables		Pseudo R^2		Number of significant variables		Pseudo R^2	
	Before	After	Raw	Matched	Before	After	Raw	Matched
Overall	15/19	0/19	0.184	0.003	16/19	0/19	0.190	0.004
Academic	14/17	0/17	0.188	0.003	13/17	0/17	0.181	0.012
Non-academic	13/17	0/17	0.156	0.004	13/17	0/17	0.181	0.004
Field of study								
Arts & humanities	5/15	0/15	0.077	0.007	7/16	0/16	0.106	0.007
Social sciences	12/16	0/16	0.184	0.010	12/16	0/16	0.207	0.008
Natural sciences	14/16	0/16	0.195	0.005	12/16	0/16	0.176	0.005
Engineering	12/16	0/16	0.210	0.011	10/16	0/16	0.238	0.007

Table contains number of significant covariates and pseudo R^2 before and after propensity score matching is implemented (for Table 7)

Table 9 OLS results on log gross hourly wages for male graduates

Dependent variable: *log gross hourly wages*	After 1 year of graduation (wave 1)						
	Overall (1)	Academic (2)	Non-academic (3)	Arts & humanities (4)	Social sciences (5)	Natural sciences (6)	Engineering (7)
Study abroad	−0.005	−0.040*	0.022	−0.033	0.003	−0.004	−0.014
	(0.016)	(0.024)	(0.022)	(0.056)	(0.028)	(0.033)	(0.028)
Age (when starting studies)	0.010	0.004	0.005	−0.008	0.009	−0.020	0.001
	(0.011)	(0.026)	(0.012)	(0.083)	(0.016)	(0.032)	(0.021)
Age squared	−0.000	0.000	−0.000	0.000	−0.000	0.001	0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Parental education (ref: high school education)							
Craftsmanship/ university of applied sciences	−0.003			0.012	−0.015	−0.010	0.003
	(0.008)			(0.038)	(0.017)	(0.019)	(0.011)
University degree or higher	−0.024**			0.010	−0.025	−0.007	−0.043***
	(0.010)			(0.038)	(0.019)	(0.020)	(0.014)
Children	0.002	−0.001	0.004	0.066	−0.014	0.048*	−0.017
	(0.013)	(0.026)	(0.014)	(0.052)	(0.027)	(0.027)	(0.016)
Long-term relationship	0.035***	0.024	0.040***	0.040	0.048***	0.022	0.035***
	(0.008)	(0.015)	(0.009)	(0.034)	(0.015)	(0.017)	(0.010)
Field of study (ref: arts & humanities)							
Social sciences	0.200***	0.190***	0.200***				
	(0.017)	(0.030)	(0.021)				
Natural sciences	0.180***	0.170***	0.180***				
	(0.017)	(0.030)	(0.021)				
Engineering	0.230***	0.210***	0.240***				
	(0.016)	(0.029)	(0.020)				
University of applied sciences	−0.025***	−0.059***	−0.013	−0.064	−0.049***	0.078***	−0.044***
	(0.010)	(0.019)	(0.011)	(0.044)	(0.018)	(0.022)	(0.014)

Table 9 (continued)

Indicator for more than one degree	0.010	0.035	−0.009	−0.150**	0.061	−0.094	0.071**
	(0.024)	(0.038)	(0.031)	(0.073)	(0.040)	(0.058)	(0.033)
Final university grade	−0.032***	−0.024	−0.035***	−0.069**	−0.006	−0.005	−0.068***
	(0.007)	(0.015)	(0.008)	(0.032)	(0.015)	(0.017)	(0.010)
High school grade	−0.022***	−0.026**	−0.021***	−0.028	−0.042***	−0.029**	−0.009
	(0.007)	(0.012)	(0.008)	(0.025)	(0.014)	(0.014)	(0.009)
Length of study (# of semesters)	−0.001	−0.003	0.000	−0.006	−0.007*	0.005*	0.001
	(0.002)	(0.003)	(0.002)	(0.005)	(0.004)	(0.003)	(0.002)
Apprenticeship	−0.006	−0.021	−0.003	−0.120**	0.0059	−0.013	−0.001
	(0.011)	(0.027)	(0.013)	(0.062)	(0.023)	(0.029)	(0.015)
Gymnasium	0.012	0.004	0.016	−0.034	0.067***	0.006	−0.010
	(0.011)	(0.024)	(0.012)	(0.052)	(0.021)	(0.025)	(0.013)
Cohort (ref: 1997)							
2001	0.032***	−0.001	0.045***	−0.069	0.058***	0.061***	0.026**
	(0.010)	(0.020)	(0.011)	(0.043)	(0.022)	(0.022)	(0.012)
2005	−0.019**	−0.022	−0.019*	−0.130***	−0.013	0.030	−0.031**
	(0.009)	(0.019)	(0.011)	(0.040)	(0.020)	(0.022)	(0.012)
2009	0.012	0.025	0.003	−0.100**	0.010	0.056**	0.019
	(0.012)	(0.022)	(0.014)	(0.049)	(0.023)	(0.025)	(0.018)
Constant	2.58***	2.62***	2.62***	2.97***	2.82***	2.96***	2.96***
	(0.14)	(0.32)	(0.15)	(0.98)	(0.21)	(0.39)	(0.25)
Observations	8038	2417	5621	640	2240	1784	3374
Adjusted R-squared	0.042	0.031	0.049	0.029	0.027	0.010	0.033

Table 9 (continued)

Dependent variable: *log gross hourly wages*	After 5 years of graduation (wave 2)						
	Overall	Academic	Non-academic	Arts & humanities	Social sciences	Natural sciences	Engineering
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Study abroad	0.022	−0.031	0.061**	−0.040	0.031	0.048*	0.005
	(0.018)	(0.025)	(0.025)	(0.056)	(0.037)	(0.029)	(0.031)
Age (when starting studies)	0.014	0.014	0.006	0.120**	0.019	−0.092*	0.026
	(0.011)	(0.029)	(0.012)	(0.058)	(0.017)	(0.048)	(0.028)
Age squared	−0.000	0.000	−0.000	−0.002*	−0.000	0.002*	−0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Parental education (ref: high school education)							
Craftsmanship/ university of applied sciences	0.014			−0.019	0.040*	0.012	0.007
	(0.010)			(0.040)	(0.022)	(0.021)	(0.013)
University degree or higher	0.009			−0.000	0.027	−0.012	0.012
	(0.011)			(0.041)	(0.023)	(0.021)	(0.016)
Children	−0.014	−0.014	−0.013	0.019	−0.058***	0.035*	−0.018
	(0.009)	(0.017)	(0.011)	(0.036)	(0.020)	(0.020)	(0.012)
Long-term relationship	0.089***	0.100***	0.085***	0.082**	0.110***	0.066***	0.092***
	(0.011)	(0.022)	(0.013)	(0.039)	(0.024)	(0.022)	(0.015)
Field of study (ref: arts & humanities)							
Social sciences	0.210***	0.220***	0.210***				
	(0.019)	(0.033)	(0.023)				
Natural sciences	0.170***	0.150***	0.180***				
	(0.018)	(0.032)	(0.022)				
Engineering	0.210***	0.210***	0.210***				
	(0.018)	(0.032)	(0.021)				
University of applied sciences	−0.075***	−0.091***	−0.071***	−0.050	−0.120***	0.026	−0.088***
	(0.011)	(0.024)	(0.013)	(0.052)	(0.023)	(0.029)	(0.016)

Table 9 (continued)

Indicator for more than one degree	0.052**	0.120***	−0.001	−0.037	0.075	−0.006	0.110**
	(0.027)	(0.042)	(0.034)	(0.063)	(0.051)	(0.050)	(0.048)
Final university grade	−0.029***	−0.026	−0.030***	−0.071**	−0.002	−0.031	−0.051***
	(0.009)	(0.017)	(0.010)	(0.028)	(0.019)	(0.020)	(0.012)
High school grade	−0.019**	−0.035**	−0.015	−0.029	−0.037**	−0.025	−0.007
	(0.008)	(0.015)	(0.009)	(0.026)	(0.018)	(0.016)	(0.011)
Length of study (# of semesters)	−0.006***	−0.008**	−0.006***	−0.009*	−0.010**	−0.001	−0.006***
	(0.002)	(0.003)	(0.002)	(0.005)	(0.005)	(0.004)	(0.002)
Apprenticeship	−0.024	−0.036	−0.020	−0.17**	0.008	−0.011	−0.032*
	(0.014)	(0.034)	(0.016)	(0.067)	(0.031)	(0.034)	(0.018)
Gymnasium	0.026**	0.043	0.023	0.007	0.056**	0.028	0.007
	(0.013)	(0.031)	(0.014)	(0.065)	(0.027)	(0.030)	(0.016)
Cohort (ref: 1997)							
2001	−0.140***	−0.170***	−0.130***	−0.150***	−0.092***	−0.150***	−0.150***
	(0.011)	(0.021)	(0.012)	(0.039)	(0.026)	(0.021)	(0.014)
2005	−0.097***	−0.110***	−0.092***	−0.077*	−0.088***	−0.074***	−0.120***
	(0.011)	(0.020)	(0.012)	(0.040)	(0.023)	(0.024)	(0.014)
2009	−0.078***	−0.120***	−0.060***	−0.017	−0.099***	−0.083***	−0.047*
	(0.016)	(0.028)	(0.019)	(0.059)	(0.032)	(0.028)	(0.025)
Constant	2.97***	2.91***	3.07***	1.79**	3.10***	4.34***	3.09***
	(0.14)	(0.36)	(0.16)	(0.71)	(0.24)	(0.55)	(0.33)
Observations	6090	1760	4330	514	1561	1417	2598
Adjusted R-squared	0.088	0.102	0.080	0.054	0.071	0.045	0.096

Significance levels ***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors in parentheses. Table contains information on estimates of regression on log gross hourly wages after 1 and 5 years of graduation for male graduates. Overall columns (1) and (8) present the results for the full sample of male graduates; the following columns present results for different subgroups depending on the parental background of graduates and their field of study. Academic parental background refers to graduates, whose one of the parents holds the university degree or higher; non-academic otherwise. Field of study refers to which field of study individuals graduated their first degree. Dependent variable is *log gross hourly wages* of a current or last job respondent has at the time of the survey. *Study abroad* is the binary dummy variable indicating if student spends part of his university career at a foreign university. *Cohort* is categorical dummy variable to control the graduate panel. Data source for analysis: DZHW graduate panels 1997, 2001, 2005, 2009

Table 10 Comparison of wage effects for different definitions of studying abroad

Dependent variable: *log gross hourly wages*	Wave 1		Wave 2	
	Our definition	Netz & Grüttner (2021)	Our definition	Netz & Grüttner (2021)
	(1)	(2)	(3)	(4)
Study abroad	0.041**	0.060***	0.010	0.019
	(0.020)	(0.014)	(0.025)	(0.017)
Cohort 2009 (ref: cohort 2005)	0.066***	0.057***	−0.049***	−0.051***
	(0.012)	(0.012)	(0.017)	(0.017)
Constant	2.280***	2.280***	2.670***	2.660***
	(0.160)	(0.160)	(0.250)	(0.240)
Socio-demographic controls	Incl.	Incl.	Incl.	Incl.
Study related controls	Incl.	Incl.	Incl.	Incl.
Observations	4312	4312	2642	2642
Adjusted *R*-squared	0.040	0.043	0.039	0.039

Significance levels ***$p<0.01$, **$p<0.05$, *$p<0.1$. Robust standard errors in parentheses. Table contains information on estimates of regression on log gross hourly wages after 1 and 5 years of graduation (wave 1 and 2, respectively). Dependent variable is log gross hourly wages of a current or last job respondent has at the time of the survey. *Study abroad* (our definition) is the binary dummy variable indicating if student spends part of her university career at a foreign university. *Study abroad* (as defined in Netz & Grüttner (2021) is the binary dummy variable indicating if student spends time abroad during university studies, including study, internship, and language stays abroad, based on self-reported information. *Socio-demographic controls* include *age (when starting studies)*, *age squared*, *parental education*, *children*, and *long-term relationships*. *Study related controls* include *field of study*, *final university grade*, *high school grade*, *length of study (number of semesters)*, *university of applied sciences*, *apprenticeship (before or during university studies)*, *gymnasium*, and *holding more than one degree*. *Cohort* is categorical dummy variable to control the graduating cohort of panels. Data source for analysis: DZHW graduate panels 2005, 2009

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Data availability The data used in this paper are proprietary but can be requested for scientific purposes from the German Centre for Higher Education Research and Science Studies (*Deutsches Zentrum für Hochschul und Wissenschaftsforschung*; *DZHW*) Hannover. Access is possible via the Research Data Center of DZHW.

Code availability All codes used for data preparation and estimation are available on request from the authors.

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