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Timing of College Enrollment and Family Formation Decisions *

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Abstract

It is likely that the extent of progression in the educational system affects whether or not one decides to start a family at a given point in time. We estimate the effect of enrolling in college in the year of application on later family formation decisions such as the probability of being a parent at a certain age. Using college admission data, we find that individuals who are above the grade requirement for their preferred college program are more likely to enroll in college in a given year. Employing an IV strategy based on this idea, we find that delays in college enrollment postpone family formation decisions. For example, we find that the effect of enrolling in college on the probability of being a parent at age 27 is about 9 percentage points, corresponding to an increase of about 70 percent.

JEL codes: I2, J12, J13 Keywords: fertility, education

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1 Introduction

Low fertility rates in several developed countries have caused a large demographic shift in recent years. To some extent this has coincided with an increase in women's educational attainment, see Goldin and Katz (2002). Understanding why we observe lower fertility rates is essential in order to design policies that can help alleviate the problem. In addition, when designing policies within other areas, e.g. education, it is important to consider the entire range of effects of such policies, and not just what may have been intended originally. For example, compulsory schooling laws have been shown to affect a wide range of outcomes, including fertility, marriage, and health, see e.g. Black, Devereux, and Salvanes (2008) and Oreopoulos (2007). Often the decisions of the timing of the first child and completed fertility are considered linked. D'Addio and d'Ercole (2005) remark that delays in family formation lead to decreases in fertility rates as well as increased health risks for mothers and children and increases in the extent of childlessness. Thus, delayed family formation may be associated with both economic and psychological costs.

A potential determinant of the timing of family formation is educational attainment or the timing hereof. This paper analyses whether the timing of family formation decisions is affected by the timing of a specific educational decision, namely college enrollment. Delayed college enrollment is often considered an adverse decision for society since it reduces the size of the skilled labor force.[1] We find evidence that delayed college enrollment has the additional adverse effect of postponing family formation decisions.[2]

From a theoretical perspective, there are a number of potential explanations why delayed educational attainment would affect family formation decisions. Education is a time-consuming activity and as such it may crowd out time spent on other activities including searching for a mate and caring for a child. Becker (1965) proposes a labor supply model in which education increases earnings and thus increases women's opportunity

[1] Delayed college enrollment is common and pronounced in the Scandinavian countries, see e.g. Humlum (2007) and Holmlund, Liu, and Skans (2008).

[2] Delayed family formation need not have only detrimental effects, Miller (2009) shows that delayed motherhood increases the test scores of the first-born child suggesting that there may be a quantity-quality tradeoff. Also, while delayed family formation is considered an adverse event in terms of fertility rates etc. when considering the more mature part of the population, very early family formation, e.g., teenage pregnancies, is also considered an adverse event.

cost of having children. However, as higher education leads to higher permanent income, this could also imply higher fertility. The literature on the quality-quantity trade-off in children (see e.g. Becker and Lewis (1973) and Becker and Tomes (1976)) predicts that fertility is decreasing in education. Happel, Hill, and Low (1984) consider a model of the timing of the first birth. Among other things they suggest that prospective parents have an economic incentive to align the costs of having a child with a period of their lives where their income is relatively high if they wish to smooth consumption over their life-cycle and capital markets are not perfect. This is what Happel, Hill, and Low (1984) term the "consumption-smoothing motive in child-timing decisions". Since household income will tend to increase substantially when one or both earners complete their education and enter the labor market, the presence of this consumption-smoothing motive implies that the timing of college enrollment may affect the timing of family formation. Also, if there is uncertainty about getting a job after completing college, or uncertainty about the wage in the potential job, then a risk-averse prospective parent may want to postpone family formation until having procured the first job. Another potential explanation is that peer effects are important in determining the timing of fertility. While studying, peers with children are relatively scarce compared to the situation in the average workplace where peers tend to be older and have more children. There is some empirical evidence suggesting that the fertility decisions of a woman's coworkers matter for her own fertility decisions, see Ciliberto, Miller, Nielsen, and Simonsen (2010).

The existing literature has documented a strong relationship between educational attainment and family formation. In order to establish whether this is indeed a causal link, existing studies have mainly used exogenous variation in the form of rules regarding age at school entry and compulsory schooling laws. For school entry rules, i.e. essentially comparing individuals born in December with individuals born in January, the existing evidence is somewhat mixed. McCrary and Royer (2011) find little effect of mother's education on fertility outcomes using natality data from Texas and California. However, using a similar approach, Skirbekk, Kohler, and Prskawetz (2004) find positive effects on the age at first and second birth and age at first marriage for Swedish women.

Using compulsory schooling laws to instrument educational attainment has been used to study the effects of education on various outcomes. Focusing on family formation outcomes, there is a substantial amount of evidence suggesting that educational attainment affects individuals' fertility and marriage choices. Whether or not the effects on family formation decisions are temporary, e.g. affecting only the age at first birth, or permanent, e.g. affecting completed fertility, appears to remain an open question though. While Monstad, Propper, and Salvanes (2008) use Norwegian data and find little effects on completed fertility, Fort, Schneeweis, and Winter-Ebmer (2011) use data from eight European countries and find that completed fertility is actually increased. Also, increasing the length of compulsory schooling reduces the incidence of teenage pregnancies, see Black, Devereux, and Salvanes (2008) for Norway and the U.S. or Silles (2011) for Great Britain and Northern Ireland. Devereux and Tripathi (2009) find that increasing compulsory schooling increases the age at first marriage.

Exogenous variation at higher levels of education is more rarely used as identification in this literature. Obviously, the mechanisms and potential effects of parents' education are likely to be different at higher levels of education. Currie and Moretti (2003) use college openings as an instrument for mother's education and find that education reduces parity. Overall, there appears to be a consensus that educational decisions and thereby educational policy affect many other important life decisions including family formation decisions. It is less clear exactly how education affects these decisions. For example, increasing the length of compulsory schooling has two main effects. First, it increases the human capital of the individual. Secondly, it increases the age at which the individual is free to pursue other activities.

We contribute to the above literature using a different source of exogenous variation than existing studies, namely college admission requirements. Thus, we use exogenous variation that affect individuals at a much later stage in life than almost all of the studies mentioned above. We will show that individuals who are affected by the admission requirements are induced to postpone their college entry, but not alter their college-going decision as such. Therefore, we interpret our estimates as reflecting primarily a timing effect and not a human capital effect. We find that later college entry leads to delays in family formation.

The main contribution of this paper is to estimate the causal effect of college enrollment in a given year on later family formation decisions. In order to deal with the likely endogeneity of the decision of when to enroll in college, we use variation in enrollment based on the college admission system in Denmark.[3] Danish colleges have capacity constraints, and a centralized admission system ensures that the most able applicants in terms of high school GPA are allocated to their preferred college programs resulting in an effective grade requirement for each college program each year. Applicants with a GPA above the requirement are admitted, and applicants with a GPA below the requirement are rejected.[4] Since the grade requirements are unknown to the applicants when they apply, the admission system potentially generates exogenous variation in enrollment.

We find that whether or not an applicant enrolls in the year of application has an effect on the timing of college completion. However, we find at most small effects on the level of college completed. Thus, the admission system appears mainly to delay educational attainment. We find that the timing of family formation is affected by the timing of college enrollment, e.g., enrollment in the year of application increases the probability of being a parent at age 27 by about 8.8 percentage points—corresponding to an increase of about 70 percent. We find effects of similar size on the probability of cohabiting at age 26 and being married at age 27. The pattern of the estimates is consistent with a setting in which the level of progression in the educational system affects individuals' choices regarding family formation and especially childbearing.

The paper is organized as follows. In section 2 the institutional settings and the Coordinated Enrolment System are presented. In section 3 we describe our empirical approach. Section 4 describes the data used, and in section 5 we present our estimation results. Finally, section 6 concludes.

2 Institutional settings

In Denmark compulsory schooling has a duration of 9 years, and children usually start school at the age of seven.[5] After compulsory school further education can be obtained by attending either a vocational education and a training program or a high school education. In high school, the students can choose between a business track, a technical track or an academic track. High school educations and to a smaller extent vocational educations

[3]See Öckert (2010) for an example of a study using a college admission system to identify causal effects of education on earnings.

[4]In reality the admission system is more complex. Additional details are given in section 2.

[5]In 2009 this was changed to 10 years of compulsory schooling starting at the age of six.

serve as qualifying educations for entering college programs. The costs of going to college are rather small in Denmark compared to for example the US, as the college programs are free and publicly provided, tuition is free of charge, and the government provides very generous student grants.[6] It is also possible to take up additional student loans at favorable terms. In general, the student grant is set to cover living expenses.

2.1 The Coordinated Enrolment System

All applications to college programs in Denmark are handled by a centralized admission system, the Coordinated Enrolment System (KOT). The applicant can apply to up to eight different college programs in the same application. For a large number of college programs there are more applicants than available slots, which implies that college applicants are potentially constrained in their choice of college program.

KOT allocates applicants to educations such that the best applicants are allocated to their preferred educations. The system is complex, but the majority of applicants are assessed exclusively on their high school GPA. In addition, each college program has some basic requirements that mainly consist of high school course requirements. Each college reports to KOT how many slots they have in each program. The applicants are ranked according to their high school GPA. Higher ranking applicants are admitted, and when the capacity constraint binds, the grade requirement is set at the GPA of the marginal applicant. Applicants with a GPA above the grade requirement are offered slots, whereas applicants with a GPA below the grade requirement are rejected. In this way, the grade requirement is determined each year after the application deadline. Even though the number of slots in each program is relatively fixed from year to year, the number of applicants vary, which implies that the grade requirement varies. Thus, applicants do not know the grade requirement at the time they apply, and at least for individuals with a GPA close to the grade requirement it will not be possible to predict whether the grade requirement of a given college program will be above or below their GPA. We substantiate this claim in section 4.4.

Many programs admit all applicants with a GPA equal to the grade requirement, but other programs use another admission rule for these applicants, namely an age tie-

[6] In 2010 the student grant for a student not living at home was DKK 5,384 corresponding to approximately USD 900 per month.

breaking rule. The rule implies that when two applicants are tied with respect to GPA, the oldest applicant is admitted. In the empirical analysis, we focus on programs that admit all applicants with a GPA equal to the grade requirement.

As mentioned some applicants are also assessed on other characteristics than their high school GPA. One can apply based on a point system which gives points partly for the GPA from the qualifying education and partly for other activities such as relevant work experience, stays abroad etc. The slots in a given year allocated to such applicants constitute a minor part of the total number of slots.

The system also allows applicants to apply for standby slots, i.e., the applicant is guaranteed a slot in the next academic year at the latest. These slots are allocated to applicants who have a GPA slightly below the grade requirement.

3 Empirical Approach

The empirical approach is inspired by the institutional settings described above. The basic idea is to use the fact that applicants at the time of application cannot perfectly foresee what the required GPA is going to be in a given college program. The underlying assumption behind the identification strategy is that applicants who end up being just above or just below the grade requirement are essentially the same. If the grade requirement for an applicant's preferred program turns out to be above the applicant's GPA, there is a much lower chance of being admitted to that program than if the grade requirement turns out to be below the applicant's GPA. Thus, we have a fuzzy regression discontinuity design if we consider each program in each year separately.

3.1 Instrumental Variables

The goal of this paper is to estimate the causal relationship between an outcome, say, being a parent, y_i, and enrollment at a given point in time, e_i, where i indexes individuals.

$$y_i = X_i\beta_0 + \delta e_i + \varepsilon_i.$$

Estimating this relationship assumes that e_i and the error term ε_i are independent, which is unlikely to be a valid assumption given that those who choose to enroll at a given point in time is a selected group of people. Following, among others, Angrist and Lavy

(1999), who also use an RD inspired IV method, we use the RD design described above to instrument enrollment.

Let d_i measure the distance between individual i's GPA and the grade requirement at individual i's preferred program.

$$d_i = GPA_i - GR_i \qquad \begin{cases} < 0 \Rightarrow t_i = 0 \\ \geq 0 \Rightarrow t_i = 1 \end{cases}$$

where GPA_i is the grade point average for individual i, and GR_i is the grade requirement at individual i's preferred program. Under the assumption that applicants cannot perfectly predict the grade requirement, t_i will be uncorrelated with later outcomes except through its effect on the enrollment decision for d_i sufficiently close to zero. Thus, for applicants with distances sufficiently close to zero, we can estimate the causal effect of enrollment on later family formation outcomes by instrumenting enrollment with the indicator for being below or above the grade requirement, t_i.

The first stage is estimated by

$$e_i = \alpha_1 + f_1(d_i) + \gamma_1 t_i + h_1(GPA_i) + X_i\beta_1 + \varepsilon_{1i}$$

where f_1 is a function such as splines or polynomials approximating the underlying variables. h_1 is a function of the GPA. For a single program in a single year GPA and distance would be perfectly correlated, but since we consider several programs in several years, the effects of GPA and distance can be separately identified. Thus, we are able to include a measure for ability (GPA) even though the admission system is in fact based on admitting the most able. This is important since the forcing variable, distance, to some extent reflects GPA and so may be correlated with the outcome. X_i is a vector of control variables such as age, gender, parental background etc.

A central question in relation to the empirical implementation of this strategy is what we can reasonably assume are distances sufficiently close to zero. A wider window—in terms of distance—will increase precision of the estimates, but can introduce bias. By looking at how the grade requirements actually change over time in section 4.4, some rough guidelines can be deduced.

3.2 Interpretation of Estimates

The estimated effects are based on IV estimation. Therefore, in the case of heterogeneous treatment effects, the interpretation of the estimated effect is that of a Local Average Treatment Effect (LATE). In this case, we can think of the estimated effect as being the average treatment effect of enrollment on later family formation outcomes for those applicants who chose to enroll because they were above the grade requirement but would not have enrolled otherwise. This parameter is very policy relevant, since it is the equivalent of increasing capacity at the universities, e.g., giving marginal students in each field access to their desired program.

4 Data

The data used for the empirical analyses is administrative data hosted by Statistics Denmark that covers the entire Danish population. These are linked to data from the Coordinated Enrolment System (KOT) for college programs in Denmark. The combined data set contains detailed information on young individuals, their college-related choices and preferences, and their educational and family background.

The KOT data contains information on all applicantions to college programs in Denmark in the period 1996-2006. Thus, the data consists of both applicants who will enroll in college at some later point and applicants who do not enroll in college. Since a college application to KOT includes a prioritized list of college programs for each individual, we can distinguish between the applicants' actual college choices and their stated college preferences.

4.1 Description of the Sample

To obtain a suitable sample for the analyses described in the empirical section, we introduce a number of restrictions on the data. Table 1 provides an overview of the sample selection. The data contains information on about $600,000$ applications to college programs in the period 1996–2006.

We choose to focus on applications where the preferred program is a long-cycle college program with a grade requirement.[7][8] The empirical strategy outlined above is not applicable for programs without a grade requirement. In addition, the data includes a number of applications to programs where another allocation rule is applied. In particular, some college programs use a non-trivial allocation rule for applicants who exactly meet the grade requirement.

In order to compute the distance to the grade requirement for each individual applicant, information about the high school grade point average (GPA) is required. GPA is missing for a number of applicants which is mainly explained by the presence of applicants with a foreign high school degree or another type of qualifying education.

After imposing the abovementioned restrictions on the sample, 144,113 observations remain. These include all applications that satisfy the above criteria, but as argued above, the empirical strategy is only valid for applicants whose GPA is in the vicinity of the grade requirement of their preferred program in the year of application (YOA). In the main analyses, a window of 0.3 is considered, i.e., 23,919 observations.[9] Figure 1 shows the distribution of the distance to the grade requirement before imposing the window. The distribution is skewed slightly to the left of 0 and resembles a normal distribution.

4.2 Descriptive Statistics

In order to gain an understanding of how the stated college preferences are related to actual college choices, Table 2 shows the distribution of actual college program level and field by the preferred program level and field. The sample is split by whether individuals are below or above the grade requirement. The preferred level and field are deduced from the applicants' ranking of programs, i.e., their stated college preferences. The preferred program level and field is the level and field of the college program the applicant gives the highest ranking.

By construction, all individuals in the sample prefer to enroll in a long-cycle college program. For about 89 and 95 percent of individuals below or above the grade require-

[7]Long-cycle college programs are programs at the university level

[8]Whether or not a particular college program has a grade requirement can vary from year to year. An application is included in the sample if the preferred program had a grade requirement in the year of application.

[9]See section 4.4 for further discussion of the choice of the size of the window and section 5.2 for some robustness checks.

ment, respectively, this corresponds to the actual level of the college program they enroll in. The remaining individuals enroll in shorter college educations or do not enroll in college at all.[10]

Comparing the preferred field with the actual field of enrollment, we observe that the majority of individuals enroll in their preferred field. For individuals below the grade requirement, 78–85 percent actually enrolled in their preferred field. For individuals above the grade requirement, 89–94 percent actually enrolled in their preferred field. Overall, Table 2 suggests that the large majority of individuals in the sample enroll in a college program that is in accordance with their preferences. However, it is clear that the admission system does impose a binding constraint on individuals' college choices.

Table 3 shows the sample means for the main covariates, three selected outcomes, and enrollment in YOA divided by whether an individual is above or below the grade requirement. The means are shown for a window of 0.3. In addition, the two columns to the right show the difference in means and whether this difference is statistically significant for a window of 0.3 and 0.1, respectively. The identification strategy requires the groups above and below the grade requirement to be relatively similar. However, Table 3 reveals some differences—even for the smaller window. Specifically, the GPA is significantly higher for individuals above the grade requirement than for individuals below the grade requirement, as is expected since distance is based on GPA. Individuals above the grade requirement also tend to be younger than individuals below the grade requirement and less likely to have been enrolled in college previously. The admission system is likely to generate a negative correlation between distance to the grade requirement and age since individuals with GPAs below the grade requirement have the opportunity of gaining admission based on a number of other criteria. Generally, older applicants are more likely to fulfil these criteria which generally require that time-intensive activities have been undertaken. Individuals above the grade requirement are also more likely to prefer Humanities and less likely to prefer Health Science. Overall, the differences between the two groups are small, except for GPA, age, and variables highly correlated with age. Since we can control for GPA and age in the estimations, we find that the statistics in the table suggest that the empirical strategy is feasible. Moreover, considering the means of the

[10]The percentages of individuals who do not enroll in college are likely to be artificially high since the data are right censored.

three selected outcomes suggests that family formation occurs earlier for applicants with a GPA above the grade requirement, i.e., the applicants that are more likely to enroll in the year of application.

We consider the following three family formation outcomes measured at a specific age or a specific number of years after application: the probability of being a parent, the probability of cohabiting, and the probability of being married. The two latter outcomes are not necessarily consistent with an individual starting a family, but for the majority of individuals in the sample, family formation will begin with either cohabitation or marriage. Figure 2 shows how the probabilities of these outcomes evolve over time. Separate graphs are shown for individuals below and above the grade requirement. The two groups generally do not deviate much in terms of these outcomes when we consider the raw data, although some minor differences appear. Generally, the probability of being a parent and being married is close to zero for very young individuals or at times when individuals apply to college. About 10 percent of the sample is cohabiting at age 21, and about 20 percent of the sample is cohabiting in the year of application.

4.3 The Discontinuity in Enrollment and the Implications for Timing of College Completion

Whether or not a prospective student chooses to enroll in college in a given year is likely to be an endogenous variable. As described earlier, we therefore instrument college enrollment by whether or not individuals are above or below the grade requirement of their preferred program in the year of application. Figure 3 illustrates the suitability of this instrument. The graph shows a clear discontinuity in the probability of college enrollment in the year of application by distance to the grade requirement. The vertical discontinuity is almost 30 percentage points, i.e., being above the grade requirement increases the probability of college enrollment by about 30 percentage points. The graph also reveals that the probability of enrollment tends to be increasing in the distance to the grade requirement. This is consistent with more able individuals (i.e., with higher GPAs) being more likely to enroll. Even for individuals below the grade requirement, the college enrollment rate is about 55 percent. There are two explanations for this. First, individuals who are not admitted to their preferred program may still be admitted to another college program. Second, individuals who are below the grade requirement can still be admitted to their preferred program given that they meet a number of other criteria as mentioned briefly in section 2. For individuals above the grade requirement, the college enrollment rate is about 85 percent. Again, there are a couple of potential explanations for this. First, individuals may decide not to enroll after all, even if offered a slot. Second, individuals may fail to meet some of the other official requirements, e.g., the high school course requirements.

In order to get an idea of how the estimates obtained in the empirical section should be interpreted, Figure 4 shows the IV estimates of the effect of enrollment on the probability of having completed college by years after application. While Table 2 showed differences in the actual college levels of individuals above or below the grade requirement, Figure 4 suggests that the effect of enrollment on the probability of having *completed three years of college* 5–7 years after application is close to zero.[11] Indeed, the graph suggests that—at least in terms of college level—the main effect of the grade requirement is to delay some individuals in their educational career.

4.4 Variation in Grade Requirements Over Time

If applicants are able to predict the grade requirement of their preferred program in the year of application, applicants who are above and below the grade requirement are likely to be systematically different. Table 4 provides a rough picture of how much the grade requirements vary from year to year. The table reports the mean absolute change and the standard deviation of the absolute change in grade requirement for each program for each year. The weights used are based on the number of applicants in the estimation sample that applies to a given program in a given year. Thus, the weighted mean is the more relevant measure in terms of individuals in the estimation sample.

The unweighted measure shows an average absolute change in grade requirements of about 0.29, whereas the weighted mean is considerably lower at about 0.16, corresponding to a yearly change of approximately 2–4 percent, which implies that potential applicants will not be able to perfectly predict the grade requirement in the year they apply. The standard deviations are also quite high, which again makes it harder for potential ap-

[11] This may seem like an odd measure, but we have chosen this measure in order to have a comparable measure across college programs and to minimize problems with right censoring.

plicants to forecast the cutoff. Presently, these measures should be considered relatively conservative, as changes in grade requirements that reflect a change from a non-binding capacity constraint to a binding capacity constraint are not included. Such changes in grade requirements would tend to be larger. The presented results will be based on applicants whose distance from the grade requirement of their preferred education is -0.3 to 0.2. Based on the statistics in Table 4, we consider this a reasonable window. However, as this is a crucial assumption in the analysis, robustness of results with respect to this assumption will also be investigated.

5 Results

We present IV estimates and robustness checks of the effect of enrollment on selected outcomes using an indicator for being below or above the grade requirement as an instrument for enrollment.[12]

5.1 Main IV Results

Table 5 shows IV estimates for three selected outcomes: being a parent at age 27, cohabiting at age 26, and being married at age 27. The table also includes the t-statistic of the instrument and the r-squared from the first-stage regressions. The t-statistics are generally high, about 19–22, suggesting that the instrument is strong. The estimated effects of enrollment are relatively large for all three outcomes and statistically significant at the 5 percent level. Enrolling in the year of application increases the probability of being a parent at age 27 by 8.8 percentage points. Given that the average probability of being a parent at age 27 is about 10–15 percent, this constitutes a substantial increase. One reason for this could be that invididuals want to postpone having children until they have established a labor market career. This would be consistent with Del Bono, Weber, and Winter-Ebmer (forthcoming) who find that being laid off after plant closure delays having children for career oriented women.

The estimated effects of enrollment on the probability of cohabiting at age 26 and being married at age 27 are 12.9 and 10.8 percentage points, respectively. Gender and age

[12]Unless otherwise stated, the presented results are for a window of 0.3, i.e., for distances to the grade requirement of -0.3 to 0.2.

in year of application are important determinants of the three family formation outcomes. Women are generally more likely than men to have begun some family formation at the specific ages considered here. Also individuals who are younger in the year of application are more likely to have begun some family formation. The age of the applicant's parents at birth appears to be the most important (of the parental background variables) determinant of the family formation outcomes. Overall, the pattern is consistent with some form of intergenerational transmission of family capital or preferences for family formation, since individuals whose parents were younger when having children are also more likely to have achieved some degree of family formation themselves by the specific ages considered here.

Generally, the coefficients on the indicators for the preferred field of the applicant are relatively small and mostly insignificant. Two exceptions are that individuals who prefer Humanities are less likely than individuals who prefer Social Science to be cohabiting at age 26, and individuals who prefer Natural Science are less likely than individuals who prefer Social Science to be married at age 27.

The family formation status in the YOA, i.e., being a parent in YOA and cohabiting in YOA, is an important determinant of later family formation outcomes. The coefficients on these two variables are positive and highly significant for all three outcomes which is natural.

Figure 5 provides a graphical illustration of how the IV strategy works for the three selected outcomes. The figure shows a graph of each outcome by distance to the grade requirement. For being a parent at age 27 and being married at age 27, the graphs are consistent with a RD setup. For cohabitation at age 26 the graph is not quite as convincing. This suggests that these estimates might be slightly more sensitive to changes in the size of the estimation window.

In order to illustrate how sensitive the IV estimates of the effect of enrollment on the selected outcomes are, Table 6 shows how the IV estimates change when different groups of covariates are gradually included. The size of the estimated coefficients and standard errors are not particularly sensitive to the inclusion of different covariates. Based on the results in this table, i.e., the fact that inclusion of covariates matter relatively little, the identification strategy appears to be relatively sound. Column (7) in Table 6 represents the results from Table 5.

We have a couple of concerns about the IV estimates. First, the specifications in

Table 5 include only very rough indicators of preferred field. If individuals below the grade requirement enroll in different fields of education than individuals above the grade requirement then the differences in fields could be driving the results. For example, if individuals below the grade requirement are more likely to enroll in Natural Science college programs and individuals who study Natural Science for some reason tend to delay family formation then the delayed family formation may be caused by a difference in the college field and not by a difference in the timing of college enrollment. The first column in Table 7 displays IV estimates where we include very detailed indicators for the actual college field (56 categories). This has little effect on the estimates. Although the centralized admission system affects the actual fields in which the applicants enroll, the effects of enrollment on family formation that we observe do not appear to be driven by differences in actual field choices.

Individuals above and below the grade requirement may also differ with respect to future income. If individuals rank college programs according to earnings potential, we would expect individuals above the grade requirement to end up with higher earnings. This gives rise to a substitution effect—it becomes more costly to spend time on children—and an income effect. We find that delayed college enrollment delays family formation suggesting that the income effect may be dominating. Also, if individuals below the grade requirement have lower earnings, they will also have a lower value on the marriage market. The second column of Table 7 presents estimates where earnings 5 and 10 years after YOA are included. Again, we find that this changes the estimates very little and conclude that differences in future earnings cannot explain the results.

Another issue is whether delayed college enrollment really affects both cohabitation, marriage, and childbearing decisions directly. Or, for example, whether delayed college enrollment delays cohabitation and marriage decisions which implies that childbearing is also delayed. Including the indicators for cohabitation and marriage tends to make the estimates on being a parent at age 27 smaller and insignificant. However, this is also the case if we include indicators for being a parent and cohabitation when estimating the effect on being married at age 27. Thus, we are not able to say anything about which of these decisions—if any—is more influenced by delayed college enrollment.

Until now, we have focused on three selected outcomes. However, what we are really interested in is how enrollment affects family formation at a range of ages and a range of years after application. Figure 6 shows the estimated effects of enrollment and 95 percent confidence bands by age and years after application. At younger ages the effects generally tend to be close to zero but especially for the probability of being a parent and the probability of being married. As age increases the effects also increase and peak at about 27 years. After that the effects tend to become smaller—although here the confidence bands become too wide to test this statistically. A similar pattern emerges when we consider the estimated effects by number of years after application. In the first years after application, the effect of enrollment on family formation outcomes is close to zero—at least for the probability of being a parent and being married. Around 7 years after application the effect becomes positive and statistically significant. Overall, the results suggest that the timing of college enrollment does affect the timing of family formation decisions. Specifically, earlier college enrollment leads to earlier family formation.

5.2 Robustness of Results

Focusing again on the three selected outcomes, Table 8 shows how sensitive the estimates are to smaller changes in the size of the window. The estimates of the effects of enrollment on the probability of being a parent at age 27 and being married at age 27 are not particularly sensitive to changes in the window. The standard errors increase as the window is reduced and the number of observations becomes smaller, but generally, we cannot reject that the estimated coefficients are the same for the different windows. For cohabitation status at age 26 the estimated coefficients do vary more substantially in size, but the standard errors are also relatively large.

Table 9 shows the IV estimates for the three selected outcomes by gender of the applicant. The instrument is strong for both men and women, and although the size of the coefficients vary slightly, the size of the standard errors implies that we cannot reject that the effects are the same across gender. However, the estimate on being a parent at age 27 is substantially higher for men. One interpretation is that women have stronger preferences for having children at specific ages and the surrounding circumstances thus matter less.

5.3 Comparison With OLS Estimates

Table 10 shows OLS estimates for the three selected outcomes. These estimates are of interest because they give an idea of the extent to which the IV approach matters for the results. It only makes sense to compare these estimates if we think of treatment effects as being homogenous. If treatment effects are heterogenous, the IV estimate can be given a LATE interpretation and is no longer directly comparable to the OLS estimate. The OLS estimates are all positive and significant at the 10 percent level. However, contrary to the IV estimates in Table 5, the OLS estimates are small. They range from 1.0 to 1.4 percentage points, whereas the IV estimates range from 8.3 to 12.9 percentage points. Thus, given that our identification strategy is valid, OLS estimates of the effect of enrolling in the year of application on family formation outcomes are downward biased. The OLS estimates do not account for the fact that individuals who choose to enroll in the year of application are likely to be different from individuals that do not.

6 Conclusion

We analyze a problem that has not been paid much attention in the literature on educational choices, namely how delays in the educational career affect the timing of family formation and fertility decisions. We argue that the identification strategy pursued allows us to identify the causal effect of delayed college enrollment on later family formation decisions. Other studies have sought to estimate effects of education on family formation, but they have focused on earlier educational interventions such as rules regarding school starting age and compulsory school leaving laws that may have both timing and human capital effects.

We find strong evidence that delayed college enrollment affects the timing of later family formation decisions. The estimated effects tend to be substantial. We find that enrolling in the year of application increases the probability of being a parent at age 27 by 8.8 percentage points which corresponds to an increase of about 70 percent. Clearly, this suggests that the timing of college enrollment—and as a consequence college completion—is an important determinant of later family formation decisions. From a policy perspective, this highlights another potential cost of delays in the educational career, namely delayed family formation and childbearing. Whether delays also lead to a reduction in completed fertility, we cannot say, but it would be a fruitful avenue for future reseach to investigate the timing of family formation with respect to educational delays in more detail in order to assess the economic and psychic costs more thoroughly.

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A Figures

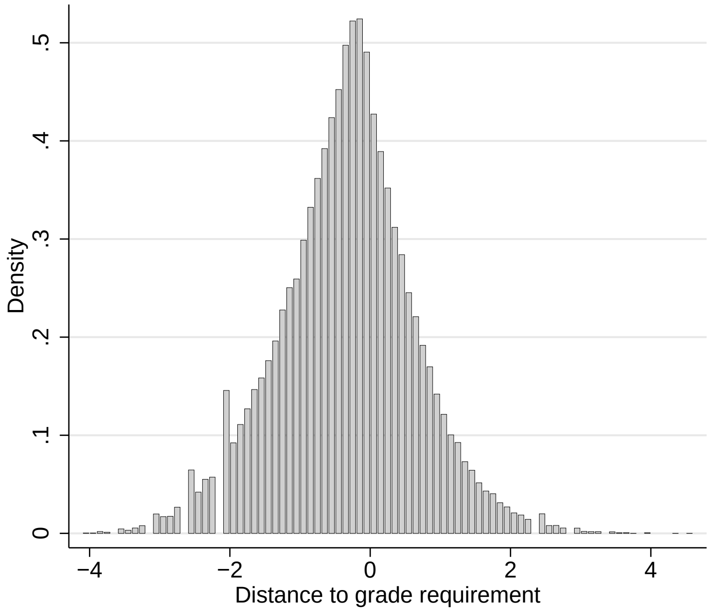

Figure 1: Distribution of distance to the grade requirement.

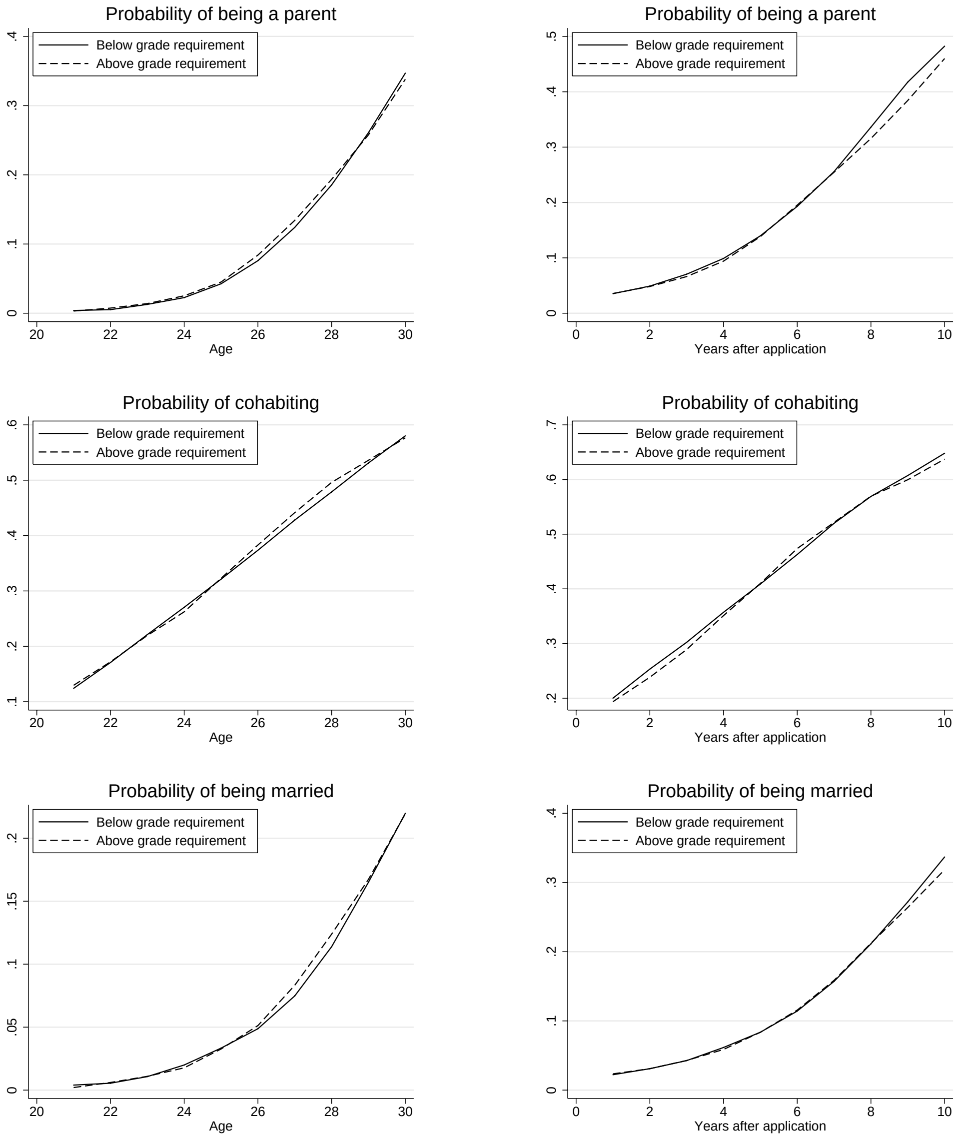

Figure 2: Means of selected outcome variables over time. Sample is based on a window of 0.3.

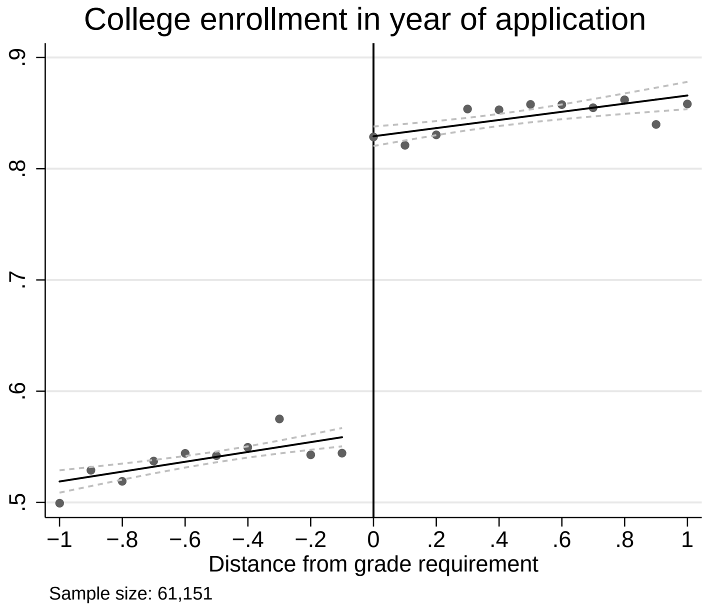

Figure 3: Discontinuity in college enrollment by distance from grade requirement. Scatter plot is overlaid with fitted values and 95 percent confidence bands from a linear regression on distance, an indicator for being above the grade requirement, and an interaction of the two.

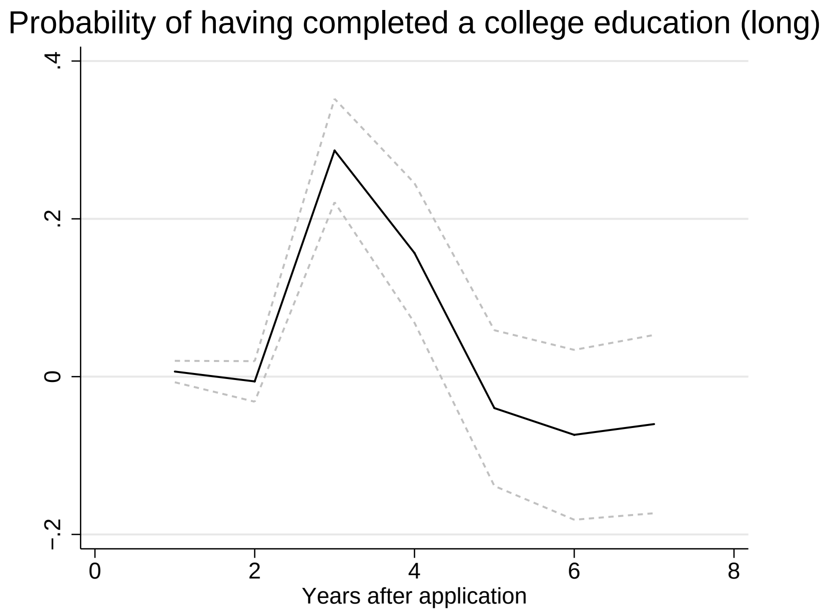

Figure 4: IV estimates of the effect of enrollment on the probability of having completed three years of college and 95 percent confidence bands. Includes all covariates. Standard errors are robust and clustered at the individual level.

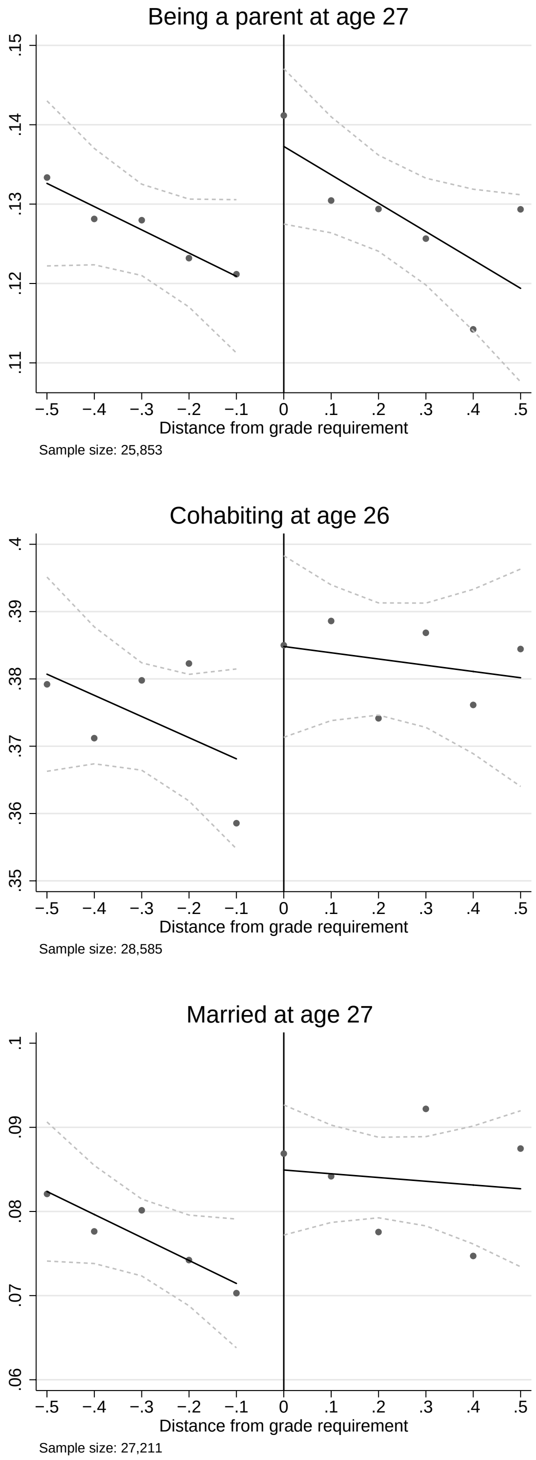

Figure 5: Selected outcomes by distance from grade requirement. Scatter plot is overlaid with fitted values and 95 percent confidence bands from a linear regression on distance, an indicator for being above the grade requirement, and an interaction of the two.

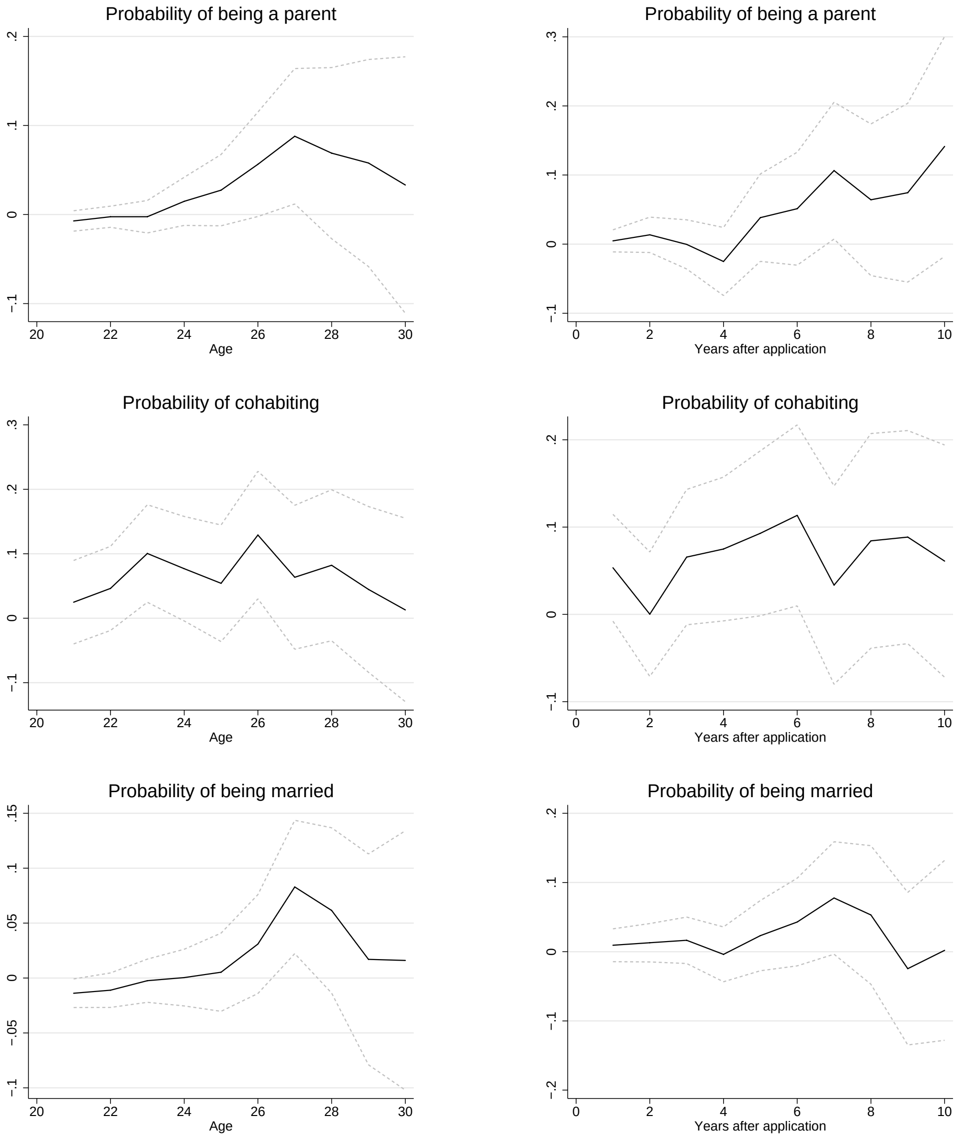

Figure 6: IV estimates of the effect of enrollment on main outcomes and 95 percent confidence bands. Includes all covariates. Standard errors are robust and clustered at the individual level.

B Tables

Table 1: Sample Selection

Description	Number of observations	Percentage of total
Applications to college programs 1996-2006	621,695	100.0
Applications to college programs(long)	288,531	46.4
The preferred program has a grade requirement	210,153	33.8
The preferred program has a simple enrollment rule for those who exactly meet the grade requirement	190,116	30.6
Non-missing GPA	144,413	23.2
Window=0.3	23,919	3.8

Table 2: Preferred and Actual Enrollment for Applicants to College (Long) Who Were Below or Above the Grade Requirement

	Preferred level			*Preferred field*							
	College (long)			Humanities		Social Science		Natural Science		Health Science	
	Below	Above		Below	Above	Below	Above	Below	Above	Below	Above
Actual level			*Actual field*								
No college	4.5	3.0	No college	5.3	3.5	4.1	2.3	5.4	3.4	3.5	2.8
College (short)	6.5	2.4	Humanities	**85.4**	**92.9**	12.4	2.8	6.7	3.8	2.7	0.9
College (long)	**89.0**	**94.6**	Social Science	5.1	2.0	**79.2**	**93.7**	5.5	1.8	4.8	1.4
			Natural Science	2.9	1.1	2.4	0.8	**78.3**	**89.1**	9.9	1.9
			Health Science	1.2	0.6	1.9	0.5	4.2	1.9	**79.2**	**93.1**
Number of observations	12,954	10,965		4,645	4,297	4,753	3,897	1,098	1,002	2,458	1,769

a) Only observations close to the grade requirement (window=0.3) are included.

Table 3: Descriptive Statistics

	Below grade requirement		Above grade requirement		Equality of means	
					Window=0.3	Window=0.1
	Mean	Std.dev	Mean	Std.dev.	Difference	Difference
Female	0.622		0.626		0.004	-0.002
Age in YOA	22.237	3.347	22.040	3.213	-0.197***	-0.173**
High school GPA	8.878	0.571	9.078	0.600	0.200***	0.078***
Preferred field						
Humanities	0.359		0.392		0.033***	0.026**
Social science	0.367		0.355		-0.012*	-0.014
Natural science	0.085		0.091		0.007*	0.008
Health science	0.190		0.161		-0.028***	-0.020**
Mother's education						
Basic	0.190		0.190		0.000	-0.008
Vocational	0.233		0.235		0.001	0.017*
College	0.531		0.532		0.002	-0.007
Missing	0.047		0.043		-0.003	-0.002
Father's education						
Basic	0.169		0.167		-0.002	-0.004
Vocational	0.254		0.246		-0.008	0.003
College	0.487		0.496		0.009	0.004
Missing	0.090		0.090		0.000	-0.003
Mother missing	0.014		0.013		-0.001	0.002
Father missing	0.033		0.036		0.003	0.006
Mother's log earnings at age 18	10.617	4.148	10.634	4.122	0.017	-0.006
Mother's earnings missing	0.039		0.035		-0.003	-0.003
Father's log earnings at age 18	12.502	0.984	12.524	0.959	0.022	0.030
Father's earnings missing	0.224		0.223		-0.001	-0.002
Being a parent in YOA	0.027		0.028		0.001	0.001
Cohabiting in YOA	0.127		0.113		-0.014***	-0.009
- Missing	0.025		0.024		-0.001	-0.005
Prior enrollments	0.265		0.240		-0.025***	-0.023**
Selected outcomes[c]						
Being a parent at age 27	0.124		0.134		0.010*	0.020**
Cohabiting at age 26	0.373		0.383		0.009	0.026**
Being married at age 27	0.075		0.083		0.008**	0.017**
Enrollment in YOA	0.554		0.827		0.273***	0.284***
Number of observations	12,954		10,965		23,919	8,514

Notes:

a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

b) In addition to the variables listed in this table, the following variables are also included in the analyses in section 5: indicators for parents' age at birth and year of application.

c) For number of observations for the selected outcomes, see Table 5.

Table 4: Variation in Grade Requirements

Absolute change in grade requirement	Mean	Std.dev.
Unweighted	0.290	0.316
Weighted	0.160	0.189

Table 5: IV Results

	Being a parent at age 27	Cohabiting at age 26	Married at age 27
First-stage			
t-statistic of instrument	18.962	21.723	19.691
R-squared	0.105	0.112	0.108
	Coef./Std.err.	Coef./Std.err.	Coef./Std.err.
Second-stage			
Enrollment	0.088**	0.129**	0.083***
	(0.039)	(0.050)	(0.031)
Distance to grade req.	-0.055	-0.078	-0.054
	(0.042)	(0.057)	(0.034)
tiXdistance	0.023	0.048	0.016
	(0.065)	(0.090)	(0.052)
Female	0.040***	0.091***	0.039***
	(0.006)	(0.009)	(0.005)
Age in YOA (ref: 20-22)			
19 or below	0.061***	0.041***	0.082***
	(0.013)	(0.016)	(0.012)
23-25	-0.047***	-0.078***	-0.033***
	(0.007)	(0.010)	(0.006)
26-29	-0.100***	-	-0.035***
	(0.010)		(0.011)
High school GPA	0.002	-0.018**	0.001
	(0.006)	(0.008)	(0.005)
Parental education (ref: basic)			
Mother - vocational	-0.016*	-0.014	-0.014*
	(0.009)	(0.013)	(0.008)
Mother - college	-0.010	-0.023*	-0.005
	(0.009)	(0.012)	(0.007)
Mother - missing	-0.013	-0.080***	-0.003
	(0.018)	(0.031)	(0.018)
Father - vocational	0.009	0.021	-0.007
	(0.009)	(0.013)	(0.008)
Father - college	0.010	0.003	-0.011
	(0.009)	(0.012)	(0.007)
Father - missing	0.004	-0.008	-0.011
	(0.015)	(0.022)	(0.013)
Father's log earnings	0.000	0.003***	-0.001**
	(0.001)	(0.001)	(0.001)
Mother's log earnings	0.002	0.009*	0.002
	(0.003)	(0.005)	(0.003)
Father - missing earnings	-0.011	0.037	-0.030
	(0.023)	(0.037)	(0.021)

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Table 5 – continued from previous page.

	Being a parent at age 27 Coef./Std.err.	Cohabiting at age 26 Coef./Std.err.	Married at age 27 Coef./Std.err.
Mother - missing earnings	0.038	0.092	0.019
	(0.040)	(0.061)	(0.035)
Mother's age at birth (ref: 25-34)			
Below 25	0.042***	0.028**	0.030***
	(0.009)	(0.012)	(0.007)
Above 34	-0.002	0.012	0.002
	(0.011)	(0.016)	(0.009)
Father's age at birth (ref: 25-34)			
Below 25	0.013	0.026	-0.004
	(0.013)	(0.017)	(0.010)
Above 34	-0.024***	-0.017	-0.001
	(0.008)	(0.012)	(0.007)
Mother missing	-0.057	-0.141*	-0.075***
	(0.044)	(0.079)	(0.019)
Father missing	-0.060***	-0.027	-0.018
	(0.022)	(0.034)	(0.018)
Preferred field (ref: Social Science)			
Humanities	-0.003	-0.032***	0.000
	(0.007)	(0.010)	(0.006)
Natural Science	0.015	-0.007	-0.019***
	(0.011)	(0.015)	(0.007)
Health Science	0.012	0.021	-0.002
	(0.009)	(0.013)	(0.007)
Prior enrollment	0.008	0.000	0.011
	(0.009)	(0.013)	(0.007)
Being a parent in YOA	0.856***	0.173***	0.189***
	(0.009)	(0.047)	(0.041)
Cohabiting in YOA	0.092***	0.244***	0.087***
	(0.011)	(0.013)	(0.009)
Cohabiting in YOA (missing)	-0.012	-0.011	0.008
	(0.015)	(0.025)	(0.014)
Constant	-0.020	0.258**	-0.020
	(0.075)	(0.109)	(0.062)
R-squared	0.077	0.035	0.019
Number of observations	15,864	17,504	16,683

Notes:

a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses. Standard errors are robust and clustered at the individual level.

b) Estimations also include indicators for year of application.

Table 6: IV Estimates of the Effect of Enrollment on Selected Family Formation Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Coef./Std.Err.	Coef./Std.Err.	Coef./Std.Err.	Coef./Std.Err.	Coef./Std.Err.	Coef./Std.Err.	Coef./Std.Err.
Being a parent at age 27	0.080*	0.079*	0.076*	0.078*	0.078*	0.079*	0.088**
	(0.041)	(0.041)	(0.041)	(0.040)	(0.040)	(0.040)	(0.039)
Cohabiting at age 26	0.116**	0.121**	0.120**	0.125**	0.127**	0.128**	0.129**
	(0.052)	(0.052)	(0.051)	(0.051)	(0.051)	(0.051)	(0.050)
Married at age 27	0.079**	0.081***	0.078**	0.079**	0.078**	0.078**	0.083***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Basic controls		+	+	+	+	+	+
Parental background			+	+	+	+	+
Preferred field				+	+	+	+
Year of application (YOA)					+	+	+
Prior enrollments						+	+
Family formation in YOA							+

Notes:

a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

Standard errors in parentheses. Standard errors are robust and clustered at the individual level.

b) Basic controls: gender, age group, and high school GPA. Parental background: level of education, earnings, age, missing. Indicators for preferred field, year of application, and prior enrollments. Family formation in YOA: cohabition status, missing, marital status. Indicators for actual field.

Table 7: Robustness: IV Estimates of the Effect of Enrollment on Selected Family Formation Outcomes

	Coef./Std.Err.	Coef./Std.Err.
Being a parent at age 27	0.091**	0.089**
	(0.039)	(0.039)
Cohabiting at age 26	0.128**	0.124**
	(0.051)	(0.050)
Married at age 27	0.083***	0.084***
	(0.031)	(0.031)
Actual field (detailed)	+	
Earnings 5 and 10 years after YOA		+

Notes:

a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses. Standard errors are robust and clustered at the individual level.

b) All regressions include the controls listed in Table 5.

Table 8: Effects of Changing the Window on IV Estimates

	(1) Being a parent at age 27 Coef./Std.Err.	(2) Cohabiting at age 26 Coef./Std.Err.	(3) Married at age 27 Coef./Std.Err.
Window			
0.2	0.076	0.159**	0.074*
	(0.051)	(0.070)	(0.042)
	[10,949]	[12,071]	[11,507]
0.3	0.088**	0.129**	0.083***
	(0.039)	(0.050)	(0.031)
	[15,864]	[17,504]	[16,683]
0.4	0.083**	0.094**	0.063**
	(0.036)	(0.047)	(0.028)
	[20,310]	[22,433]	[21,347]

Notes:

a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses. Standard errors are robust and clustered at the individual level. Number of observations in brackets.

b) Estimations include all control variables.

Table 9: IV Estimates for Selected Outcomes by Gender

	(1) Being a parent at age 27 Coef./Std.Err.	(2) Cohabiting at age 26 Coef./Std.Err.	(3) Married at age 27 Coef./Std.Err.
Gender			
Men	0.141**	0.097	0.074
	(0.063)	(0.091)	(0.048)
	[6,156]	[6,704]	[6,470]
t-statistic of instrument	10.562	11.652	10.760
Women	0.061	0.148**	0.086**
	(0.049)	(0.060)	(0.040)
	[9,708]	[10,800]	[10,213]
t-statistic of instrument	15.823	18.572	16.627

Notes:
a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses. Standard errors are robust and clustered at the individual level. Number of observations in brackets.
b) Estimations include all control variables.

Table 10: OLS Estimates for Selected Outcomes

	(1) Being a parent at age 27 Coef./Std.Err.	(2) Cohabiting at age 26 Coef./Std.Err.	(3) Married at age 27 Coef./Std.Err.
Enrollment	0.010*	0.014*	0.010**
	(0.006)	(0.008)	(0.004)
	[15,864]	[17,504]	[16,683]

Notes:
a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses. Standard errors are robust and clustered at the individual level. Number of observations in brackets.
b) Estimations include all control variables.

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