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The effect of schooling vouchers on higher education enrollment and completion of teachers: A regression discontinuity analysis

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Abstract

This paper investigates the effects of schooling vouchers for teachers. We study effects on enrollment and completion of higher education programs, and on the retention of teachers in the education sector. We do this by exploiting a fuzzy regression discontinuity design. The discontinuity in the probability of being assigned a voucher arises due to budget constraints in the first application period. Our estimates suggest that effects of voucher assignment on both higher education enrollment and completion rates are in the order of 10 to 20 percentage points as measured five and a half years after application. Relative to a baseline enrollment rate of 77 percent and a baseline completion rate of 54 percent (i.e. of applicants that were not assigned a voucher), these effect estimates correspond to a 12 to 29 percent higher enrollment and to a 17 to 42 percent higher completion. Effects on enrollment and completion are relatively small for shorter studies (up to one year) and for teachers that had already started at the time of application. The teacher voucher crowds out both funding by schools out of their regular professional development budgets as well as financial contributions by teachers themselves. Our results suggest small positive effects of voucher assignment on retention in education as measured four years after application.

JEL Codes: C26, I22, H43, J24, M53

Keywords: regression discontinuity, impact evaluation, instrumental variables estimation, adult education vouchers, teachers.

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1. Introduction

This paper reports about the effects of a public teacher voucher program in which teachers are eligible to receive a voucher to enroll in a bachelor or master degree program. The program was set up by the Dutch government in 2008 to promote participation of teachers in professional development activities that lead to a higher education level or to acquire more skills and knowledge at the same education level. The teacher voucher scheme is targeted at teachers from primary to higher vocational education. The teacher voucher not only consists of compensation for teachers for admission fees and costs of travel and study material, but also of compensation for their employer to arrange a substitute teacher while they are on study leave. The combined value of these two voucher elements may amount to a maximum of 30 thousand euro per voucher application. Nearly 400 million euro has been granted to about 40 thousand teachers and schools over the first five years after the introduction of the voucher scheme (2008-2013).

Raising teacher quality is one of the main concerns of the Dutch government, as it is in many countries. A large literature shows that teacher quality is an important driver of pupil performance. Children assigned to a teacher with a one standard deviation higher quality gain in terms of achievement in the order of 0.10 to 0.25 standard deviations (see e.g. Rockoff, 2004; Rivkin et al., 2005; Aaronson et al., 2007; Kane & Staiger, 2008; Hanushek & Rivkin, 2010). Moreover, higher teacher quality also seems to positively affect later labour market outcomes of pupils (Chetty et al., 2014). Teacher professional development activities in general and raising the share of teachers with a Master Degree in particular could potentially be one of the channels through which teacher quality and thereby pupil performance can be raised. The literature on the effects of teachers having a Master degree as compared to a bachelor degree on pupil performance shows a mixed picture, however, with some studies finding positive effects, while other studies do not find any effects or even negative effects (see review in Harris & Sas, 2011).¹ There is also a literature on the effects of (providing

¹ This is a predominantly US literature. It is uncertain whether the same results apply in other education systems and with a possibly other variation in value added of master versus bachelor teacher studies.

more money for) professional development activities for teachers on pupil performance, showing mixed evidence (e.g. Angrist & Lavy, 2001; Jacob & Lefgren, 2004; Garet et al., 2008 & 2010; Harris & Sas, 2011). The heterogeneity of the type of professional development activities and specific interventions (e.g. providing schools with money for training of teachers or directly offering specific training programs) as well as that of target groups (e.g. math versus language teachers; teachers at average versus at bad performing schools) prevents us to draw general conclusions from this literature.

In this paper we investigate the effects of teacher education vouchers on enrollment in and completion of higher education degree programs, as well as on retention of teachers in the profession. We investigate these effects by exploiting a discontinuity in the probability of (ever) having been assigned a voucher that was caused by budget restrictions in the first year of the voucher scheme. A large number of teachers applied for a voucher in a relatively brief period of one-and-a-half month. This led to a situation in which the teachers vouchers have been assigned on a first-come-first-served basis and in which an unexpected cut-off date was in place after which suddenly no applications for vouchers could be granted anymore. Several validity checks on the regression discontinuity design are carried out in this paper.

Estimating effects on enrollment and completion is relevant because in order to trigger an effect on teacher productivity one should at least find effects of voucher assignment on enrollment and, even more important, on completion. Large effects of vouchers for adult workers on training or schooling participation are not obvious. Two earlier studies of training vouchers for adult workers found that considerable deadweight loss was involved with these vouchers (Schwerdt et al, 2012; Hidalgo et al., 2015). Deadweight loss arises when training vouchers are being used to finance participation of employees in training that would have been undertaken anyway, that is, in the absence of these vouchers.² Both studies are based on randomized experiments. The study by Schwerdt et al. (2012) studies the effects of a Swiss training voucher experiment for adults of all education levels. Hidalgo et al. (2015) investigate effects of a Dutch training voucher experiment for predominantly low-skilled

² Deadweight loss is a serious risk in any public intervention aimed at promoting training participation among adult workers, not particularly only in case of training vouchers for employees. For instance, Abramovsky (2011) finds no evidence of effects on qualification-based training of employer-based incentives for low-qualified employees under the Employer Training Pilots undertaken in the UK between 2002 and 2006. Leuven and Oosterbeek (2004) find disappointing effects on training participation of age-related tax deduction for employers for their employees training expenses. They find that these age-related incentives just postpone training participation among workers rather than increasing it.

adult workers. Appendix Table A1 gives a comparison of the three voucher schemes and of the main findings of effects on training / higher education participation. Schwerdt et al. (2012) find a deadweight loss of 30 percent, whereas Hidalgo et al. (2015) find a deadweight loss of sixty percent.

Our paper contributes to the small literature on effects of training vouchers for workers in the following way. First, we study the impact of training vouchers for a specific population that consists entirely of highly educated workers, rather than the general population of workers (Schwerdt et al., 2012) or predominantly low educated workers (Hidalgo et al., 2015). Teachers are in particular an interesting target group since they are crucial for human capital production in a country. Second, we study the effect of much larger vouchers in terms of face values as compared to earlier voucher studies. Another distinctive feature of the teacher voucher scheme is the compensation offered to employers for arranging replacement during study leave of their employees. Third, we investigate effects on the probability of completion of higher education programs as well. These effects are relevant to investigate since longer-term degree programs are involved rather than relatively short study courses or training programs. Effects on completion rates may therefore differ from effects on enrollment rates if there are differences in study dropout and delay among voucher receivers and non-receivers. A fourth contribution of this paper is that we also investigate effects of vouchers on retention in the profession. Retention seems particularly important in the case of teachers since recent evidence shows that more experienced teachers produce larger achievement gains among their pupils (e.g. Harris & Sas, 2011; Wiswall, 2013; Gerritsen et al., 2014).

Our main findings are as follows. First, estimates of the effects of voucher assignment on both higher education degree program enrollment and completion rates are in the order of 10-20 percentage points, from a base of 77 percent (enrollment) and 54 percent (completion) for teachers who applied for but never received a teacher voucher. These effect estimates point at a substantial degree of crowding out of other means of funding, a phenomenon that is also found in earlier studies on training vouchers for employees. Deadweight loss of the teacher voucher scheme is estimated at about 80 to 90 percent. Second, our results suggest small positive effects of voucher assignment on retention in education, as measured four years after voucher application. This would be a positive side-effect, since recent studies have found that teacher productivity increases with experience. Third, we have indications of heterogeneous effects of voucher assignment across subgroups by applicant and application characteristics.

Effects on both enrollment and completion are larger for teachers who had not started their study yet at the time of application. The abolishment of the possibility to apply for a voucher for a study that was already started is expected to have raised effects of voucher assignment on both enrollment and completion by about five percentage points. Effects on enrollment and completion appear much smaller for studies with duration of a year or less, as compared to longer studies. Effects on retention in the teaching profession appear to be concentrated among teachers working in secondary education and teachers above 35 years old.

This paper proceeds as follows. Section 2 describes the teacher education voucher scheme. Section 3 presents the data. Section 4 presents the empirical strategy and section 5 the main estimation results. Section 6 discusses heterogeneous treatment effects. Section 7 sheds light on the complier population for which effects can be estimated. Section 8 discusses substitution patterns in sources of financing of the higher education programs. Section 9 concludes and discusses the implication of our findings.

2. The teacher voucher scheme

The Dutch teacher voucher scheme (Dutch name “Lerarenbeurs”) was introduced in 2008. It aims to stimulate participation in lifelong learning among teachers in primary and secondary education, intermediate and higher vocational education, and special education. Teachers can use the teacher voucher to enroll in a bachelor or master program. Typically four types of programs are involved. The first type is programs targeted at mastery of specific pedagogical and didactical skills. Master Special Educational Needs is an example of this type.

Applications for this particular master account for about 30 percent of all applications in the period 2008-2013, with even larger shares among applications of teachers in primary education (42 percent) and in special education (56 percent). The second type is subject-specific programs. These programs are aimed at either acquiring a certification at the same level in another subject or at acquiring certification in the same subject at a higher level (i.e. at master level instead of at bachelor level). This type of programs is most often applied for by teachers in secondary education. The third type is programs targeted at management skills. The fourth type consists of more generic masters such as pedagogy, theory of education and “learning and innovating”.

The teacher voucher consists of two subsidies, one for teachers and one for schools. The teacher receives subsidy for tuition costs up to 3500 euro per year and for study materials and travel costs up to 700 euro per year.³ The school may receive subsidy for giving the teacher study leave and to arrange a substitute teacher while the teacher is on study leave. This subsidy for study leave is maximized at 160 hours per year per teacher (i.e. half a day per week) for a full-time teacher. This amounts to a maximum of 5200 euro per year for schools in primary education to 6700 euro for schools in higher vocational education.

The most important conditions of the teacher voucher scheme are the following:

- The applicant is a certified teacher.
- The applicant is employed at a school or working at a school on a contract with another agency (i.e. not self-employed).
- The applicant is teaching for at least twenty percent of his or her contract.
- The applicant can only apply once in his or her career for a teacher schooling voucher.

³ From 2011 onwards, the maximum subsidy for tuition costs has been raised from 3500 to 7000 euro, and for costs of travel and study material from 350 to 700 euro.

- After completion the applicant should continue working in education for at least a year.⁴
- The study program should be completed at most three years after the end of the subsidy period. If not, the subsidy should be paid back according to the share of credits that were not obtained.⁵

Between 2008 and 2013 almost 40 thousand teachers have been assigned a teacher voucher in seven different application periods. About seventy percent of these vouchers were related to applications for bachelor or master degree programs.⁶

In the first application period in the spring of 2008 a little less than 7500 teachers applied for a voucher. Due to a predetermined maximum budget only around two-thirds of these applications could be awarded a teacher schooling voucher. Vouchers have been awarded on a first-come-first-served basis. It is this budget constraint in the first application period that creates a discontinuity in voucher assignment by day of application that we will exploit to determine effects of voucher assignment on enrollment and completion of degree programs.

In later years the yearly budget for new applications for the teacher voucher scheme has been increased further. In total 394 million euro of subsidy is involved with the assigned vouchers between 2008 and 2013, of which 174 million euro is targeted to teachers to compensate them for the tuition fees, travel costs and costs of study material. This implies that the majority of the total teacher voucher subsidy, that is 220 million euro or 56 percent, is directed towards schools to compensate them for the costs of arranging replacement while their teachers are on study leave.

Appendix B provides more facts and figures about the teacher voucher scheme and about professional development of teachers in the Netherlands, as well as about the policy context in which the teacher voucher was introduced.

⁴ This condition has been abolished as from 2013 onwards.

⁵ This condition has been abolished as from 2013 onwards. Instead, a yearly minimum of 15 ECTS credits should be obtained.

⁶ As from 2012 onwards, teachers could only apply for registered bachelor or master degree programs. Applications for short courses or other programs not leading to a bachelor or master degree were not allowed anymore. The analyses in this paper are solely focused on applications for bachelor or master programs.

3. Data

3.1 Data sources

We use administrative data from three different databases. The first database is called *ABL* and provides data from the administration of the voucher scheme. This database contains information on applications and assignments of vouchers in the first application period and reapplications and assignments in subsequent application years. Applicant characteristics taken from this database are gender, birth date, sector of work and the appointment in FTE. The application characteristics we use are program duration, a dummy indicating whether or not the applicant already started the higher education course at the time of application, and the day of application in the first application period in 2008.

The second source is a national database containing data on higher education enrollment and completion, which is called *BRON HO*. From this database we derive information on whether the applicants actually enrolled in higher education courses after their application and whether they succeeded to complete these courses. We use information regarding the period 2008-2013. Data have been merged to the voucher scheme administration data from *ABL* by a unique personal identifier.

The third source is a national database of teachers. This database contains information on salary and the region of the teacher. We have merged these data with the data from the other two sources by using a unique personal identifier as well.

The data from the three different sources have been supplied by *Dienst Uitvoering Onderwijs (DUO)* that operates the teacher voucher scheme.

3.2 Sample

First we have selected all applicants of the first application round. Within this group we make two sub-selections, one on sector of work and one on study type. First, we select applicants working in primary, secondary and special education. These are the sectors for which the budget constraint was binding, that is, sectors where more applications were received than vouchers were available. This implies that we do not consider applications from teachers working in intermediate or higher vocational education, since there is no discontinuity in voucher assignment as in the other sectors. In total 12 percent of all applications in the first round are left out of the estimation sample for this reason.

The second selection is that we only select applications for registered higher education studies. This implies we do not consider applications for (predominantly) brief courses.⁷ The reason is that we cannot track enrollment and completion in these courses for all applicants, particularly for the ones that did not receive a voucher. Applications for these brief courses account for about one-third of all applications for these sectors in the first application period. The budget share is lower at an estimate of around 20 percent according to information on assigned amounts of money per applicant. This is due to differences in study length and due to the condition that the voucher subsidy to schools for arranging replacement for teachers on study leave can only be made for higher education courses.

These selections result in an estimation sample of 4,220 teachers out of 7,485 applicants in the first application round. These teachers applied in a relatively brief period of 47 days in the spring of 2008.

3.3 *Summary statistics*

Table 1 shows descriptive statistics for the total estimation sample of 4,220 teachers, for the subgroups of applicants on either side of the cut-off date (before: N=3,037, after: N=1,183), and for the voucher recipients (N=3,392) versus the ones that never received a voucher (N=828). Panel A shows descriptive statistics of the applicants and applications. Applicant characteristics are compared to the total relevant teacher population as well (see population averages between brackets).⁸ This comparison shows that voucher applicants are younger than the average teacher population (about five years), and are somewhat more likely to be female (3 percentage points). Applicants are somewhat more likely to work in schools outside the urbanized Randstad region (3 percentage points), whereas their salary is lower than average (almost 10 percent less) in line with their lower than average age. Their appointment is somewhat larger than average (0.06 FTE). The probability of applying for a teacher voucher for a higher education study is below average for teachers in primary education and above average for teachers in secondary and special education.⁹

⁷ It should be noted that, as from 2012 onwards, teacher vouchers could only be assigned for registered higher education studies (i.e. bachelors, masters or premasters), not for brief courses anymore. That is, the type of applications we consider in this paper is the exact same type as the type that is targeted in the current teacher voucher scheme.

⁸ Population averages are calculated from a national teacher database provided to us by *Dienst Uitvoering Onderwijs (DUO)*.

⁹ A relatively large share of applications from teachers in primary education was made up by applications for (brief) courses not being a bachelor or master course. This possibility ended in 2011.

Panel B reports group means for the treatment variable, i.e. being assigned a voucher. Ninety percent of all applicants before the cut-off date were assigned a voucher in the first application period versus zero percent of the applicants after the cut-off date. Due to reapplications and assignment of vouchers in later application periods the difference in the probability of eventual assignment of a voucher has become smaller over time: 94 versus 46 percent. The difference is still sizeable and statistically significant. This results in the discontinuity in voucher assignment around the cut-off date in the first application round that we exploit in this paper, as also illustrated in Figure 1.

Panel C reports group means for our two main outcome variables: ever been enrolled in higher education within the period 2008-2013 and completed a higher education program somewhere in 2008-2013. Completing a higher education program is defined as obtaining either a Bachelor or a Master degree. Both enrollment (93 versus 87 percent) and completion (72 versus 61 percent) rates are higher for the group that applied before the cut-off date than for the group that applied after the cut-off date. The differences are much smaller however than the differences in voucher assignment. On average three quarters of the group that was ever enrolled in higher education during 2008-2013 has succeeded in completing a higher education program within this period. This share is higher in the group before the cut-off date than in the group that applied after the cut-off date (77 versus 70 percent). The next section presents the effect estimates of voucher assignment on higher education enrollment and completion.

Appendix Table D1 shows the same descriptive statistics by sector of work. Most notable differences in terms of applicant characteristics are the relative large share of female teachers among applicants in secondary education (58 percent versus 47 percent in the population of secondary school teachers) and the relatively larger appointments in terms of FTE in primary and special education. The proportion of teachers who already started the higher education program at the time of voucher application is markedly larger in secondary education (26 percent) than in special education (16 percent) and program duration in secondary education is also markedly longer than in the other two sectors (0.7 years longer). Whereas higher education enrollment shares are the same in all three sectors, completion shares are markedly larger in primary education than in secondary education (75 versus 62 percent).¹⁰

¹⁰ This may have to do with longer average program duration in secondary education (0.7 years longer). Teachers in secondary education more frequently report serious bottlenecks in terms of study intensity (40

4. Empirical strategy and validity checks

4.1 Empirical strategy

The main goal of this paper is to identify the causal effect of being assigned a teacher schooling voucher on higher education enrollment and completion as well as on retention in the teaching profession. To do so, we have to take into account that there are differences between teachers who did and who did not receive a teacher schooling voucher and that these differences will have separate effects on the outcomes of interest. To identify causal effects, we employ a fuzzy regression discontinuity design (Campbell, 1969; Troachim, 1984; Hahn et al., 2001). We exploit the limited budget for teacher schooling vouchers in the first application round leading to a greater number of applications than could be granted. Vouchers have been assigned on a first-come-first-served basis. This situation results in a clear discontinuity in the probability of immediately being assigned a voucher around a cut-off date as can be seen in the left panel of Figure 1.

We would have faced a sharp RD design if all teachers who applied before the cut-off date would have been assigned a voucher and all applicants after the cut-off date would not have been assigned a voucher. There are two reasons however why the discontinuity is not sharp, but fuzzy. The first reason is that a limited share (i.e. less than 10 percent) of the applications before the cut-off date did not meet the conditions of the teacher voucher scheme and was therefore not assigned a voucher. The second reason is that teachers who applied after the cut-off date could reapply for a voucher in later years. While 94 percent of applicants that applied before the cut-off date in the first application rate are assigned a voucher, 46 percent of those that applied after the cut-off date are also awarded a voucher at some point. This results in a drop at the cut-off date in the probability of ever receiving a voucher of approximately 40 percentage points, as can be seen in the right panel of Figure 1.

Treatment effects in case of a fuzzy RD can be estimated by two-stage-least-squares, as in an instrumental variables approach (Hahn et al, 2001). This is what we do in this paper. The following first stage equation is estimated:

$$(1) \quad V_i = \beta_0 + \beta_1 D_i + f(T_i) + \beta_2 X_i + \eta_i$$

percent), the combination of the study with the private situation (30 percent) and the time that is made available by the school for doing the study (21 percent), see Vink et al. (2012).

where V is a dummy indicating voucher assignment in any of the years 2008-2013, D is a dummy variable indicating whether the application was received before or after the cut-off date c in the first application round (with $D = 1$ if $T \geq c$ and $D = 0$ if $T < c$), $f(T)$ is a smooth function of the day of application which is allowed to be different at either side of the cut-off, X is a vector of predetermined applicant and application characteristics and η is an error term. β_1 is the effect of application after the cut-off date on the probability of ever having been assigned a voucher over the period 2008-2013.

The second stage equation then uses the predicted values of voucher assignment from the first stage equation to produce the parameter of interest α_1 , which is the effect of voucher assignment on the outcomes of interest Y , which is either enrollment, completion or retention in the teaching profession.

$$(2) \quad Y_i = \alpha_0 + \alpha_1 \hat{V}_i + f(T_i) + \alpha_2 X_i + \varepsilon_i$$

Again, $f(T)$ is a smooth function of the day of application which is allowed to be different at either side of the cut-off, X is a vector of predetermined applicant and application characteristics and ε is an error term.

The effect estimates we present in this paper are treatment effects on the so-called compliers or local average treatment effects (LATE). A complier is defined in our case by the subset of teachers who are assigned a voucher if they apply before the cut-off date, but are not assigned a voucher if they apply after the cut-off date.¹¹ We will present an analysis that characterizes the complier population to some extent, that is, showing subgroups according to predetermined applicant and application characteristics that are either more or less likely to be compliers. This characterization of the complier population gives some idea about the external validity of our estimation results.

4.2 *Assumptions and validity checks*

For applying an instrumental variables estimation approach in a regression discontinuity setting a couple of conditions should hold.

¹¹ This is to distinguish from never-takers and always-takers. These are teachers who would never (always) be assigned a teacher voucher, regardless of applying before or after the cut-off date.

A first condition is that there should be no weak instruments problem. This implies in our case that applying after the cut-off should have an effect on the probability of ever being assigned a voucher that is strong enough. First stage estimates of the effect of application after the cut-off date on voucher assignment are presented for various bandwidth samples in Table 2. These estimates indicate that the after cut-off date dummy is a strong instrument for voucher assignment, causing an exogenous drop in voucher assignment of about 40 percentage points. The F-statistics are well above the minimum threshold of 10 suggested by Staiger & Stock (1997) which implies that we do not have a weak instrument problem. Figure 1 shows this graphically.

A second condition is that the exclusion restriction assumption should hold. This assumption implies that crossing the cut-off date cannot impact the outcomes of interest except through its effect on voucher receipt. This assumption is not testable. It is not directly clear however why applying (just) after the cut-off date would have a direct effect on the outcomes of interest, other than through its effect on voucher receipt.

A third condition is that the distribution of the baseline covariates should not change discontinuously at the threshold. We check this by both conducting a graphical analysis as well a formal estimation, as suggested by Lee and Lemieux (2010). Figures 3 and 4 show the distribution of the baseline applicant and application characteristics over the full application period. It can be seen that there are no indications of discontinuities around the cut-off date. The formal test produces RD estimates for the covariates. These estimates are shown in Table 3 for four different estimation samples ranging from seven days around the cut-off date to the full sample of all applicants. The vast majority of the RD estimates are statistically insignificant for the baseline covariates. The most notable estimate is that on program duration in the full sample that is 0.13 years lower of applicants after the cut-off date. This is related to somewhat longer program duration of the very early applicants, which can also be seen in Figure 4. The other discontinuity samples show no statistically significant differences in program duration before and after the cut-off date.

By carrying out effect analyses on smaller bandwidth samples around the cut-off date we attempt to mirror a situation in which we locally have a randomized experiment. This should make it less likely that any unobserved characteristics are unbalanced between applicants on different sides of the cut-off date.

Another condition for generating a causal effect estimate in regression discontinuity designs is that each individual has imprecise control over the assignment variable, i.e. the cut-off date in our case. We check the plausibility of this assumption by plotting the number of applicants per day against the day of application (as suggested by Lee & Lemieux, 2010; Schochet et al., 2010). If individuals would have had knowledge about the cut-off date, we would expect to see a spike in the number of applications just before the cut-off date. We do not observe such a pattern however. Instead, the number of applications received per day seems to have a rather stable weekly pattern with clear spikes on every Tuesday, probably because teachers have more often finalized their applications in the weekend. A simple test proposed by McCrary (2008) to test whether there is a discontinuity in the density around the cut-off also indicates imperfect control of individuals over applying before or after the cut-off date. Table 4 shows the outcomes of a regression of the number of applications on the day of the week the application was received and a dummy variable indicating whether the application was done before or after the cut-off date. This test shows that the number of applications received per day is not significantly lower or higher after the cut-off date, the difference being 3.6 applications per day higher after the cut-off on an average of 130 applications per day.

5. Main Results

In this paper, we use parametric specifications to carry out the instrumental variables analyses. The preferred shape of the smooth function of the day of application turns out to depend somewhat on the size of the bandwidth. The preferred specification is determined by using the Akaike Information Criterion, as suggested by Lee and Lemieux (2010). We report results for a variety of bandwidths, ranging from seven days around the cut-off date to the full sample of all applicants. Outcomes are measured over the period 2008-2013 for enrollment and completion, and for 2012 for retention. The results should be interpreted as estimates of medium-term effects, given that we consider applicants of the first application period in 2008.

5.1 Effects on higher education enrollment

Figure 5 shows the relationship between the day of application and the actual share of higher education enrollment. The figure also shows fitted lines on either side of the cut-off using a quadratic fit. We observe a small drop in higher education enrollment after the cut-off date.

This drop is likely to result from the difference in voucher assignment at the cut-off (see also Figure 1). If receiving a voucher had a large impact on higher education enrollment we would have expected higher education enrollment to fall rapidly after the cut-off date.

Table 5 shows the results from simple OLS estimates of the effect of voucher receipt on higher education enrollment. Effects are shown for four different bandwidths: 7, 14 and 21 days around the cut-off, and the full sample of all applicants. The OLS estimates with all controls (see row 3) suggest that voucher assignment increases higher education enrollment by about 16-21 percentage points. However, selection of voucher assignment on observables raises concerns that selection on unobservable characteristics may still bias the estimates. We estimate the IV model discussed in Section 3 to address this concern.

Table 6 shows the results from the IV estimation results for a range of bandwidths and smooth functions of the day of application. Throughout the paper, we show results of different smooth functions of the day of application up to a quadratic polynomial. This follows Gelman and Imbens (2014), who argue that estimates based on higher order polynomials can be misleading. The effect estimates from the preferred specification based on the Akaike Information Criterion are presented in bold. This is a quadratic specification at bandwidths of at least 21 days around the cut-off and a zero order specification at smaller bandwidths. Effect estimates from the preferred specification vary between 9 and 22 percentage points higher enrollment in higher education due to voucher assignment. The estimates of the preferred specification are all statistically significant at the 1 percent significance level. Our preferred IV estimates are roughly in the same range as our OLS estimates. This suggests little bias in OLS effect estimates.

Remarkably, these estimates of the voucher effect on higher education enrollment are pretty much in line with self-reports of teachers in a questionnaire that was carried out among voucher applicants in 2011. Thirteen percent of teachers who received a voucher in the first application period report they would not have started the study program if they would not have received a teacher voucher (N=787 respondents).

Deadweight loss

On the basis of these estimation results we calculate a bandwidth for the deadweight loss of the voucher scheme. We do this in a similar way as done by Hidalgo et al. (2015). Instead of using descriptive statistics on enrollment and voucher utilization we use estimation results of

a reduced form estimation of the effect of applying after the cut-off on enrollment. Furthermore we use estimation results of the first stage regression of the effect of applying after the cut-off date on the probability of being assigned a voucher. We calculate lower and upper bounds for deadweight loss by using the highest and lowest preferred effect estimate of the effect of applying after the cut-off on higher education enrollment. The calculations are summarized in Table 7. The calculations suggest that the average deadweight loss of the teacher voucher scheme is between 78 and 91 percent. This is larger than the deadweight loss of the Swiss voucher scheme (30 percent, Schwerdt et al., 2012) and of the Dutch training voucher scheme (60 percent, Hidalgo et al., 2015). This difference in deadweight loss could be due to several factors. First, differences in the way the vouchers have been assigned may play a role. The Schwerdt et al. (2012) and Hidalgo et al. (2015) studies involve voucher experiments in which vouchers have been randomly assigned to workers irrespective of their desire to follow training. We observe rather low utilization rates in both studies. Our study involves vouchers for which teachers could apply, and therefore involves workers that are already interested in schooling. It would be interesting to see if deadweight loss of teacher vouchers would decrease if these teacher vouchers would be (randomly) assigned to teachers irrespective of their desire to train, instead of via an application procedure. A second explanation for the higher deadweight loss found for the teacher vouchers could be that schools already had regular yearly budgets for training and schooling of their teaching personnel that exceed training budgets in the two voucher experiments. The yearly budgets of schools amount to over 1 percent of the total wage costs. Moreover, participation in schooling was already subject to tax deduction in the Netherlands for all employees including teachers. A third explanation could be that our voucher scheme is targeted at high educated consistently found that high educated workers more often participate in professional development activities than lower educated workers. This may lower the potential for policy initiatives to increase participation in professional development activities among higher educated workers.

The right hand side of Table 7 indicates that the deadweight loss seems somewhat smaller for vouchers that have been assigned to teachers who had not started at the time of application, that is, between 74 and 87 percent. This corresponds to larger than average positive enrollment effects for this subgroup of non-starters, which will be shown in section 6 where we discuss heterogeneous effects. This is a relevant finding since the possibility of

applying for a study that has been started at the time of application has been abolished in 2011.

5.2 *Effects on higher education completion*

Figure 6 shows actual higher education completion rates by day of application and fitted lines on either side of the cut-off again using a quadratic fit. In accordance with the figure on enrollment shares we observe a small drop in completion shares among applicants after the cut-off date.

Table 8 shows the results from simple OLS estimates of the effect of voucher receipt on higher education completion. The OLS estimates with the full set of controls suggest that voucher assignment raises the probability of completing a higher education study by a little over 20 percentage points. OLS point estimates on higher education completion are a couple percentage points larger than those on higher education enrollment.

Table 9 shows the IV estimates that attempt to address the issue of selection on unobservables. Preferred impact estimates vary between 9 and 23 percentage points higher completion rates due to voucher assignment. These estimates are in the same order of magnitude as the estimates on higher education enrollment. In relative terms effect estimates on completion are larger though, since baseline completion (54 percent) is lower than baseline enrollment (77 percent). The effect estimates point to a 17 to 42 percent increase in completion due to voucher assignment. The precision of the IV completion effect estimates is somewhat lower than of the IV enrollment effect estimates. Our IV estimates on completion are pretty much in line with our OLS estimates on completion for the same bandwidths.

5.3 *Effects on retention in education*

Figure 7 shows shares of applicants still working in education four years after (first) application by day of application in the first application period and fitted lines on either side of the cut-off again using a quadratic fit. This figure suggests a small drop in stay rates after the cut-off date.

Table 10 shows results from simple OLS estimates of the effect of voucher assignment on the probability of still working in education. The OLS estimates with the full set of controls suggest a small positive effect on the probability of staying in education of around 3-5 percentage points.

Table 11 shows the IV estimates. Preferred estimates on the basis of the Akaike Information Criterion for model specification range from minus 9 to plus 11 percentage points impact on the probability of still working in education. The negative estimate for the 7 days bandwidth sample with a second order polynomial control for the day of application may well imply an over-specified model for this small bandwidth. The other three preferred estimates range between plus 4 and plus 11 percentage points. These estimates generally lack precision however.

All in all, our analyses suggest a small positive effect of voucher assignment on the probability of still working in education four years after first applying for a voucher. A (small) positive effect may partially occur because of the voucher scheme requirement to keep working in education at least one year after completing the course. A voucher recipient has to pay back the subsidy if he leaves the profession within one year after completion.

6. Heterogeneous treatment effects

Table 12 shows the effect estimates for various sub-samples by applicant (Panel A) and application characteristics (Panel B).¹² We only focus on the OLS results here due to the reduction in precision in IV estimates when we carry out analyses on subgroups. This approach is in line with Jacob & Lefgren (2011) and Schwerdt et al. (2012), among others.¹³

Panel A shows little differences in effect estimates of voucher assignment on higher education enrollment and completion by sex and sector of work. Effects on completion probabilities (but not on enrollment) seem to increase somewhat by the size of a teacher's appointment in FTE, with point estimates being almost 10 percentage points higher for teachers with an appointment of more than 0.8 FTE as compared to teachers working less than 0.5 FTE. Effects of voucher assignment on both enrollment and assignment seem somewhat smaller for younger teachers (i.e. 15-34 years) than for older teachers (35-64 years), with point estimates being 5-8 percentage points higher for the older group.

¹² Descriptive statistics of treatment and outcome variables for the various subgroups are presented in Appendix Tables D2 and D3.

¹³ Under the assumption that any remaining omitted variable bias in the OLS models does not differ across the sub-populations, the more precise OLS models are informative about the relative size of the effects (Schwerdt et al., 2012).

It should be noted that completion probabilities gradually decline with age. Teachers in the category 55-64 have a completion probability that is 30 percentage points lower than that of teachers aged 15-24, keeping voucher status and all other applicant and application characteristics constant. Completion probabilities also differ by sex (5 percentage points higher for female teachers), assignment size (about 5 percentage points lower for teachers working more than 0.8 FTE as compared to less than 0.8 FTE) and sector of work (about 8 percentage points lower in secondary education as compared to primary education), again keeping voucher status and all other characteristics constant.¹⁴

In terms of application characteristics we find some interesting differences in effect estimates as well (see Panel B). First, voucher assignment seems to have relatively small effects (if any) for teachers applying for short higher education studies, that is, with program duration of one year or less. Voucher assignment seems to have largest effects for studies with program duration longer than one year but at most two years, particularly on completion probabilities. Effect estimates on both enrollment and completion probabilities for studies with a program duration of more than two years are somewhere in the middle.

The completion probability declines significantly by program duration. Controlling for all other applicant and application characteristics and voucher assignment, the completion probability is about 20 percentage points lower for studies with duration longer than two years as compared to one year or less.

Another noticeable finding is that enrollment and completion effects of voucher assignment are smaller for teachers applying for a voucher for a study that was already started at the time of application. This is particularly the case for effects on higher education enrollment with the OLS effect estimate being more than twice as big for the group of applicants that did not start their study yet as compared to that for the ones that had already started at the time of application. OLS effect estimates on completion probabilities are about five percentage points higher than average. Appendix Table C2 shows IV effect estimates on higher education enrollment (panel A) and higher education completion (panel B) for the subgroup of applicants that did not start at the time of application. Preferred estimates are four to six percentage points higher than for the total group of voucher applicants including those that had already started at the time of application. These differences in effect estimates

¹⁴ These differences are statistically significant and robust to different estimations on different bandwidth samples and with different specifications (OLS or IV). These differences are identified in regressions controlling for all applicant and application characteristics at the same time.

by starting status suggest that the deadweight loss of the voucher scheme has been reduced by the abolishment in 2012 of the possibility to apply for a voucher for a study that has already been started at the time of application. Our IV estimates suggest that this may have increased effects of voucher assignment on enrollment to 13-27 (from 9-22) percentage points and on completion to 13-28 (from 9-23) percentage points. Appendix Figures C1 and C2 show visually that differences in both enrollment and completion around the cut-off are marked for the subpopulation of non-starters, but do hardly exist for the subpopulation of starters at the time of application.

Finally we turn to heterogeneous effects of voucher assignment on the probability of still working in education four years after (first) applying for a voucher, as presented in the last two columns of Table 12. Regarding applicant characteristics larger than average effect estimates are found for male teachers, teachers working in secondary education, teachers with an appointment of 0.5 to 0.8 FTE, and teachers of 35 years and older at the time of application. Regarding application characteristics, our results suggest larger than average effects on stay rates for teachers who had not started the study yet at the time of application, and for applications for studies lasting between more than one and two years. These patterns of heterogeneous effects on stay rates for subgroups by application characteristics are pretty much in line with patterns found for effects on higher education enrollment and completion.

7. Characterizing the compliers

Regression discontinuity estimates reported in this paper should be considered as the effect of voucher assignment on the population of so-called compliers. Compliers are teachers who take up a voucher when they apply before the cut-off date, but do not when they apply after the cut-off date. It is not possible to directly distinguish compliers from always-takers (i.e. being assigned a voucher irrespective of the timing of application) and never-takers (i.e. never being assigned a voucher). Angrist and Pischke (2009) however show that it is possible to characterize the complier population by making use of the variation in the first-stage estimates across subgroups. The relative probability that a complier has a certain characteristic is given by the ratio of the first stage estimate for the particular subgroup with that characteristic to the overall first stage estimate. This knowledge about compliers may be important for policy-makers as it shows which groups are either more or less affected in terms of voucher take-up by a budget restriction.

Table 13 shows the first-stage ratios for various subgroups by applicant and application characteristics. In terms of applicant characteristics the probability a complier has a certain characteristic is higher than average for males (ratio of 1.21), younger teachers (1.12), teachers in primary (1.09) and special education (1.10) and teachers working more than 0.8 FTE (1.12). Compliance in terms of voucher receipt with the cut-off date is somewhat lower than average for females (0.92), teacher of 35 years and older (0.92), teachers working in secondary education (0.84) and teachers working less hours (appointments smaller than 0.8 FTE).

In terms of application characteristics teachers who have already started at the time of application are more likely to be compliers (1.13). Compliance is particularly larger among applicants for a study with duration of a year or less (1.50), whereas it is lower than average for the group with a program duration longer than two years (0.77). This lower compliance among applicants for longer studies may indicate that schools and/or teachers were less able or willing to finance these longer (and arguably more expensive) studies by means other than the voucher and were more likely to wait for the next application round to obtain a voucher if they were too late to obtain one in the first application period in 2008.

8. Crowding out of other types of funding

We have observed that a considerable share of the teachers who did not receive a voucher was still enrolled in higher education studies and managed to complete these studies. This suggests that the voucher substitutes for other sources of funding of these studies. Table 14 gives an indication of what type of funding the voucher substitutes for. Data are from questionnaires among voucher applicants. These data suggest that the voucher substitutes for school funding and for funding by own means of the teacher. Indications that the voucher substitutes for school funding may not be surprising since schools have yearly budgets reserved for professional development of their personnel.¹⁵ Co-funding by both schools and teachers happens as well. The shares of these funding means are almost equal on average.

¹⁵ Expenses of schools on continuing education of their personnel are about 1.4 percent in primary education and 1.1 percent in secondary education of the total wage costs, as reported by school directors (see Vink, 2012). Thirty percent of teachers in 2011 agree that the teacher voucher has led to less school means for individual continuing education. This share is increasing since 2009 (a year after the introduction of the teacher voucher scheme), when 19 percent of teachers agreed that school budgets for continuing education had been reduced due to the teacher voucher.

Program duration seems to matter: longer studies are more often completely financed by teachers whereas shorter studies are more often completely financed by schools.

Figure 8 shows the evolution of the share of enrolled teachers who is financed with a voucher in total enrollment by teachers for a couple of main categories of teacher studies. The figure shows a strong increase in enrollment by teachers with a voucher at the expense of enrollment by teachers without a voucher since the introduction of the voucher scheme. This is particularly the case for the master Special Educational Needs (i.e. the single program most applied for) and for teacher studies at master level at higher vocational education institutes, where shares of enrollment with a teacher voucher have steadily increased from zero to about 65 percent in three years time since the introduction of the teacher voucher scheme.

Further indications of crowding out come from questionnaires among teachers. Thirty percent of surveyed teachers in 2011 (three years after the introduction of the teacher voucher) agrees that the teacher voucher scheme has led to less available money at their schools for individual professional development, which is up from 19 percent of teachers in 2009 (Vink et al., 2012).

9. Conclusions and discussion

In this paper we have exploited a discontinuity in the probability of receiving a teacher voucher that was caused by budget restrictions to detect effects of teacher voucher assignment. We find positive effects of voucher assignment in the order of 10-20 percentage points on the probability of both higher education enrollment and completion among teachers. Higher education enrollment among voucher applicants that never received a voucher is 77 percent, whereas higher education completion among this group equals 54 percent, both measured over a period of five years since voucher application. This lower completion base rate implies that relative effects of voucher assignment on completion are larger than on enrollment. The deadweight loss of the voucher scheme in terms of enrollment in higher education degree programs is estimated at about 80 to 90 percent.

The teacher voucher scheme appears to crowd out both school-financed and teacher-financed participation in continuing education by teachers. This phenomenon of substantial crowding out of other sources of financing by public vouchers has also been found in earlier studies on training vouchers for workers (e.g. Schwerdt et al., 2012; Hidalgo et al., 2015).

Vouchers for relatively short studies (i.e. up to one year) more often appears to crowd out funding by schools out of regular budgets, whereas vouchers for longer studies (more than two years) more often appears to crowd out funding by teachers themselves. Regular yearly school budgets for professional development of teachers amount to a little over 1 percent of the total wage costs.

We find heterogeneous treatment effects of voucher assignment by program duration and starting status at the time of application. Our results suggest largest effects of applications for studies with duration of between one and two years and for applications for studies that have not been started yet at the time of application. The voucher seems to trigger least additional enrollment and completion for studies with a duration of one year or less. The possibility to apply for a voucher for a study that has been started yet at the time of application has been abolished in 2011. Our estimates suggest that this may have led to an increase in the effects of voucher assignment on both higher education enrollment and completion by about five percentage points.¹⁶ The deadweight loss is expected to have fallen to the same extent. Our estimation results also suggest that effects on enrollment and completion are somewhat smaller for teachers aged under 35 than for older teachers. These effects do not seem to differ strongly by sex, size of appointment and education sector.

Teachers who were more reliant on voucher funding may have been more likely to have reapplied for a voucher in later application periods when they did not receive a voucher in the first application period. An indication of this is the larger reapplication probability for longer studies. Arguably more costs are involved in these longer studies, that is, both in terms of direct study costs and the costs for schools for arranging replacement while teachers are on study leave. The enrollment and completion experience of these re-applicants that received a voucher in later rounds is not reflected in our estimated local average treatment effects. The possibly larger reliance of re-applicants (and their schools) on voucher funding would imply that our *local* average treatment effect estimates are somewhat lower than the average treatment effects of voucher assignment on enrollment and completion.

¹⁶ There may well be some other differences in teacher and application characteristics and in contextual factors (e.g. the financial position of the schools, the need for certified teachers, the promotion opportunities for teachers) between the first application period and later application periods that may cause differences in voucher effects in more recent application periods. It is difficult to investigate these effects in more recent application periods in the same manner since there was no discontinuity anymore in voucher assignment that we could exploit in later application periods. Survey results among voucher recipients of subsequent application periods that are not yet available may shed some light on the evolution of voucher effects over time. These indications would be based on stated preferences rather than revealed preferences however.

Our results suggest small positive effects of voucher assignment on the probability to stay working in education as measured four years after voucher application. These effects seem concentrated among teachers working in secondary education, teachers aged 35-64 years, teachers who did not start their study yet at the time of application, and teachers applying for a study with a duration of between one and two years. Positive effects on teacher retention would be a positive side effect of the teacher voucher scheme since recent evidence shows that teacher value added improves with experience. It would be interesting to monitor whether these small positive retention effects persist over a longer-term.

The teacher voucher instrument could have had effects on other policy relevant outcomes that were not studied in this paper. One may think of effects on alleviating shortages of certified teachers in certain subjects or regions, on the attractiveness of teaching as a profession and on the professional culture in schools. Another interesting question for further research would be if and to what extent voucher utilization for participation in higher education degree programs crowds out participation in other professional development activities.¹⁷

¹⁷ A first indication of the occurrence of some effects is that fifteen percent of surveyed voucher applicants state that they are not allowed anymore to participate in other continuing education activities due to the teacher voucher. Twenty percent of teachers state that they didn't have time anymore to participate in training activities related to maintenance of their teacher competences (Vink et al., 2012).

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Tables and figures

Figure.1 Relationship between day of application and probability of immediate (left panel) and eventual (right panel) voucher assignment

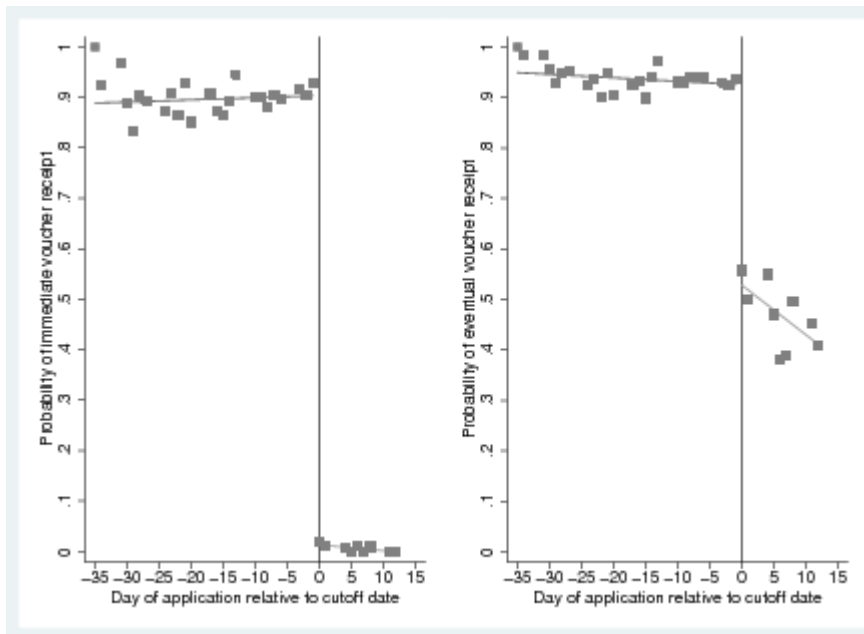


Figure.2 Number of applications by day of application

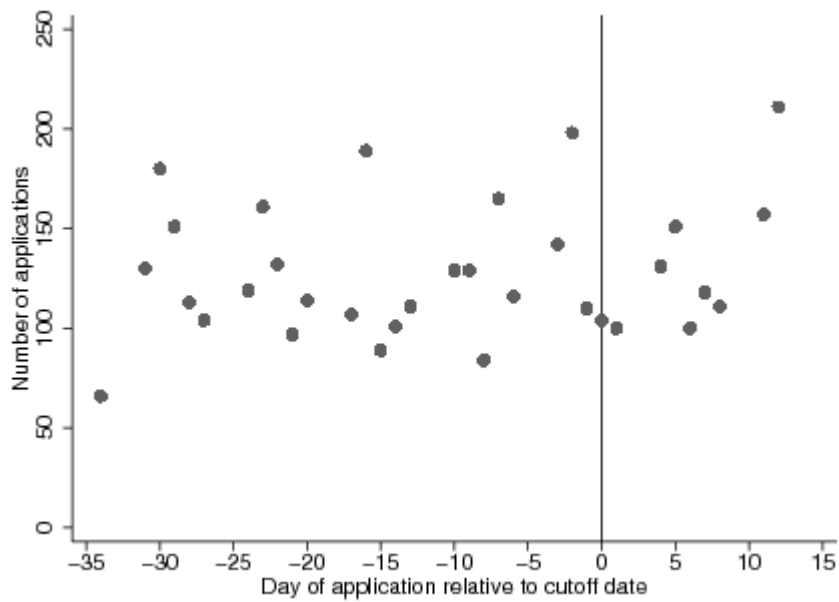


Figure.3 Applicant characteristics by day of application in first application round

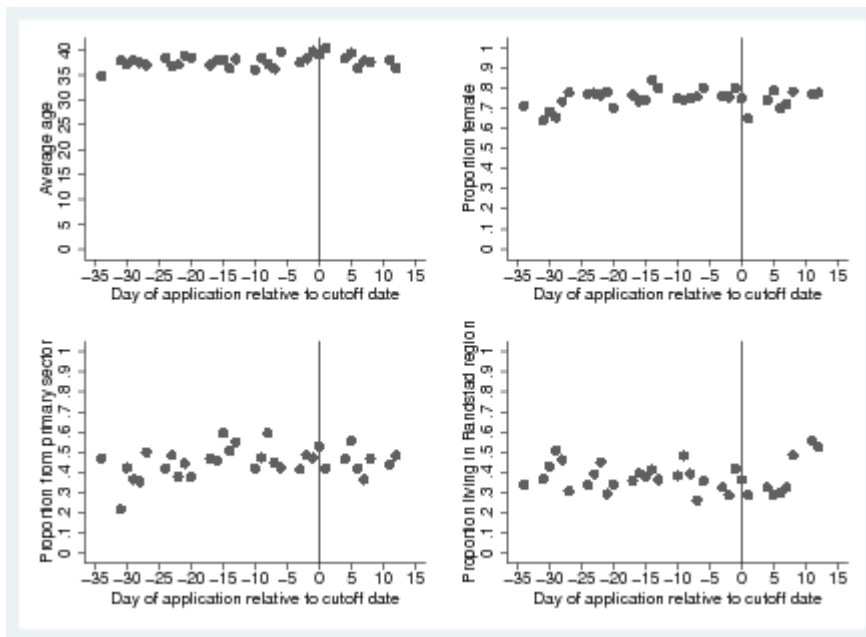


Figure.4 Applicant and application characteristics by day of application in first application round

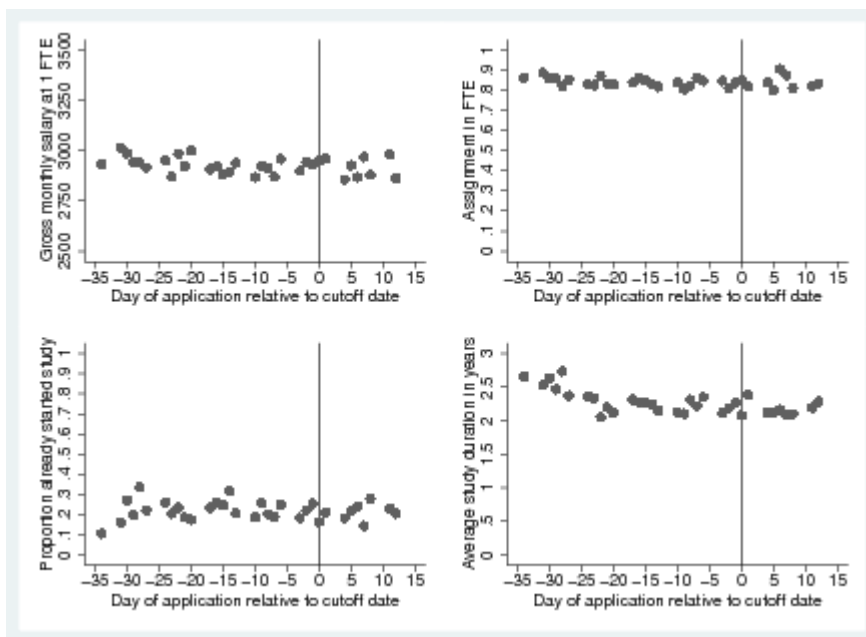


Figure.5 Proportion ever having been enrolled in higher education during 2008-2013 by day of application

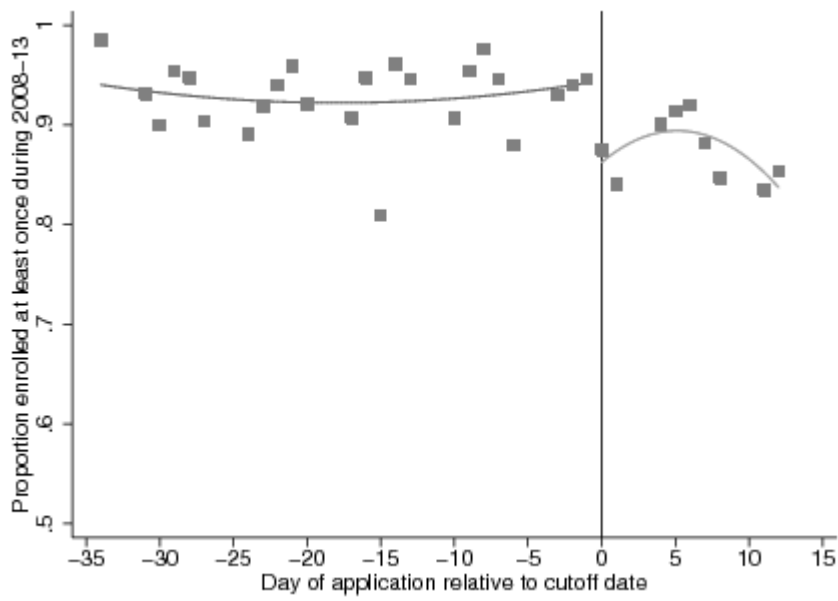


Figure.6 Proportion having completed higher education during 2008-2013 by day of application

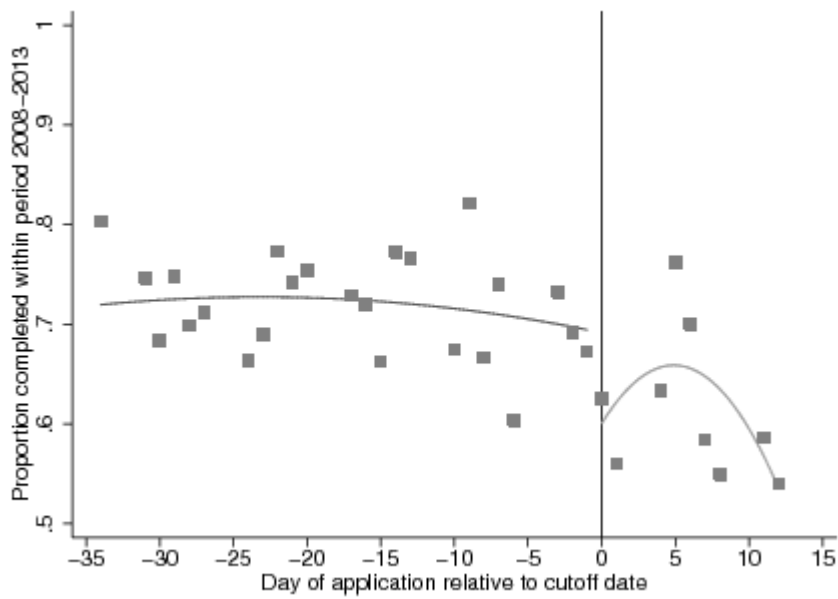


Figure.7 Probability of still working in education in 2012 by day of application

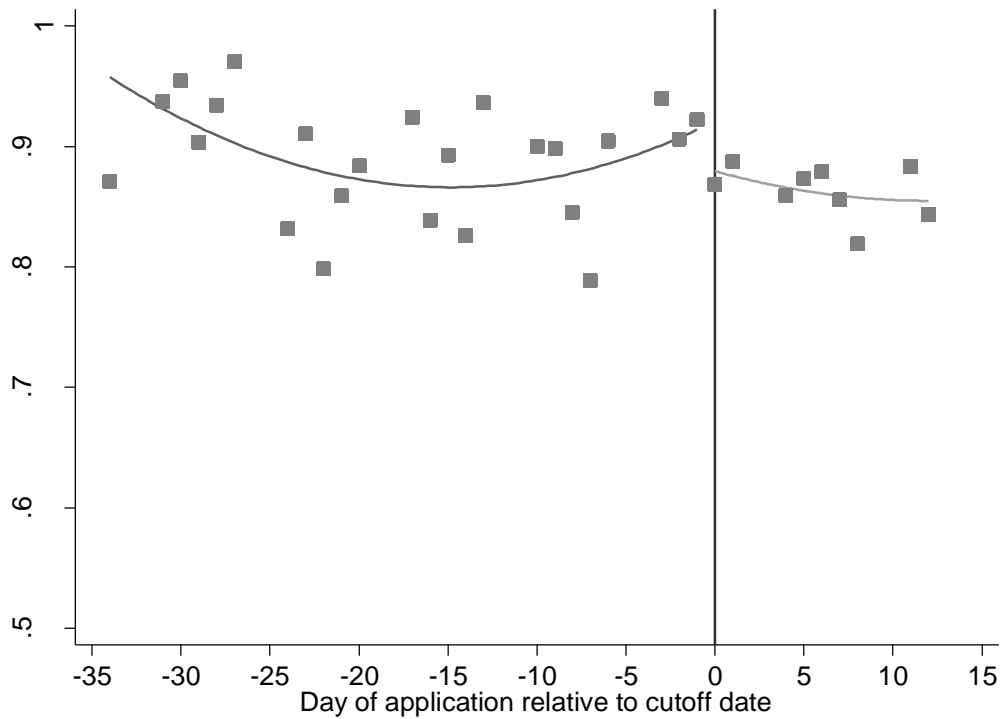


Figure.8 Share of enrollment by teachers in teacher studies that is financed with a teacher voucher (source: own calculations based on tables in Vink et al., 2012)

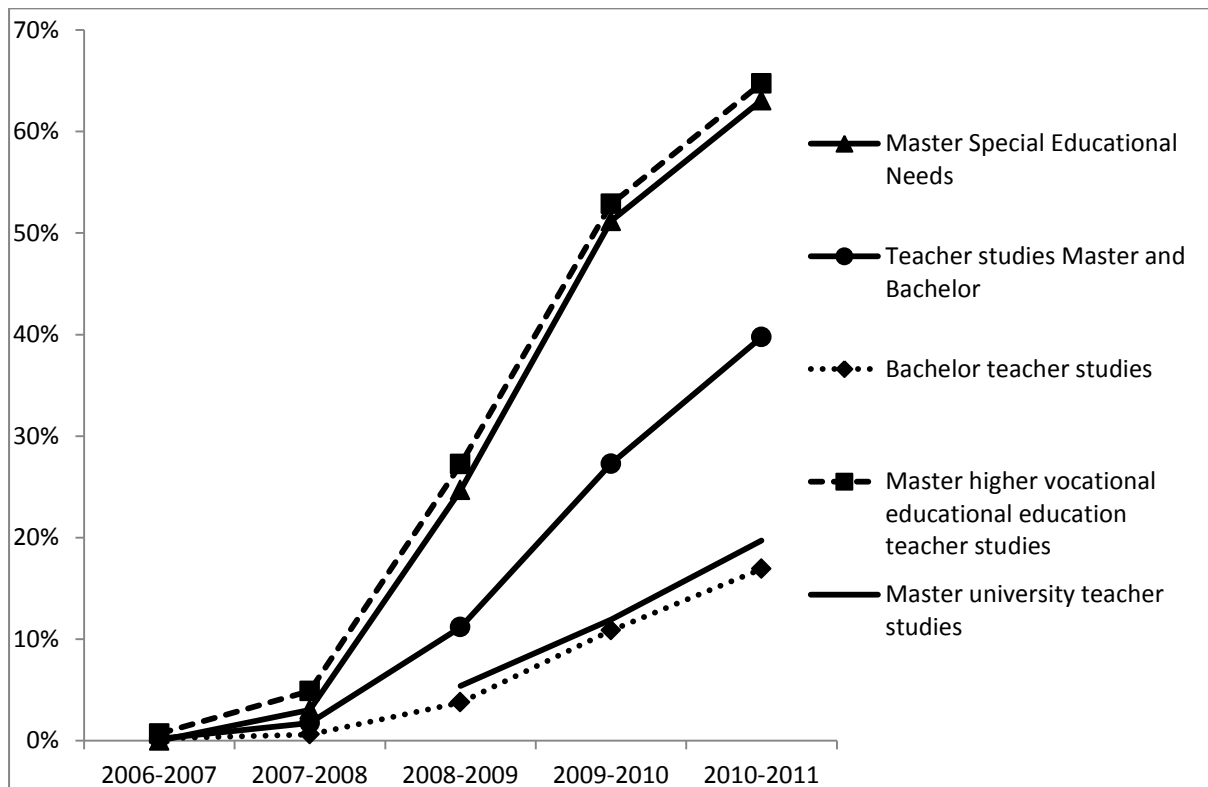


Table.1 Descriptive statistics sample of teacher schooling voucher applicants for higher education studies

Variables	(1) All	(2) Before cut-off date	(3) After cut-off date	(4) Ever received voucher	(5) Never received voucher
Panel A					
<i>Applicant characteristics</i>					
Female	0.75 [0.72]	0.75	0.75	0.75	0.74
Age	37.8 [42.8]	37.6	38.1	37.7	38.1
Working in Randstad region	0.38 [0.41]	0.38	0.40	0.38	0.40
Working in primary education	0.45 [0.56]	0.44	0.46	0.45	0.46
Working in secondary education	0.42 [0.35]	0.43	0.39	0.44	0.36
Working in special education	0.13 [0.10]	0.12	0.15	0.12	0.18
Gross monthly salary (2008) at appointment of 1 FTE	2926 [3213]	2930	2915	2920	2954
Appointment in FTE	0.84 [0.78]	0.84	0.84	0.84	0.84
<i>Application characteristics</i>					
Already started higher education program at time of application	0.22	0.23	0.21	0.19	0.33
Program duration (in years)	2.27	2.30	2.18	2.30	2.13
Panel B					
<i>Treatment variables</i>					
Received voucher in first application period (2008)	0.65	0.90	0.00	0.80	0.00
Received voucher in any of first seven application periods (2008- 2013)	0.80	0.94	0.46	1.00	0.00
Panel C					
<i>Outcome variables</i>					
Ever having been enrolled in higher education (2008-2013)	0.91	0.93	0.87	0.95	0.77
Completed higher education program (2008-2013)	0.69	0.72	0.61	0.73	0.54
Proportion completed higher education program of those enrolled (over 2008-2013)	0.75	0.77	0.70	0.77	0.69
Still enrolled in higher education in 2013 but did not complete yet	0.06	0.06	0.09	0.07	0.03
Still working in education in 2012	0.88	0.89	0.86	0.89	0.85
N	4,220	3,037	1,183	3,392	828
Proportion of all applicants	1.00	0.72	0.28	0.80	0.20

Country averages are presented between brackets.

Table 2 First stage estimates of effect of application after cut-off date on probability of voucher assignment

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Effect of application after cut-off	-0.368*** (0.0380)	-0.383*** (0.0304)	-0.399*** (0.0296)	-0.395*** (0.0289)
F-statistic	90.05	159.12	182.11	187.50
Applicant and application controls	Y	Y	Y	Y
Order of polynomial of day of application and interaction term with cut-off date	1	1	1	1
N	1,435	2,468	3,064	4,220

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The estimates are from regressions with a linear control for the day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Table 3 OLS estimates of application after cut-off date on pre-determined applicant and application characteristics

Sample	(1) female	(2) age	(3) working in primary education	(4) gross salary 2008 (€)	(5) assign- ment in FTE	(6) Randstad region	(7) already started	(8) program duration (years)
1) +/- 7 days around cut-off	-0.0411* (0.0228)	0.491 (0.548)	0.0131 (0.0263)	3.368 (24.00)	0.0042 (0.0106)	-0.00368 (0.0240)	-0.0230 (0.0213)	-0.0648 (0.0528)
N	1434	1435	1435	1356	1365	1364	1435	1431
2) +/- 14 days around cut-off	-0.0242 (0.0172)	0.291 (0.418)	-0.00745 (0.0201)	1.572 (18.29)	0.0007 (0.0084)	0.0394** (0.0190)	-0.0152 (0.0166)	-0.0221 (0.0396)
N	2466	2468	2468	2316	2332	2331	2467	2461
3) +/- 21 days around cut-off	-0.0147 (0.0159)	0.202 (0.385)	-0.00451 (0.0185)	-2.652 (16.97)	-0.0035 (0.0076)	0.0388** (0.0175)	-0.0157 (0.0153)	-0.0346 (0.0360)
N	3062	3064	3064	2886	2906	2905	3063	3057
4) All	0.00142 (0.0149)	0.409 (0.353)	0.0227 (0.0170)	-13.83 (16.06)	-0.0099 (0.0069)	0.0207 (0.0162)	-0.0171 (0.0142)	-0.126*** (0.0329)
N	4217	4219	4220	3990	4017	4015	4219	4213

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; No control for day of application.

Table 4 Formal test on discontinuity in the density of the assignment variable

Dependent variable	(1) Estimate on number of applications per day	(2) Standard error
Application after cut-off date	3.6	9.7
<i>Day of week (reference = Monday)</i>		
Tuesday	43.4***	12.5
Wednesday	-19.3	13.0
Thursday	-14.6	13.0
Friday	-27.6**	12.5
Constant	129.7***	9.2
N	33	

*** p<0.01, ** p<0.05, * p<0.1

Table 5 OLS estimates of effect of voucher assignment on probability of higher education enrollment in period 2008-2013

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
(1) No controls	0.127*** (0.0200)	0.147*** (0.0158)	0.164*** (0.0155)	0.173*** (0.0150)
(2) Adding applicant and application characteristics	0.149*** (0.0218)	0.160*** (0.0165)	0.176*** (0.0160)	0.186*** (0.0155)
(3) Adding day of application and interaction term with cut-off	0.176*** (0.0254)	0.160*** (0.0165)	0.198*** (0.0190)	0.211*** (0.0182)
Preferred order of polynomial of day of application and interaction term with cut-off date	1	0	2	2
Control group mean	0.82	0.80	0.79	0.77
N	1435	2468	3064	4220

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with a dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Preferred estimates are presented in bold. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Table 6 IV estimates of effect of voucher assignment on probability of higher education enrollment in period 2008-2013

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Polynomial of day of application and interaction term with cut-off date of order:				
Zero	0.0922*** (0.0338)	0.137*** (0.0250)	0.125*** (0.0242)	0.123*** (0.0229)
One	0.219*** (0.0795)	0.0938 (0.0594)	0.0991* (0.0544)	0.0905* (0.0525)
Two	0.351*** (0.121)	0.215*** (0.0824)	0.221*** (0.0804)	0.208*** (0.0728)
Preferred order of the polynomial of day of application and interaction term with cut-off date	0	0	2	2
Applicant and application controls	Y	Y	Y	Y
N	1,435	2,468	3,064	4,220

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Preferred estimates are presented in bold. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Table 7 Deadweight loss calculation of teacher vouchers

	all voucher applicants irrespective of starting status		applicants for studies that have not been started	
	lower bound DWL	upper bound DWL	lower bound DWL	upper bound DWL
(1) Effect on enrollment of application after cut-off (a)	-0.08	-0.04	-0.11	-0.05
(2) Effect on voucher assignment of application after cut-off (b)	-0.37	-0.44	-0.40	-0.43
(3) Crowding out = (1) - (2)	29%	40%	30%	37%
(4) Deadweight loss = (3)/(2)	78%	91%	74%	87%
Bandwidth sample (number of days around the cut-off)	21 days	7 days	21 days	7 days
Order of polynomial of control for day of application and interaction term with after cut-off dummy	2	0	2	0

Notes: the smallest and the largest preferred effect estimates are taken to calculate the upper and lower bound for deadweight loss of the teacher voucher scheme.

(a) This is the so-called reduced form estimate.

(b) This is the so-called first stage estimate.

Table 8 OLS estimates of effect of voucher assignment on probability of higher education completion in period 2008-2013

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
(1) No controls	0.122*** (0.0280)	0.162*** (0.0207)	0.185*** (0.0203)	0.191*** (0.0190)
(2) Adding applicant and application characteristics	0.191*** (0.0274)	0.218*** (0.0207)	0.235*** (0.0195)	0.244*** (0.0183)
(3) Adding day of application and interaction term with cut-off	0.227*** (0.0316)	0.217*** (0.0249)	0.235*** (0.0237)	0.243*** (0.0220)
Preferred order of polynomial of day of application and interaction term with after cut-off dummy	1	2	2	2
Control group mean	0.58	0.54	0.54	0.54
N	1,435	2,468	3,064	4,220

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Preferred estimates are presented in bold. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Table 9 IV estimates of effect of voucher assignment on probability of higher education completion in period 2008-2013

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Polynomial of day of application and interaction term with cut-off date of order:				
Zero	0.0919* (0.0536)	0.208*** (0.0384)	0.223*** (0.0362)	0.241*** (0.0337)
One	0.174 (0.124)	0.0203 (0.0934)	0.0421 (0.0832)	0.0468 (0.0783)
Two	0.279 (0.205)	0.185 (0.129)	0.201* (0.121)	0.226** (0.107)
Preferred order of polynomial of day of application and interaction term with after cut-off dummy	0	2	2	2
Applicant and application controls	Y	Y	Y	Y
N	1,435	2,468	3,064	4,220

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Preferred estimates are presented in bold. Applicant controls are sex, age category (5 categories), sector of work, baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started or not and program duration (four categories).

Table 10 OLS estimates of effect of voucher assignment on probability of still working in education in 2012 (four years after voucher application)

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Effect of voucher assignment	0.039* (0.0235)	0.047*** (0.0157)	0.035** (0.0168)	0.027* (0.0155)
Preferred order of polynomial of day of application and interaction term with after cut-off dummy	2	0	0	2
Applicant and application controls	Y	Y	Y	Y
Control group mean	0.85	0.84	0.85	0.85
N	1,365	2,332	2,906	4,017

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Preferred estimates are presented in bold. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Table 11 IV estimates of effect of voucher assignment on probability of still working in education in 2012 (four years after voucher application)

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Polynomial of day of application and interaction term with cut-off date of order:				
Zero	0.045 (0.0393)	0.054* (0.0298)	0.042 (0.0282)	0.055** (0.0260)
One	0.222** (0.0925)	0.105 (0.0649)	0.0774 (0.0587)	0.0115 (0.0548)
Two	-0.087 (0.141)	0.180* (0.0972)	0.134 (0.0888)	0.112 (0.0781)
Preferred order of polynomial of day of application and interaction term with cut-off date	2	0	0	2
Applicant and application controls	Y	Y	Y	Y
N	1365	2332	2906	4017

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Applicant controls are sex, age category (5 categories), sector of work, baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started or not and program duration (four categories).

Table 12 Heterogeneity of effects of voucher assignment on probability of higher education enrollment and completion and on working in education four years after voucher application

Effect on subgroup	Higher education enrollment		Higher education completion		Still working in education in 2012	
	+/- 14	all	+/- 14	all	+/- 14	all
Baseline	0.160*** (0.0165)	0.211*** (0.0182)	0.217*** (0.0249)	0.243*** (0.0218)	0.047*** (0.0157)	0.027* (0.0155)
<i>Panel A: Applicant characteristics</i>						
Female teachers	0.162*** (0.0188)	0.221*** (0.0212)	0.206*** (0.0290)	0.247*** (0.0256)	0.039** (0.0192)	0.024 (0.0186)
Male teachers	0.159*** (0.0344)	0.199*** (0.0357)	0.235*** (0.0495)	0.227*** (0.0426)	0.064* (0.0358)	0.031 (0.0328)
Working in primary education	0.133*** (0.0242)	0.191*** (0.0273)	0.218*** (0.0376)	0.252*** (0.0333)	0.027 (0.0225)	0.010 (0.0235)
Working in secondary education	0.188*** (0.0286)	0.226*** (0.0290)	0.218*** (0.0399)	0.227*** (0.0339)	0.080*** (0.0303)	0.057** (0.0261)
Working in special education	0.188*** (0.0376)	0.251*** (0.0472)	0.221*** (0.0634)	0.278*** (0.0562)	0.023 (0.0434)	0.025 (0.0459)
Appointment <= 0.5 FTE	0.165*** (0.0528)	0.203*** (0.0549)	0.138 (0.0929)	0.167** (0.0766)	-0.003 (0.0754)	-0.047 (0.0677)
Appointment > 0.5 & <= 0.8 FTE	0.165*** (0.0326)	0.198*** (0.0396)	0.194*** (0.0522)	0.243*** (0.0489)	0.085** (0.0335)	0.055 (0.0372)
Appointment > 0.8 FTE	0.159*** (0.0205)	0.218*** (0.0223)	0.231*** (0.0304)	0.250*** (0.0260)	0.046** (0.0198)	0.027 (0.0180)
Age 15-34	0.119*** (0.0228)	0.180*** (0.0267)	0.176*** (0.0377)	0.222*** (0.0331)	0.019 (0.0222)	0.016 (0.0243)
Age 35-64	0.197*** (0.0235)	0.236*** (0.0248)	0.255*** (0.0336)	0.261*** (0.0291)	0.061*** (0.0213)	0.040* (0.047)
<i>Panel B: Application characteristics</i>						
Already started study at time of application	0.081*** (0.0215)	0.112*** (0.0268)	0.172*** (0.0498)	0.204*** (0.0397)	0.033 (0.0348)	0.009 (0.0311)
Did not start study yet at time of application	0.184*** (0.0208)	0.254*** (0.0232)	0.221*** (0.0291)	0.256*** (0.0263)	0.053*** (0.0197)	0.036* (0.0195)
Program duration 0-1 years	0.058** (0.0284)	0.119*** (0.0462)	-0.020 (0.0621)	0.067 (0.0588)	0.049 (0.0315)	0.013 (0.0377)
Program duration >1-2 years	0.199*** (0.0281)	0.242*** (0.0302)	0.315*** (0.0392)	0.335*** (0.0341)	0.083*** (0.0270)	0.059** (0.0256)
Program duration >2 years	0.166*** (0.0273)	0.216*** (0.0277)	0.196*** (0.0388)	0.206*** (0.0329)	0.015 (0.0271)	0.004 (0.0263)

Notes: These estimates are based on OLS regressions similar to those in row 3 of Tables 4, 7 and 9. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13 Characterizing compliers

	First stage estimate	Ratio to overall first-stage	N
All	-0.400*** (0.029)	1.00	4330
Applicant characteristics			
<i>Sex</i>			
Female	-0.368*** (0.033)	0.92	3234
Male	-0.485*** (0.054)	1.21	1093
<i>Age (years)</i>			
15-34	-0.446*** (0.046)	1.12	1948
35-64	-0.368*** (0.037)	0.92	2381
<i>Sector of employment</i>			
Primary education	-0.434*** (0.040)	1.09	1952
Secondary education	-0.335*** (0.048)	0.84	1819
Special education	-0.441*** (0.073)	1.10	559
<i>Appointment in FTE in 2008</i>			
0-0.5 FTE	-0.350*** (0.103)	0.88	334
>0.5-0.8 FTE	-0.331*** (0.055)	0.83	1017
>0.8 FTE	-0.440*** (0.036)	1.12	2866
Application characteristics			
<i>Status of planned study at time of application</i>			
Already started	-0.453*** (0.066)	1.13	953
Did not start	-0.388*** (0.031)	0.97	3376
<i>Program duration of planned study (in years)</i>			
0-1 year	-0.601*** (0.060)	1.50	661
>1-2 years	-0.379*** (0.044)	0.95	1903
>2 years	-0.307*** (0.047)	0.77	1758

*** $p < 0.01$. Robust standard errors in parentheses. First-stage estimates are estimated by regressions using the full set of application and applicant controls and a linear control for day of application and a linear interaction term of day of application with a dummy indicating whether the application was done after the cut-off date. The ratio in the last column indicates the relative probability compliers have the particular applicant or application characteristic indicated in each row.

Table 14 Funding means of studies by teachers who applied for but did not receive a teacher voucher

	<= 1 year	1-2 years	> 2 years	All studies
<i>Share financed by</i>				
school	0.71	0.48	0.16	0.38
school and teacher	0.05	0.28	0.29	0.24
teacher	0.10	0.33	0.55	0.39
other means	0.14	0.02	0	0.03
<i>Number of respondents</i>				
	21	54	56	131

Source: own calculations based on questionnaire data among voucher applicants by IVA Onderwijs together with CPB Netherlands Bureau for Economic Policy Analysis that was carried out in 2009.

Appendix A Teacher voucher scheme versus two other adult training voucher schemes

Table A.1 Comparison of teacher voucher with two other training voucher schemes

	Schwerdt et al. (2012)	Hidalgo et al. (2015)	Van der Steeg en Van Elk (2014)
Country	Switzerland	The Netherlands	The Netherlands
Year	2006	2006	2008
Type of education/training	All kinds of study courses / training sessions	All kinds of study courses / training sessions	Degree programs (Bachelor or Master)
Eligibility	Employed and unemployed with varying educational attainment	Employees in four sectors in the Netherlands; mainly low educated workers	Employed teachers; high educated
Voucher value	250/750/1500 Swiss Francs	1000 euro	Max 4200 euro per year for teachers (a) and max 6700 euro per year for their employer to arrange replacement for study leave.
Redemption period	Within six Months	Within two years	Within one year
Redemption rate	18 percent	41 percent	95 percent
Type of data	Labour Force Survey panel data	Survey data collected particularly for evaluation	Administrative data
Sample size	10,521	1,266	4,220
Empirical approach	Randomized experiment	Randomized experiment	Fuzzy RD
Effects investigated over period of	One year	Two years	Five years after first voucher application
Effect size of voucher receipt on participation / enrollment	+13 percentage points	+20 percentage points	+9 to +22 percentage points (b)
Control group mean participation	33 percent	45 percent	77 percent
Relative effect (= effect size in percentage points / control group mean)	+39 percent	+44 percent	Between +12 and +29 percent on average (b)
Deadweight loss	30 percent	59 percent	Between 78 and 91 percent (b)
Other noticeable findings	- Smaller effects for vouchers with lowest face value - Significant crowd-out of firm-financed education	- Positive impact on future training plans - No effects on job mobility	- Larger effects for applications for studies that had not been started yet at the time of application - Smallest effects for applications for short term studies (a year or less)

(a) This maximum amount has been raised to 7700 euro per year from 2011 onwards.

(b) Depending on bandwidth and functional form. Deadweight loss is estimated at 74 to 87 percent for studies that had not been started yet at the time of application.

Appendix B Facts and figures of the teacher voucher scheme, teacher professional development in the Netherlands and policy measures and goals

The teacher voucher scheme

Table B.1 shows the evolution of the number of requested and assigned teacher vouchers over the first seven application periods. These numbers include applications for generally brief courses and applications for acknowledged bachelor or master degree programs. As from 2012 onwards, vouchers could only be requested for bachelor or master degree programs.

Table B.1 Number of requested and assigned teacher vouchers and amount of money involved

Appli- cation period	Year	Number of applications	Number of vouchers assigned	Share of applicants assigned a voucher	Subsidy assigned to teachers (million euro)	Subsidy assigned to schools (million euro)	Subsidy assigned to teachers and schools (million euro)	Average total subsidy per assigned voucher (euro)
1	2008	7,501	4,866	65%	14.2	16.6	30.8	6,324
2	2009	4,128	3,497	85%	10.6	14.4	25.0	7,135
3	2009	5,679	5,169	91%	17.5	24.4	41.9	8,114
4	2010	8,304	7,087	85%	26.6	36.6	63.2	8,918
5 (a)	2011	8,747	8,227	94%	36.0	38.6	74.5	9,061
6 (b)	2012	5,221	4,722	90%	29.0	40.6	69.6	14,739
7 (c)	2013	6,916	6,188	87%	40.4	48.7	89.1	14,399
Total	2008-13	46,496	39,609	85%	174.2	219.9	394.1	9,950

(a) The maximum yearly subsidy that could be assigned to teachers has been raised to 7700 euro in 2011. Between 2008 and 2010 it was 4200 euro.

(b) The possibility to apply for brief courses (i.e. being not bachelor or master degree programs) has been abolished in 2012.

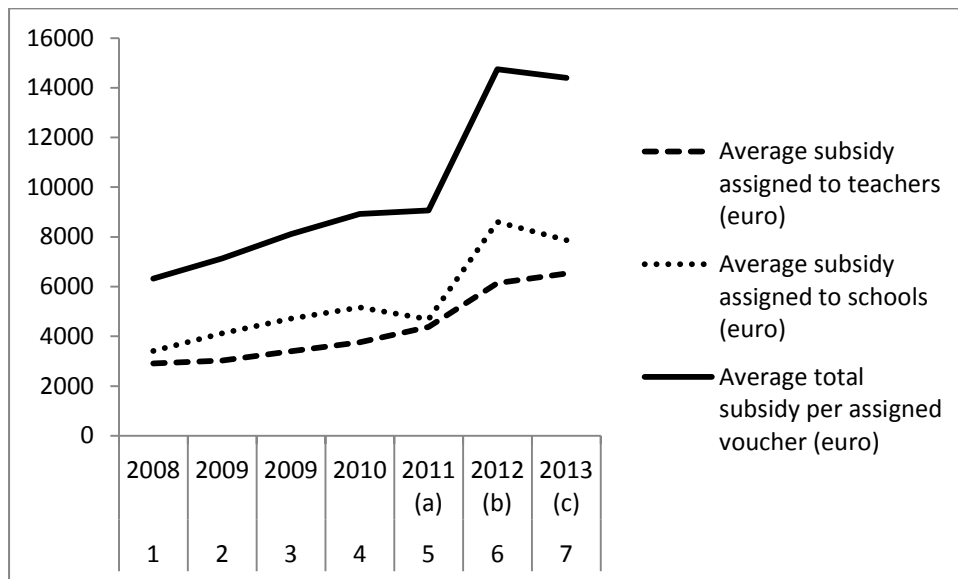
(c) Vouchers have been assigned for one year only since 2013. If a study program lasts for more than a year, the teacher has to reapply for a voucher in the next year(s). The figures shown for 2013 are predicted figures on the basis of the ratio of assigned subsidies for the total study period relative to those for the first study year, taken from the preceding year 2012.

Source: own calculations on figures provided by *Dienst Uitvoering Onderwijs (DUO)*.

Almost 40 thousand teacher vouchers have been assigned over the period 2008-13 in seven application periods. Almost 400 million euro of subsidies is involved with these vouchers, of which 174 million goes to teachers as compensation for study fees and costs of study materials and travel costs, and 220 million goes to schools to give them the opportunity to provide study leave and arrange a replacement teacher. The average total subsidy per assigned voucher has more than doubled over time, that is, from 6.3k euro in 2008 to 14.7k euro in 2012. This is due to a number of factors. First, the maximum yearly subsidy for teachers has been raised from 4,200 to 7,700 euro in 2011. Second, vouchers could only be assigned for registered bachelor or master degree programs as from 2012 onwards. Vouchers could not be assigned for other brief courses or training programs anymore. This has raised

the share of applications for bachelor or master degree programs in one year by 40 percentage points. These bachelor and master degree programs are often more expensive in terms of total study fees because of longer study duration. Moreover, compensation to schools for study leave is only possible for applications for bachelor or master degree programs. Figure B1 shows the evolution of average total subsidy costs per voucher and the average subsidy provided to schools and to teachers.

Figure. B.1 Evolution of average costs per voucher



See notes for years 2011, 2012 and 2013 under table B1.

The abolishment of the opportunity to apply for a voucher for other courses or training programs than bachelor or master degree programs has contributed to the strong decline in the total number of applications in 2012. The extension of the voucher eligibility to teachers with a flexible contract or replacement teachers in 2013 has contributed to the increase in the number of applications to a small extent, according to figures provided to us by DUO.

On average 2.9 percent of all teachers in the eligible education sectors have applied yearly for a teacher voucher over the period 2008-2013. On average 2.0 percent of all teachers have applied yearly for a voucher for a bachelor or master degree program, which amounts to nearly 70 percent of all applications. The share of teachers applying yearly for a bachelor or master degree program ranges from 1.6 percent in intermediate post-secondary vocational education (MBO) to 2.5 percent in secondary education. Shares in primary education (1.8 percent) and special education (2.2 percent) are in between. Nearly one third of all applications have been for Master Special Educational Needs, a degree program in which teachers learn to cope better with pupils with special educational needs. This share is largest

in special education (56 percent) and primary education (42 percent). In secondary education and intermediate post-secondary vocational education relatively larger shares of applications have been for subject-specific degree programs.

Teacher professional development in the Netherlands: concerns and figures

Raising teacher quality is high on the policy agenda in the Netherlands. This stems from concerns about teacher quality that have been expressed by policymakers, The Inspectorate of Education, school leaders and teachers themselves. Results from the TALIS survey among teachers in 32 countries show that a large share of over 70 percent of teachers in the Netherlands thinks that good education is hindered by a shortage of qualified and/or good performing teachers (OECD, 2014). PISA (2012) figures show that the Netherlands have the highest share of uncertified teachers in lower secondary education of all OECD countries (Kordes et al., 2013). Berndsen et al. (2013) show that on average 17 percent of all lessons in secondary education in 2011 were given by teachers who are not certified for the subject (or not at the required level) with even larger shares in certain shortage subjects and in the more urbanized regions. The Dutch Inspectorate of Education has found that two-thirds to three-quarters of all teachers does not succeeds in differentiating their lessons according to differences in level and speed of their pupils in secondary education, intermediate post-secondary vocational education and in special education. In primary education this share is between 40 and 50 percent (Inspectorate of Education, 2014).

TALIS survey results show that though the degree of participation in professional development activities among Dutch teachers is somewhat larger than average, the intensity of these activities in terms of number of days involved is lower than average (OECD, 2014). Participation of teachers in qualification programs (e.g. a degree program) is relatively low compared to participation in brief courses or workshops in the countries participating in the TALIS survey (18 versus 71 percent of teachers in the last twelve months). This contrasts with the opinion of teachers that these more intensive and longer professional development activities are the more effective professional development activities (Inspectorate of Education, 2012). PISA 2012 figures show that professionalization activities of Dutch teachers in math stay behind those of teachers in other OECD countries, particular among math teachers (Kordes et al, 2013).

Both TALIS and a large Dutch survey among teachers offer insights into impeding factors for participation in professional development activities. TALIS finds that the most

mentioned impediments for participation are in descending order that there is no relevant professional development offered (39 percent), that professional development conflicts with the work schedule (38 percent), that there are no incentives to participate in such programs (30 percent), a lack of employer support (27 percent), that professional development is too expensive/unaffordable (26 percent), and that they do not have the prerequisites (8 percent). Results from a large Dutch teacher survey show that about sixty to seventy percent of Dutch teachers state that their professional development is seriously hindered because they are too busy with their daily work (Berndsen et al., 2014). Other less frequently mentioned limiting factors mentioned by teachers in this survey are that professional development is impeded by their work schedule (34-46 percent), no time because of family affairs (16-32 percent), that the employer does not give enough support (17-26 percent), that it is too expensive (15-25 percent), and that it is not stimulated by their managers (14-23 percent).

The Dutch Inspectorate of Education mentions that in Dutch primary education professionalization activities are often team activities. This causes a lack of tailored activities to the professionalization needs of individual teachers (Inspectorate of Education, 2012). In a more recent publication the Inspectorate concludes that the room for professionalization that teachers have is certainly not used by all teachers, particularly not by the weakest teachers. High work pressure experienced by teachers and limitations within the school organization to reserve time are most mentioned impediments for teacher professionalization (Inspectorate of Education, 2013). The Inspectorate also concludes in this publication that professionalization activities by teachers often have too little focus and are too often not targeted at specific goals to improve own teaching practices.

The share of teachers who had to pay for none of the professional development activities undertaken is above average of the TALIS countries (i.e. 78 versus 66 percent). This share is lower than in North-Western Europe however (Van der Boom and Stuivenberg, 2014). Non-monetary support for Dutch teachers in terms of for instance study leave is about average (13.5 versus 14.1 percent). Unfortunately data are lacking to compare the evolution of monetary and non-monetary support over time in an international perspective. The introduction of the teacher voucher in the Netherlands may have affected both types of support.

Policy measures and goals

The most recent policy program of the Ministry of Education is the Teachers Program 2013-2020. This program was developed in collaboration with teachers, principals, school boards and educators. The program has seven broad areas of attention, for which specific targets and policy measures have been formulated.¹⁸ One of the specific goals formulated in this program is to raise the share of teachers with a master degree in 2020 to 50 percent in secondary education and to 30 percent in primary education. This is up from a current share of 37 percent and 20 percent, respectively.¹⁹ Apart from this general master goal that makes no distinction between vocational and academic masters, there is a specific goal to raise the share of academic master teachers in upper secondary education from 60 to 80-85 percent by 2020. The number of uncertified teachers should gradually fall to zero by 2020, down from 17 percent in 2011.²⁰

One of the important policy tools to achieve these goals of more master teachers and less uncertified teachers is the teacher voucher scheme. Budgets for the teacher voucher scheme have been raised every year since the start of the scheme. Other recently announced policy measures that may contribute to this goal is promoting alternative and more flexible routes to teaching for talented master educated young people. These measures are part of a policy package *Landelijke impuls leraren tekortvakken* in which in total 100 million euro will be spent over the years 2013-2016 (Ministry of Education, 2013).

A larger policy package named *Actieplan Leerkracht van Nederland* targeted at raising teacher quality and quantity has been launched in 2007 (Ministry of Education, 2007). Over eighty percent of this more than one billion euro package was directed towards improvement in teacher compensation. These salary measures had two major components. The first component was gradually providing extra money to schools to enable them to place a larger share of their teachers in higher pay scales. An underlying goal of this measure was to create more variety in teacher salaries, which should trigger teachers to keep on investing in their

¹⁸ These areas of attention are: better students in teacher training programs, better teacher training programs, attractive and flexible development pathways, starting as a teacher, schools as learning organisations, all teachers skilled and qualified, and a strong professional organization.

¹⁹ See

http://www.trendsbeeld.minocw.nl/vervolg.php?h_id=5&s_id=29&v_id=60&d_id=38&titel=Master/academi

[ci](#)

²⁰ See

http://www.trendsbeeld.minocw.nl/vervolg.php?h_id=5&s_id=29&v_id=60&d_id=37&titel=Gekwalificeerde_leraren

skills and careers in order to increase their chances of being promoted. The second component was a gradual reduction in the number of years in which a teacher reaches the maximum of his or her salary scale. The launch of the teacher voucher scheme was part of the policy package *Actieplan Leerkracht van Nederland* as well.

Appendix C Outcomes of regression analyses

Table C1 IV effect estimates on higher education enrollment and higher education completion for subgroup of applicants that had not started yet at the time of application

Specification	Bandwidth (days around the cut-off date)			
	7	14	21	all
Panel A: effect on higher education enrollment				
Polynomial of day of application and interaction term with cut-off date of order:				
Zero	0.128*** (0.0416)	0.169*** (0.0308)	0.156*** (0.0300)	0.161*** (0.0282)
One	0.271*** (0.889)	0.160** (0.1347)	0.160** (0.0640)	0.136** (0.0630)
Two	0.366*** (0.1347)	0.259* (0.143)	0.265*** (0.0878)	0.251*** (0.0816)
Preferred order of the polynomial of day of application and interaction term with cut-off date				
Applicant and application controls	0	0	2	2
Control group mean	0.78	0.77	0.74	0.73
Panel B: effect on higher education completion				
Polynomial of day of application and interaction term with cut-off date of order:				
Zero	0.131** (0.0648)	0.247*** (0.0468)	0.266*** (0.0442)	0.161*** (0.0282)
One	0.247*** (0.1347)	0.086 (0.1080)	0.104 (0.0962)	0.081 (0.0924)
Two	0.322 (0.2306)	0.259* (0.1403)	0.253* (0.1303)	0.282** (0.1174)
Preferred order of the polynomial of day of application and interaction term with cut-off date				
Applicant and application controls	0	2	2	2
Control group mean	0.51	0.48	0.47	0.46
N	1,141	1,934	2,396	3,289

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The preferred order of the polynomial of day of application and its interaction term with the dummy indicating whether the application was done after the cut-off date is chosen using Akaike's information criterion. Applicant controls are sex, age category (5 categories), sector of work (three categories), baseline gross monthly salary, appointment size and the region of work (inside or outside Randstad region). Application controls are a dummy indicating whether the applicant had already started and program duration (four categories).

Figure C1 Proportion ever having been enrolled (left panel) and ever having completed (right panel) higher education during 2008-2013 by day of application, for subgroup of non-starters at time of application

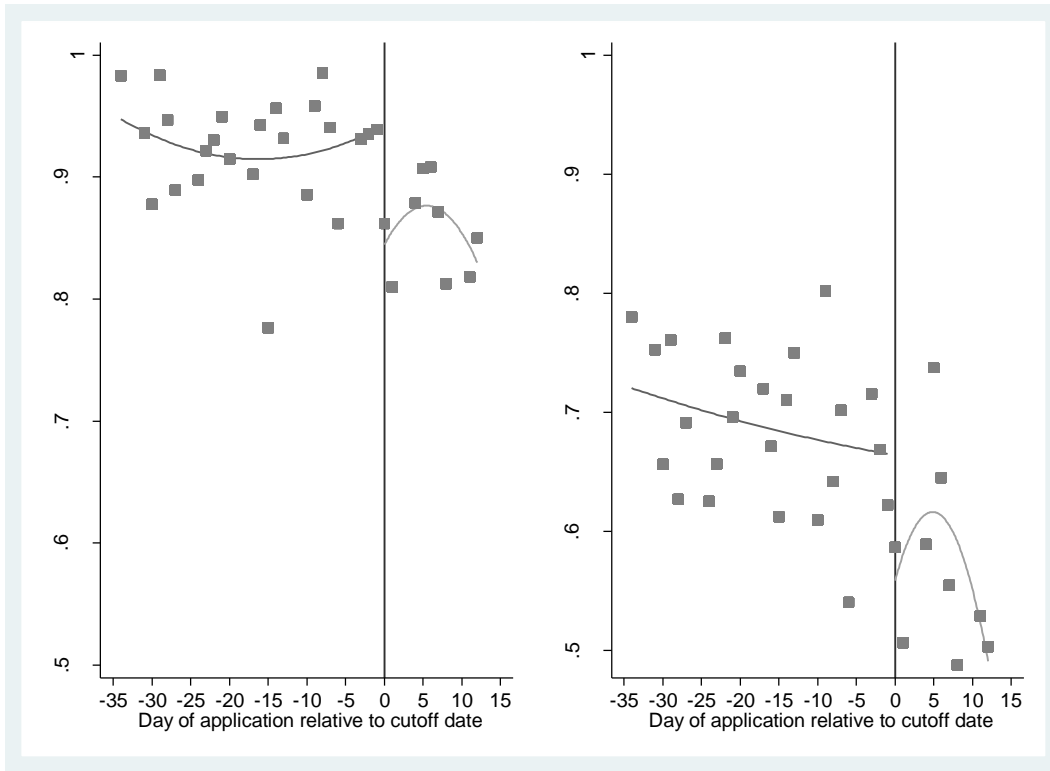
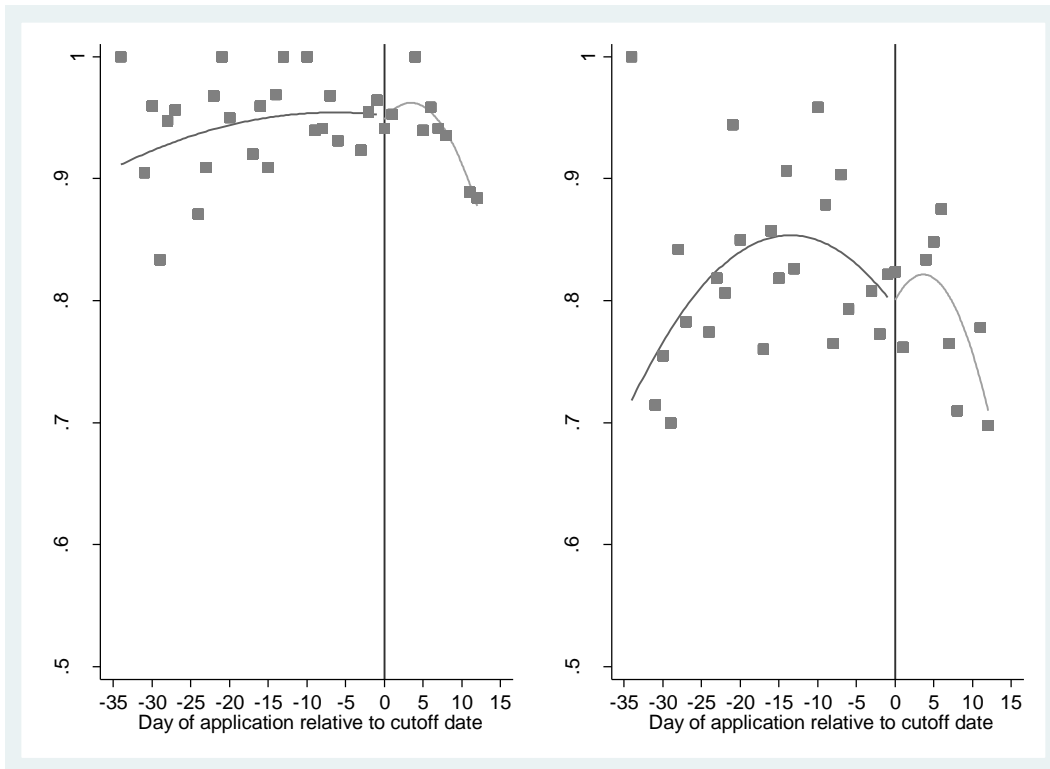


Figure C2 Proportion ever having been enrolled (left panel) and ever having completed (right panel) higher education during 2008-2013 by day of application, for subgroup of applicants that had already started at time of application



Appendix D Descriptive tables for subgroups by applicant and application characteristics

Table D1 Descriptive statistics sample of voucher applicants for bachelor of master degree programs by sector of work

Variables	(1) Primary education	(2) Secondary education	(3) Special Education
Panel A			
<i>Applicant characteristics</i>			
Female	0.89 [0.86]	0.58 [0.47]	0.78 [0.75]
Age	37.2 [41.9]	38.4 [44.3]	37.7 [42.5]
Living in Randstad region	0.39 [0.40]	0.37 [0.41]	0.39 [0.39]
Gross monthly salary (2008) at appointment of 1 FTE	2829 [3099]	3030 [3383]	2938 [3275]
Appointment in FTE	0.82 [0.74]	0.85 [0.83]	0.88 [0.81]
<i>Application characteristics</i>			
Already started higher education program at time of application	0.20	0.26	0.16
Program duration (in years)	1.97	2.68	1.96
Panel B			
<i>Treatment variables</i>			
Received voucher in first application period (2008)	0.64	0.66	0.60
Received voucher in any of first seven application periods (2008-2013)	0.80	0.83	0.73
Panel C			
<i>Outcome variables (2008-2013)</i>			
Ever having been enrolled in higher education	0.91	0.91	0.91
Completed higher education program	0.75	0.62	0.68
Proportion completed higher education program of those enrolled	0.82	0.68	0.75
Still enrolled in higher education in 2013 but did not complete a program during 2008-13	0.03	0.11	0.03
Still in education in 2012	0.89	0.81	0.89
N	1,893	1,776	551
Proportion of all applicants	0.45 [0.56]	0.42 [0.35]	0.13 [0.10]

Country averages are presented between brackets.

Table D2 Treatment and outcome variables before and after the cut-off date by sector of work and age category

Variables	(1) Primary education	(2)	(3) Secondary education	(4)	(5) Special education	(6)	(7) 15-34 years	(8)	(9) 35-64 years	(10)
	before	after	before	after	before	after	before	after	before	after
Panel A										
<i>Treatment variables</i>										
Received voucher in first application period (2008)	0.91	0.00	0.88	0.00	0.89	0.00	0.89	0.00	0.90	0.00
Received voucher in any of first seven application periods (2008-2013)	0.93	0.44	0.93	0.54	0.92	0.33	0.94	0.44	0.93	0.48
Panel B										
<i>Outcome variables (2008-2013)</i>										
Ever having been enrolled in higher education	0.90	0.88	0.93	0.86	0.93	0.86	0.94	0.90	0.92	0.85
Completed higher education program	0.77	0.68	0.65	0.53	0.70	0.63	0.76	0.65	0.68	0.59
Proportion completed higher education program of those enrolled	0.85	0.77	0.70	0.61	0.75	0.73	0.81	0.74	0.73	0.69
Still enrolled in higher education in 2013 but did not complete a program during 2008-13	0.03	0.05	0.10	0.15	0.02	0.03	0.05	0.09	0.06	0.08
Still in education in 2012	0.90	0.88	0.91	0.85	0.82	0.82	0.89	0.86	0.89	0.86
N	1,382	570	1,352	467	381	178	1,377	523	1,660	660

Table D3 Treatment and outcome variables before and after the cut-off date for subgroups by program duration and starting status

Variables	(1) Program duration 0-1 year	(2)	(3) Program duration >1-2 years	(4)	(5) Program duration > 2 years	(6)	(7) Not started at time of application	(8)	(9) Already started at time of application	(10)
	before	after	before	after	before	after	before	after	before	after
Panel A										
<i>Treatment variables</i>										
Received voucher in first application period (2008)	0.92	0.00	0.92	0.00	0.87	0.00	0.93	0.00	0.78	0.00
Received voucher in any of first seven application periods (2008-2013)	0.94	0.26	0.95	0.49	0.92	0.55	0.96	0.51	0.85	0.30
Panel B										
<i>Outcome variables (2008-2013)</i>										
Ever having been enrolled in higher education	0.93	0.88	0.93	0.86	0.93	0.88	0.92	0.86	0.94	0.93
Completed higher education program	0.81	0.65	0.77	0.65	0.64	0.55	0.69	0.57	0.82	0.78
Proportion completed higher education program of those enrolled	0.88	0.74	0.83	0.76	0.68	0.62	0.74	0.66	0.87	0.84
Still enrolled in higher education in 2013 but did not complete yet	0.02	0.06	0.03	0.04	0.09	0.15	0.06	0.09	0.05	0.07
Still in education in 2012	0.88	0.86	0.90	0.88	0.88	0.85	0.89	0.87	0.89	0.84
N	387	261	1,376	481	1,274	441	2,353	936	684	246



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