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College Admissions Decisions, Educational Outcomes, and Family Formation *

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Abstract

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The level of progression of an individual's educational or labor market career is a potentially important factor for family formation decisions. We analyze the relationship between the timing of college enrollment, educational outcomes, and the timing of family formation decisions in early adulthood. We use variation in college admission requirements to shed light on this issue. We employ a regression discontinuity design to estimate the effects of being above the admission requirement for one's preferred college program on college enrollment decisions and the timing of family formation. Based on the analysis on enrollment and auxiliary analyses on labor market participation and earnings, we find that being above the admission requirement mainly affects the timing of college enrollment and not the college-going decision. Being above the admission requirement speeds up college enrollment, college completion and labor market entry. We find that being above the admission requirement has substantial effects on the timing of family formation, for example being above the admission requirement increases the number of children 8 years after year of application by about 0.1 corresponding to an increase of about 40 percent. Our results suggest that career postponements such as delays in the educational system can have large effects on family decision-making.

JEL codes: I2, J12, J13 Keywords: fertility; education policy; career interruptions; delayed college enrollment; regression discontinuity

1 Introduction

Having children and forming a family is a major life event. Individuals who are parents behave and are treated differently than individuals who are not parents—also in terms of economic outcomes. It is well-established that there are substantial differences in labor market outcomes across women who have children and women who do not have children (see, e.g., Waldfogel (1998)). The *timing* of fertility is arguably also important, but has received considerably less attention in research. Specifically, both the determinants and the consequences of the timing of fertility are not well-understood. The main contribution of this paper is to analyze the relationship between the timing of college enrollment and the timing of family formation decisions in early adulthood.¹ We will present empirical evidence suggesting that delayed college enrollment leads to delayed family formation in Denmark.

Understanding the underlying determinants of the timing of family formation is important for several reasons. First, delayed childbearing and childlessness is especially pronounced among highly educated women (see, e.g., Ellwood and Jencks (2004)) who may also face high labor market costs of childbearing. Delayed childbearing has been shown to positively affect women's earnings, wages, work hours (see, e.g., Miller (2011)) and even entire wage trajectories (Wilde, Batchelder, and Ellwood (2010)). Thus, the timing of family formation can have important implications for gender equality in the labor market.

Second, low fertility rates in almost all OECD countries have caused a large demographic shift in recent years. Fertility rates in Italy, Spain, Germany, and Japan are as low as 1.3 children per woman, whereas only the United States, New Zealand, Ireland, Iceland, and France have fertility rates above 1.9 children per woman (Feyrer, Sacerdote, and Stern (2008)). One of the causes of low fertility rates is the increase in delayed childbirth since the 1970's (OECD (2012)). Fertility rates below the reproductive rate leaves the countries with aging populations and an economic problem of financing this shift in demography (Kohler, Billari, and Ortega (2006)). This is especially true in large welfare states with pay-as-you-go tax systems such as the Nordic countries.

¹Delayed college enrollment has become increasingly widespread in recent years in many countries, for example, Italy (Cammelli, Antonelli, di Francia, Gasperoni, and Sgarzi (2011)), Sweden (Holmlund, Liu, and Skans (2008)), and the US (Bozick and DeLuca (2005) and Horn, Cataldi, Sikora, and Carroll (2005)).

The drop in fertility has to some extent coincided with an increase in women's educational attainment (Goldin and Katz (2002)), and there is considerable empirical evidence linking education and fertility decisions (see, e.g., Currie and Moretti (2003) and Black, Devereux, and Salvanes (2008)). An increase in education is typically considered to have two types of effects on fertility: A type of incarceration effect and a human capital effect.

Using a regression discontinuity design and the setup of the Danish college admission system, we estimate the effect of being above the admission requirement on later family formation decisions.² Our results show that being above the admission requirement affects mainly the timing of college enrollment and not the college-going decision. We find that the effect of being above the admission requirement increases the number of children 8 years after year of application (YOA) by about 0.1 corresponding to an increase of about 40 percent.³ The pattern in the estimates over time and the estimated effects on intermediary outcomes is consistent with a setting in which the level of progression in the educational and labor market career affects family decision-making. Thus, our analysis suggests that later college entry leads to delays in family formation.

The contribution of this paper is threefold. First, we provide evidence on the relationship between the timing of college enrollment and the timing of family formation decisions in early adulthood. Understanding the determinants of the timing of fertility is important for understanding the observed trends in delayed childbearing and gender differences in labor market outcomes such as wages.

Second, we use a very different source of exogenous variation than existing studies, namely college admission requirements. We thus exploit the exogenous variation in the timing of college, which is a source of variation that affects individuals at a much later stage in life than what previous studies have done using e.g. school entry rules. The variation used in this study occurs at a time when most individuals start to make their family formation decisions, i.e. in early adulthood, such as finding the partner with whom they will later have kids. Our results show

²Using similar empirical strategies, Öckert (2010) estimates causal effects of education on earnings in Sweden, Kirkeboen, Leuven, and Mogstad (2016) estimate returns to field of study in Norway, Hastings, Neilson, and Zimmerman (2013) find very heterogeneous returns to college fields in Chile, and Kaufmann, Messner, and Solis (2013) find that admission to a higher-ranked university in Chile implies that women find a partner of higher quality.

³In the presence of peer effects, our individual-level estimates represent at lower bound of the macro-level effect, see Feyrer, Sacerdote, and Stern (2008) for more arguments of larger macro-level effects.

that being above the admission requirement does not affect the amount nor the quality or type of education. Thus, this corresponds to holding both quality and quantity constant. This type of variation is interesting to study from a policy perspective because—to a large extent—it is a policy choice whether or not to encourage immediate enrollment in college.

Third and finally, we show that being above the admission requirement affects mainly the timing of college enrollment indicating that timing (and not years of education) really is the channel through which family formation is affected. Rich administrative data sets allow us to estimate effects on a large range of related outcomes including enrollment, college completion, labor force participation, and earnings at different points in time. These auxiliary analyses are used to shed light on the mechanisms through which being above the admission requirement affects the timing of family formation. Our results suggest that the effects are primarily driven by the timing of college enrollment.

The paper is organized as follows. In section 2 the background literature is presented, and section 3 contains a description of the institutional settings and the Coordinated Enrollment System for colleges in Denmark. In section 4 we outline our empirical approach. Section 5 describes the data used, and in section 6 we present our estimation results along with a discussion of potential mechanisms. Finally, section 7 concludes.

2 Background Literature

In this section, we first provide a short discussion of relevant empirical studies of education and family formation. Secondly, we discuss different channels through which delayed college enrollment could affect family formation decisions based on existing research.

2.1 Empirical Studies on Education and Family Formation

Our study is closely related to the literature on the relationship between educational attainment and family formation. This literature has documented a strong link between the two. In order to establish whether this is indeed a causal link, many studies have used exogenous variation in educational attainment generated by rules regarding age at school entry and compulsory schooling

laws. The observed effects of educational attainment on fertility can generally reflect both changes in human capital and changes in the timing of the educational and labor market career.

The age at school entry has been shown to affect children's performance in school (Bedard and Dhuey (2006)), but also out-of-school outcomes such as teen fertility (Black, Devereux, and Salvanes (2011) and Tan (2017)) and crime (Cook and Kang (2016) and Landers, Nielsen, and Simonsen (Forthcoming)). Several studies have also found effects of school starting age on tracking (see, e.g., Puhani and Weber (2007) and Fredriksson and Öckert (2014)). The effects of school entry age on longer-term outcomes are more mixed, for example, Dobkin and Ferreira (2010) find no effects on later labor market outcomes while McCrary and Royer (2011) find no effects on women's fertility outcomes.

McCrary and Royer (2011) analyze the effects of mothers schooling on the timing of fertility decisions. They use exogenous variation from school entry rules to determine the effects on women's fertility using birth records from California and Texas. They find little evidence that school entry policies affect the probability of motherhood or the age at first birth. At the same time, women born after the school entry date have significantly lower schooling. McCrary and Royer (2011) argue that for women with preferences for being a young mother there is a limited role for education policies affecting the fertility decision.

Black, Devereux, and Salvanes (2011) estimate the effect of schooling on teenage pregnancies using exogenous variation in the school starting age. Using Norwegian data they find that starting school older implies a lower probability of teenage pregnancy. They also estimate the effect of school starting age on educational attainment but find little impact.

It has been hypothesized that school starting age may have several offsetting effects. With this in mind, Tan (2017) analyzes the effect of school entry rules on education and teen fertility using administrative data from North Carolina. The analyses suggest that there are indeed offsetting effects of school starting age which could explain the often-found null effects for fertility and labor market outcomes.

Overall, these studies suggest that variation in school entry age is not particularly well-suited for answering the question of how timing of the educational career affects post-teen fertility—even though school entry age obviously is important for explaining many other outcomes.

Skirbekk, Kohler, and Prskawetz (2004) use a similar approach by exploiting exogenous variation in the age of graduation from compulsory school. They estimate the effects of birth month on timing of fertility and marriage using Swedish register data. In contrast to McCrary and Royer (2011), they find that a delay in graduation of 11 months implies a delay in the age at first birth of 4.9 months. The delay effect is persistent throughout the timing of second births and for first marriages. However, neither completed fertility nor marriage before age 45 is affected by the delay in compulsory school graduation.

Compulsory schooling laws have been used to instrument educational attainment 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 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 effect on completed fertility, Fort, Schneeweis, and Winter-Ebmer (2016) use data from six European countries and find that more education actually increases completed fertility for the continental countries and decreases fertility for England. Also, increasing the length of compulsory schooling reduces the incidence of teenage pregnancies (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 the length of compulsory schooling increases age at first marriage.

To find exogenous variation that only changes the length of education at higher levels in the educational system is much more rare. Obviously, the mechanisms and potential effects of education are also likely to be different. Currie and Moretti (2003) use college openings as an instrument for education and find that increasing education reduces completed fertility. More recently, Hall (2012) and Grönqvist and Hall (2013) analyze the effects of a Swedish reform that prolonged vocational tracks from two to three years. Hall (2012) finds that educational attainment—in terms of upper secondary schooling—increased, but university enrollment was unaffected. In line with this, Grönqvist and Hall (2013) find that the reform reduced early fertility. Overall, there appears to be a consensus that educational decisions and thereby educational policy affect many important

life decisions including family formation decisions.

2.2 Delayed College Enrollment and Family Formation

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 cost of having children. However, as higher education leads to higher permanent income, this could also lead to higher fertility. The literature on the quantity-quality trade-off regarding children generally makes the prediction that fertility is decreasing in education (Becker and Lewis (1973) and Becker and Tomes (1976)).

The literature on education and fertility tends to focus on the timing effects that occur due to actually attending school which are also sometimes referred to as incarceration effects. Since more education also affects the timing of labor market entry, there are potentially additional timing effects if the level of career progression matters for fertility decisions. For example, 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. It may also be that women prefer to delay childbirth until they have reached certain career-related milestones due to social norms or differences in life-time costs of childbearing, e.g. a career-related milestone could be getting a first job. These mechanisms are likely to be especially important for career-oriented and highly-educated women, who are likely to be over-represented in our sample of college applicants. In fact, Miller (2011) and Wilde, Batchelder, and Ellwood (2010) find that postponement of childbearing reduces the labor market costs of childbearing—especially for highly-educated women.

Relatedly, Happel, Hill, and Low (1984) consider a model of the timing of the first birth where 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. This is under the assumptions that parents wish to smooth consumption over their life-cycle and capital markets are not perfect. Happel, Hill, and Low (1984) refer to this incentive as the "consumption-smoothing motive in child-timing decisions". Since household income will tend to increase substantially when one or both wage

earners complete their education and enter the labor market, the presence of this consumption-smoothing motive constitutes another channel through which the timing of college enrollment may affect the timing of family formation.

Finally, delayed college enrollment likely increases an individual's age relative to that of his college cohort. Thus, individuals who delay college enrollment tend to be exposed to relatively younger peers compared to themselves. If there are peer effects in fertility, this could lead to delayed family formation.⁴

3 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 training program or a high school program. In high school, the students can choose between a business track, a technical track, or an academic track. High school programs and to a smaller extent vocational programs qualify graduates for entering college programs. We focus on long college programs for reasons that will be clear later. These programs consist of a three year bachelor degree program followed by a two to three year master program. It is uncommon in Denmark to stop after the bachelor program.

The costs of going to college are negligible in Denmark compared to, for example, the US, as college programs are free and publicly provided, and very generous student grants are provided by the government.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.

Denmark also has favorable policies regarding parental leave. If a student has a child during his/her studies, the student can remain enrolled. The student is entitled to additional student grants. After college completion, individuals are entitled to parental leave benefits at the level of unemployment benefits which is higher than the student grants. Also, in almost all jobs, parents

⁴Peer effects in fertility are documented by Ciliberto, Miller, Nielsen, and Simonsen (2016) (in the labor market) and Kuziemko (2006) (in sibling-pairs).

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

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

would be entitled to some months of parental leave with full wage compensation. The period at full wage compensation is determined by centralized bargaining between trade unions and employer associations.

3.1 The Coordinated Enrollment System

All applications to college programs in Denmark are handled by a centralized admission system, the Coordinated Enrollment System (CES). In this paper we will use the term college program about a program, e.g. medicine, at a particular college, e.g. Aarhus University. The applicant can apply to up to eight different college programs in the same application. In practice the vast majority of applicants for long programs rank only 1-3 programs. 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 programs.

CES allocates applicants to college programs such that the best applicants are allocated to their preferred college programs using a deferred acceptance mechanism. Thus, a student that qualifies for more than one of his listed programs will always be offered a slot in the preferred program. 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 CES how many slots they have in each program. The applicants are ranked according to their high school GPA. Higher-ranking applicants are admitted, and the admission requirement for a particular college program is set at the GPA of the marginal applicant after several clearing rounds. An applicant with a GPA above the admission requirement is offered a slot, whereas an applicant with a GPA below the admission requirement is rejected. In this way, the admission requirement for each college program is determined each year after the application deadline.

Even though the number of slots in each program varies little from year to year, the number of applicants varies, which means that the admission requirement varies. Thus, applicants do not know the admission requirement at the time they apply, and at least for individuals with a GPA close to the admission requirement, it will not be possible to predict whether the admission

requirement of a given college program will be above or below their GPA.⁷

Many programs use a simple tie-breaking rule for applicants with a GPA equal to the admission requirement; they simply offer admission to all of these applicants. Another common rule is an age tie-breaking rule. The rule implies that when two applicants are tied with respect to GPA, the oldest applicant is admitted. In addition, some college programs use other types of admission rules for these marginal applicants. In the empirical analysis, we focus on programs that use a simple tie-breaking rule.⁸

As previously mentioned, some applicants are assessed on other characteristics besides their high school GPA. One can apply for special admission 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 allocation of slots in this system leaves a lot of discretion to the individual college programs and activities that qualify for points in one program may not qualify for points in another program. Special admission slots constitute a minor part of the total number of slots. In addition, if an applicant qualified for his preferred college program based on GPA, he would never be taken into consideration for special admission. Only applicants who did not qualify based on GPA were potentially assessed based on other characteristics. As we show later this implies that some students with a GPA below the admission requirement are offered a slot.

Another distinctive feature of the system is the availability of standby slots. A standby slot guarantees a slot in the next academic year at the latest. The reason for offering standby slots is that it is likely that some individuals will drop out of the specific college program, and it is costly to have vacant slots in a given program. Therefore, the different college programs offer standby slots, which enables them to enroll students from the standby list during the academic year. To compensate the students on the standby list for their risk, they are guaranteed a slot in the next academic year at the latest. One must apply specifically for a standby slot to be taken into consideration for these slots. If a student is assigned a standby slot, he is not considered for admission in any of his lower-ranked programs.

⁷We document the time variation in the admission requirements in section 5.3.

⁸In Appendix C, we conduct an alternative analysis using a donut regression discontinuity design which allows us to include college programs with other tie-breaking rules. Our results are robust to this design.

Standby slots are allocated to applicants who have a GPA slightly below the admission requirement. For college programs that offer standby slots, a standby requirement will be determined along with the admission requirement. The availability of the standby slots implies that individuals who are just below the admission requirement are likely to enroll in their preferred college program within a year of their original application, if they have applied for a standby slot. Standby slots are used extensively and especially at the college programs that we include in the estimation sample. For example, the ratio of standby slots to regular slots across relevant college programs at the largest university in Denmark in 2001 was about 10 percent.

4 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 predict what the admission requirement 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 admission requirement are essentially the same *ex ante*.⁹ If the admission 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 in that year than if the admission requirement turns out to be below the applicant's GPA. Thus, one can think of this as a set of fuzzy regression discontinuities (RDs)¹⁰, if one considers each college program in each year separately.

Let d_i measure the distance from the admission requirement of individual i 's preferred college program to individual i 's high school GPA.¹¹

$$d_i = GPA_i - AR_i \quad \begin{cases} < 0 \Rightarrow Z_i = 0 \\ \geq 0 \Rightarrow Z_i = 1 \end{cases}$$

⁹Students can select which high school program to enroll in. Since some of these programs are easier than others students can, to some extent, control the level of their GPA. However, this fact does not make them capable of precisely controlling which side on a GPA requirement to be at. Only whether or not they will be in the vicinity of the GPA cut-off.

¹⁰Imbens and Lemieux (2008) provide a useful methodological overview of regression discontinuity designs.

¹¹The preferred college program is the applicant's highest ranked program, and the distance to the admission requirement is only based on the preferred college program. In Appendix C we consider alternative specifications that make use of the information from lower-ranked programs.

where GPA_i is the high school GPA for individual i , and AR_i is the admission requirement at individual i 's preferred college program. We will refer to $d_i = 0$ as *the discontinuity point*. Under the assumption that applicants cannot perfectly predict the admission requirement, Z_i will only be correlated with later outcomes to the extent that it affects college-going decisions, such as the timing of enrollment and the choice of college program. Thus, for applicants with distances sufficiently close to zero, we can estimate the causal effect of being above the admission requirement of one's preferred college program ($Z_i = 1$) on later outcomes. Our focus is on family formation outcomes, but in order to explore the mechanisms behind our results, we will also analyze how being above the admission requirement affects college enrollment, completion, and labor market outcomes.

For an individual i with preferred college program k in year t , we consider the following **reduced form** outcome equation,

$$y_i = f(d_i, Z_i) + X_i\beta + \theta_{tk} + \gamma Z_i + \varepsilon_i \quad (1)$$

where y_i is the outcome. f is a function such as polynomials approximating the underlying variables. Specifically, we will allow for the effect of d_i to vary by whether an individual is above or below the admission requirement. X_i is a vector of control variables such as age, gender, parental background etc. θ_{tk} is a preferred program-year fixed effect (program k in year t). For example, there will be a separate fixed effect for applicants who prefer to enroll in Medicine at a particular college in a particular year. This captures differences across time and college programs and underlines the fact that we are essentially pooling $K \times T$ (No. of college programs $\times$ No. of time periods) regression discontinuities.¹² Finally, γ is the parameter of interest. We will refer to the estimates of γ as the reduced form estimates. To account for the fact that the individual error terms, the ε_i 's, may be correlated within college programs, we generally cluster standard errors at the college program level.

Pooling a larger number of 'individual' RD design into one by normalizing the running vari-

¹²In the estimation sample of young applicants, we have 151 college programs and 518 college program-years reflecting that not all programs are present in all years.

able (GPA in our case) is common. Cattaneo, Keele, Titiunik, and Vazquez-Bare (2016) point out that pooling has certain implications for the interpretation of the parameter measuring the treatment effect. With pooling, the estimated effect is generally a double average. γ represents the weighted average across college programs of the average treatment effect across all applicants to a particular college program. More weight is given to programs with many applicants around the admission requirement.

We estimate the effect of being above the admission requirement in the year of application on later family formation decisions. Hence, the year of application (henceforth abbreviated by YOA) is the obvious reference point, and we consider marriage and the number of children x years after YOA.¹³¹⁴ In this sense, we estimate a series of parameters, γ_x , corresponding to a series of outcomes, y_{ix} .

5 Data

The data used for the empirical analysis are administrative data hosted by Statistics Denmark and cover the entire Danish population. These data are linked to data from the Coordinated Enrollment System (CES) 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 CES data contains information on all applications to college programs in Denmark in the period 1996–2006. The data thus provides information on all individuals who *applied* to college during this period. Since a college application to CES includes a prioritized list of college programs, we can distinguish between the applicants' actual college choices and their stated college preferences.

¹³We have also looked at cohabitation. The results are qualitatively the same, but they are less clear. We suspect that this is caused by the way cohabitation is constructed. Whereas marriage information is derived from registers directly, cohabitation is constructed by Statistics Denmark and especially for students it is hard to tell apart cohabitation as a couple and cohabitation with a friend of different sex.

¹⁴In earlier versions of the paper, we also presented the effects by age, but since the patterns were very similar, we now focus on the effects by YOA.

5.1 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. The data contains information on 288,531 applications to long college programs in the period 1996–2006. These applications represent 618 distinct preferred college programs and 1,674 distinct college programs of any rank in the application. The effect on the sample of each of the steps below can be seen in Table 1.

We focus on the first application¹⁵ where the preferred program is a long college program and we only use information from the preferred program in the main analyses.¹⁶¹⁷ Thus, if an applicant is not admitted to the preferred program the information from the lower ranked programs is not used. By using only the first application and the preferred program, we ensure that the sample is more homogenous and we avoid giving more weight to individuals who apply repeatedly over many years or apply to several programs in a given year. Also, the availability of standby slots makes the use of the lower ranked programs in analyses less interesting, since we do not know whether the individual is offered a standby slot in his preferred program.

The regression discontinuity design places further restrictions on the observations that we can use. First, the preferred program must have a grade requirement, i.e., the admission requirement must be a binding grade requirement. In other words, the program must be oversubscribed and GPA must be the criterion used to allocate slots. Second, the preferred program must have a simple tiebreaking rule for marginal applicants, cf. section 3.¹⁸ Whether or not a particular college program has a (binding) grade requirement can vary from year to year depending on the number of applicants relative to the number of slots. To be included in the sample, the preferred program has to have a grade requirement in the YOA. Out of 221,554 first applications, about 70 percent list a program with a grade requirement as the preferred program. However, only about

¹⁵Since we only have application data from 1996 onwards, we cannot be sure that we can identify the first application. However, if we alternatively impose the restriction that only individuals who graduated high school in 1995 or later are included in the sample this has very little effect on the size of the estimation sample and the results.

¹⁶Long college programs are programs at university level. The application data include information on applications to short college programs, but shorter programs are less likely to meet the restrictions needed for the RD design. Short programs would constitute less than 10 percent of the estimation sample if they were included.

¹⁷In Appendix C we explore alternative strategies that use more of the available data. Our results are robust to these changes in the sample.

¹⁸For programs that do not use a simple tiebreaking rule, the standard RD design does not work.

half of these are programs using the simple tiebreaking rule for marginal applicants. Limiting attention to college programs with a grade requirement and a simple tiebreaking rule leads to substantial reduction in the number of distinct preferred college programs in the sample which drops from 618 to 170.

In order to compute the distance to the admission requirement for each individual applicant, information about the high school GPA is required. The GPA is missing for a number of applicants which is mainly explained by the presence of applicants with a foreign high school degree or other types of qualifying education where the GPA was not registered.

After imposing all of the above restrictions on the sample, 58,723 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 admission requirement of their preferred program in the YOA. For the graphs that illustrate discontinuities in enrollment and fertility outcomes, we use a window of 1.0 grade points. The estimations are based on a narrower window of 0.3 grade points.¹⁹

In order to obtain a relatively homogenous sample in terms of age—which is arguably a very important factor in fertility decisions—we focus on applicants who were 20 years old or younger when they applied.²⁰ Younger applicants are more likely to be affected by delays in college enrollment since they are less likely to have formed relationships and families at the time of application. Results for both old and young applicants will be presented, but the main analyses focus on the young applicants. The main estimation sample for young applicants has 6,349 observations in 151 different college programs.

5.2 Descriptive Statistics

Given the restrictions imposed on the data, the estimation sample of young applicants cannot be considered a random sample of college applicants. It consists mainly of applicants for relatively

¹⁹See section 5.3 for further discussion of the choice of the size of the window and appendix C for a robustness check.

²⁰The age range of first-time applicants in Denmark is wider than what is observed in many other countries. There is no universal college-going age since many high school graduates delay enrollment for one or more years. Based on the data the typical college-going age (for first-time applicants to long college programs) is 21 ranging from below 17 to above 70. About 80 percent of applicants are 19-23 years old. The division into young and old applicants is based on the effects found for different age groups.

prestigious college programs at the two largest universities in Denmark. Table 2 shows the sample means for the included control variables, some relevant application and enrollment variables, and three selected outcomes by whether an individual was above or below the admission requirement.

As suggested by Lee and Lemieux (2010), we test for covariate balance by estimating the size of the jump at the discontinuity point for each covariate separately. Specifically, we regress each covariate on Z_i , d_i , and their interaction including preferred college program-year fixed effects. In the table, we report the coefficient on Z_i and the corresponding p-value. This exercise reveals a few statistically significant jumps in the control variables—mainly for some of the indicators for missing data and mother’s age—but overall our interpretation is that covariates appear to be fairly balanced for individuals below and above the admission requirement. In addition, we run a joint test of covariate balance by estimating a set of seemingly unrelated regressions, where each covariate is regressed on Z_i , d_i , and their interaction. A test of the null of all coefficients on Z_i being equal to zero cannot be rejected, and the p-value is about 0.45.²¹

The statistics in Table 2 highlight that this is not a representative sample of young individuals. Almost 70 percent of the applicants are young women. The average age of the applicants is 19.6 years. Their parents tend to be well-educated. More than 50 percent of both mothers and fathers have a college degree. In addition, the high school GPA which is listed with the college enrollment variables is on average about 9 for this sample, which is considerably above the general average in a high school cohort.²² Like the above covariates, the GPA does not appear to jump discontinuously at the discontinuity point. A division of applicants by the field of their preferred college program reveals that about 40 percent of the applicants prefer to enroll in a program in Social Science. Slightly less apply for a college program within Humanities and Health Science, and Natural Science is the least popular choice for the applicants in the sample. We will explore the differences in enrollment further in section 6.1.

Generally, we consider the following three family formation outcomes: Being a parent, num-

²¹We have also plotted predicted school starting age (based on month of birth), age at high school graduation, age at application and labor market experience in the YOA against distance and find no evidence that these variables jump at the discontinuity.

²²The GPA is not included as a covariate in the estimations as the distance to the admission requirement and the GPA measure the same thing when we include college program-year fixed effects. For the same reason, we do not include indicators of YOA.

ber of children, and being married.²³ We measure each outcome x years after YOA, for example, one outcome is the number of children 5 years after YOA. Table 2 includes just the above three outcomes 5 years after YOA. Based on these, there is some initial indication that individuals above the admission requirement move faster into parenthood. The outcomes are censored since the observation period ends in 2010 for childbearing and labor market variables and in 2011 for marriage. This implies that the estimated effects many years after the YOA will rely on older college application cohorts than the effects shortly after the YOA.

In Denmark premarital cohabitation is widespread and therefore marriage is not the best indicator for family formation, but we include this outcome in lack of a better measure. Figure 1 shows how the probabilities of these outcomes evolve over time for the estimation sample. Generally, the probability of being a parent and the probability of being married are close to zero around the YOA.²⁴ The probabilities are increasing and 10 years after YOA about 40 percent are parents and about 25 percent are married. Similarly, the average number of children is close to zero around the YOA, increases steadily and reaches one 13 years after YOA (which corresponds to the early 30s of these individuals). Clearly, the time period studied constitutes a stage in these individuals' lives where family formation is important.²⁵

5.3 Time Variation in Admission Requirements

If applicants are able to predict the admission requirement of their preferred college program in the YOA, applicants who are above and below the admission requirement are likely to be systematically different. Time variation in admission requirements is crucial for the validity of the RD design.

Figure 2 depicts the variation in admission requirements over time. If there was no time variation in admission requirements all observations would be on the 45 degree line. A regression of the admission requirement in year t on the admission requirement in year $t - 1$ yields a regression

²³ Parenthood and number of children is based on a custodial and not biological measure.

²⁴ The incidence of teenage pregnancy is low in Denmark. The number of births per 1,000 women aged 15 – 19 ranged from 6.0 in 2006 to 8.2 in 1996 based on numbers from the United Nations Population Division, World Population Prospects. In comparison, the corresponding number for the United States is above 40 in this period.

²⁵ Applicants who are married or have children at the time of application are included in the sample. Each group constitutes less than 0.1 percent of the main estimation sample.

line very close to the 45 degree line. More importantly, from the graph it is clear that there is substantial variation. We expect that admission requirements are generally harder to predict for small programs (in terms of the number of applicants) and programs that tend to have a number of applicants that is similar to the number of vacancies. In line with this, the graph suggests that admission requirements for larger programs (in terms of the number of applicants) are easier to predict. The slope of the regression line is slightly less than one implying that the admission requirements exhibit mean reversion over time.

Some college programs are undersubscribed and have non-binding admission requirements. In the graph, a non-binding admission requirement corresponds to a GPA of 6.0 which is the minimum passing grade. The observations on the horizontal axis represent programs with non-binding admission requirements in year $t - 1$ whereas the observations on the vertical axis represent programs with non-binding admission requirements in year t . The large mass of observations at (6.0, 6.0) represent programs that have non-binding admission requirements in both years. The estimation sample only includes applicants to programs that have a binding admission requirement in the YOA. As a result, programs that are repeatedly oversubscribed are given more weight in the estimations.

Plotting the distribution of distance from the admission requirement to the high school GPA, we see no sign that applicants bunch just to the right of cutoff. The distribution is centered slightly to the left of zero and resembles a normal distribution. Following the procedure outlined in McCrary (2008) we conduct a formal test for whether applicants are able to manipulate their GPA and thus the distance from the admission requirement. The null of no discontinuity in the density of distance from the admission requirement cannot be rejected.²⁶

The estimation results will be based on applicants within 0.3 grade points of the admission requirement. We present robustness tests with alternative window sizes in Appendix C.

²⁶Results are available upon request.

6 Results

A natural first step of our analysis is to estimate the effect of being above the admission requirement on different measures of enrollment. We hypothesize that being above the admission requirement affects enrollment decisions and through these has effects on later family formation decisions. Once we have established how being above the admission requirement affects college enrollment, we proceed with the main analyses where we estimate the effect of being above the admission requirement on family formation outcomes. Subsequently, we discuss the potential mechanisms behind the effects in more detail. Alternative specifications and robustness checks are presented in Appendix C.²⁷

6.1 How Does Being Above the Admission Requirement Affect Enrollment Decisions?

Based on the setup of the centralized admission system in Denmark, we hypothesize that being above the admission requirement²⁸ potentially affects mainly three aspects of the college-going decision: Whether or not to enroll in college at all, the choice of specific college program, and the timing of college enrollment.

To investigate how the college-going decision is affected, we plot different measures of college enrollment against distance from the admission requirement. Figure 3 shows how different aspects of the college-going decision is affected by being above the admission requirement of one's preferred college program. The probability of enrolling in college in the YOA and the probability of enrolling in one's preferred college program in the YOA jump about 45 and 50 percentage points, respectively. In comparison, the probability of *ever* enrolling in college clearly does not. These graphs confirm the picture we saw in Table 2. The linear fit is obviously not particularly good for the probability of ever enrolling in one's preferred college program, and based on the graph it is hard to argue that this probability jumps discontinuously at the discontinuity point. Overall, the

²⁷Unless otherwise stated, the presented results are for a window of 0.3, i.e., for distances to the admission requirement of -0.3 to 0.2 . Notice, that the window is symmetric, since applicants with zero distance are offered enrollment.

²⁸When we refer to being above the admission requirement, it is implicit that the admission requirement is the admission requirement of the preferred college program.

graphical analysis suggests that being below the admission requirement does not discourage individuals from attending college. Furthermore, it affects mainly the timing of college enrollment and maybe—to some smaller extent—the choice of specific college program.

The design can be considered a fuzzy design in the sense that the probability of enrollment does not jump from 0 to 1 at the cutoff. Even to the right of the cutoff, the probability of enrollment in any program is only about 0.85. There are two types of applicants who do not enroll even when they are above the cutoff. The first type is an applicant who receives an admission offer and rejects it.²⁹ The second type is an applicant who does not meet the basic requirements for college admission, e.g. high school course requirements.

Enrollment in any program in the YOA is higher than enrollment in the preferred program to the right of the cutoff. This can be a result of applicants who change their mind and decide that they want to enroll in another college program than the one listed as their preferred program on the application. Applicants who do not meet the basic requirements of their preferred program, but who do meet the requirements for one of their lower ranked programs would also imply that enrollment in any program is higher.

The probability of enrollment in any program in the YOA to the left of the cutoff is about 0.40. There are three types of applicants who will enroll in college even when their GPA is below the admission requirement of their preferred college program:

- (i) Applicants who listed several programs and were admitted to one of their less preferred programs
- (ii) Applicants who applied for special admission and were offered admission based on alternative criteria including GPA
- (iii) Applicants who applied for a standby slot and were offered a standby slot that allowed for enrollment in the YOA

Only the two latter types are relevant for explaining enrollment in the preferred college program to the left of the cutoff. Enrollment in the preferred college program is a little bit below 0.20 to the left of the cutoff (and getting closer to zero as the distance to the cutoff increases). The

²⁹We measure enrollment, not admission offers.

probability of enrollment decreases as the distance to the cutoff increases since standby slots and special admission is also based—at least partly—on GPA. The more than 20 percentage points difference in enrollment in any program and enrollment in the preferred program in the YOA is driven by applicants of type (i).

Why is it that we do not see a discontinuity in the probability of ever enrolling in the preferred college program? If we imposed a more flexible fit on the data instead of a linear fit, we would see a roughly continuous but kinked curve. We attribute the lack of discontinuity to the availability of standby slots that are allocated based on GPA and special admission slots that are allocated based on alternative criteria including GPA. Specifically, only individuals who are below the cutoff will be offered standby slots and special admission slots. In addition, the grade requirement for a standby slot is typically a couple of grade points below the actual admission requirement. Thus the availability of standby slots and special admission slots imply that being above the admission requirement only has a limited effect on the chance of being enrolled in one's preferred college program. But being above the admission requirement has a substantial impact on the *timing* of enrollment.

Acknowledging the fact that being above the admission requirement may have heterogeneous effects on prospective students, we estimate the size of the discontinuous jumps in enrollment by age and gender of the applicants. In Table 3, we report the estimated jumps for the four enrollment outcomes for these subgroups. For now, we note that for almost all subgroups, we observe a pattern similar to that observed in the estimation sample: Being above the admission requirement affects whether you enroll in the YOA, but not whether you ever enroll. This pattern is clearly more pronounced for young applicants suggesting that old applicants are less affected by being above the admission requirement. We do not observe any difference between men and women.

6.2 How Does Being Above the Admission Requirement Affect Family Formation?

Now that we have an understanding of how enrollment decisions are affected by being above the admission requirement, we proceed with the analysis of the corresponding effects on family formation decisions. First, we analyze in depth the effect on the three family formation outcomes at a specific point in time, namely 5 years after YOA. Next, we proceed by estimating the reduced form model for all years after YOA for each outcome.³⁰

By analyzing the effects 5 years after YOA, we do not consider the points in time where the estimated effects are largest, as will be evident later. However, we have chosen points in time where Figure 1 suggests that many individuals have begun making family formation decisions. In addition, 5 years after YOA, many individuals will have graduated from college.

Figure 4 provides a graphical illustration of how the RD strategy works for these selected outcomes. Note that the graphs are plotted for a window of 0.5 which differs from that of the estimation sample.³¹ The figure shows a graph of each outcome by distance from the admission requirement. For marriage, these graphs do not suggest any substantial effects of being above the admission requirement. For being a parent or the number of children, the graphs are consistent with the hypothesis that being above the admission requirement affects family formation. Particularly, being above the admission requirement appears to have a positive effect on being a parent and number of children 5 years after YOA.

Table 4 shows the reduced form estimates for the selected outcomes with different conditioning sets. The preferred specification is specification (5) with all controls. The estimates are very insensitive to the inclusion of controls as also suggested by our balancing tests. This is reassuring as it suggests that the RD assumption of covariate balance below and above the admission requirement is reasonable. Taking a closer look at the estimates for marriage, the estimated effect of being just above the admission requirement on the probability of being married 5 years after

³⁰Of course, it would be preferable to present both graphical evidence and detailed estimation results for outcomes measured at every point in time. However, due to spatial considerations we present only graphical evidence and estimation results for a subset of outcomes. Detailed estimation results are available upon request for every outcome at every point in time.

³¹ The window differs from the estimation sample such that the reader can make an eye-balling fit him-/herself, and to show that the estimation sample does not consist of cherry-picking the estimations with the largest effects.

YOA is 1.0 percentage points. This indicates that family formation starts earlier for those who are just above the admission requirement. However, for the marriage outcome, the estimates are generally insignificant.

A clearer picture emerges when we consider the effects on the probability of being a parent and the number of children. These estimates are generally relatively large and statistically significant at the 5 percent level. Being above the admission requirement increases the probability of being a parent by 3.8 percentage points 5 years after YOA. Given that only about 5 percent of individuals in the young estimation sample are parents 5 years after YOA, being above the admission requirement increases the probability of being a parent at this specific point in time by more than 50 percent. For number of children, the conclusion is similar, and coefficients are of the same order of magnitude. This is to be expected since many individuals in the sample will at most have one child 5 years after YOA. In the long run, it will be of interest to see whether the effects on these two parenthood outcomes differ.

In order to get a clear overview of how the timing of family formation is affected by being above the admission requirement, Figure 5 shows the reduced form estimates for each of the three outcomes plotted against years after YOA. Thus, these are estimates of the effect of being above the admission requirement on the entire range of family formation outcomes that we consider.

First, considering the effects on the probability of being married, we see that the estimates tend to be imprecise, but the overall pattern suggests that individuals who are above the admission requirement get married earlier. However, this positive effect decreases substantially around 11 years after YOA. But, for example, around 8 years after YOA individuals who were above the admission requirement are more likely to be married.

For the two parenthood outcomes, we see that individuals who were above or below the admission requirement tend to have similar tendencies to have children one to three years after YOA. But already four years after YOA, we find significant effects on the probability of being a parent and number of children. This positive effect continues to increase until about 10 years after YOA. For being a parent, the estimates again hover around zero about 12-14 years after YOA. These estimates are highly insignificant though.

The main difference between the graphs for being a parent and number of children is that

the dramatic decline in the estimates in the longer run described above, cannot be seen when we consider number of children.³² Our analyses show that being above the admission requirement speeds up the timing of the first child. Unfortunately, we cannot follow the individuals in the sample long enough to draw definitive conclusions about completed fertility. Often the decisions about the timing of the first child and completed fertility are considered linked (see, e.g., Björklund (2006)), but timing of the first child can also affect the spacing of subsequent children.

In the main analysis, we disregard old applicants, i.e. applicants that are 21 years or older when they apply. The results in Table 3 illustrate that the old applicants are affected somewhat differently by being above the admission requirement than their younger counterparts. In particular, being above the admission requirement increases the probability of enrolling in the YOA by about 56 percentage points for young applicants, but only about 26 percentage points for old applicants. A potential explanation is that it is likely to be more costly for old applicants to delay enrollment. Therefore, being above the admission requirement affects these individuals less in terms of timing, but more in terms of the specific college program attended. When we estimate the models for old applicants, the estimated effects are never statistically different from zero and the confidence intervals are very wide, cf. Table 5. We can think of three main explanations for this. First, they constitute a more heterogeneous group. Second, they are less affected by being above the admission requirement in terms of timing of enrollment decisions, and finally, they are more likely to have already made their family formation decisions at points in time where they would be affected by the admission requirement.

6.2.1 Gender Differences

Being above the admission requirement potentially affects men and women differently. We saw in Table 3 that men and women were affected similarly in terms of enrollment decisions, but since childbearing has different implications for men and women, we are interested in how the effects on family formation may differ by gender.

Table 5 shows that there is a tendency for the estimated effects on number of children to be larger for women than for men, although the difference is not statistically significant. Since

³²Given the similarity of the results for being a parent and number of children, we will focus on number of children in the remaining part of the analysis.

women's careers are usually more affected by childbearing than men's, it makes sense that any effects of being above the admission requirement would be larger for women than for men. In comparison, the estimated effects on marriage are roughly the same for men and women.

Since men and women face different tradeoffs when deciding to have a child, we further split the sample on whether the wage level in the preferred program is high (above sample median) or low (below sample median). This is not based on the actual wage level of the individuals, but the average wage level within detailed educational categories in the year following college completion. Since women usually spend much more time away from the labor market in connection with pregnancy and childbirth, we expect that especially for women the wage level is important. A woman who earns higher wages has a higher opportunity cost of childbearing, but on the other hand she has more money to provide for her family. However, since there is generous family-friendly policies in Denmark such as paid maternity leave, potential mothers are not likely to be severely credit constrained. Table 5 shows that the estimated effects are generally larger for women who apply to college programs with a high initial wage level which is also what we would expect if opportunity costs play a role in delayed childbearing. This is consistent with the findings of Wilde, Batchelder, and Ellwood (2010) and Miller (2011). In comparison, if there are effects for men, these effects seem to be driven by men with low initial wage levels.

6.3 A Discussion of the Underlying Mechanisms

We began our analysis with an investigation of the effects of being above the admission requirement on college enrollment decisions. Given that we have now also established that being above the admission requirement affects family formation decisions, we would like to elaborate a little bit on this issue, since it is crucial for interpretation of the estimates. It is not that interesting in itself that being above the admission requirement affects family formation. The interesting question is *why* being above the admission requirement affects family formation. Does it induce differences in the timing of enrollment across individuals? Does it induce differences in the type of college program attended? Or both?

While we cannot give a definitive answer to these questions, we can interpret the empirical evidence at hand. The enrollment graphs in Figure 3 clearly suggest that being above the admission

requirement has substantial effects on the timing of college enrollment, but only modest effects, if any, on enrollment in a specific program. Timing of enrollment may affect subsequent family formation decisions in a number of ways. The main point is that the timing of college enrollment is likely to determine the timing of many other career milestones, such as college completion and labor market entry. The timing of college enrollment is also likely to matter for an individual's future income stream. However, the choice of college program may also matter for future income and other aspects of life, e.g. marriage market opportunities, peers, social norms, which could all be expected to affect family formation decisions.

To corroborate our claim that being above the admission requirement affects mainly the timing of college enrollment, we consider three additional outcomes, namely college completion, labor market participation³³ and earnings. Figure 6 shows the estimated effects of being above the admission requirement on these outcomes. Specifically, college completion is defined as having completed at least a three-year college program.³⁴ In the short run, i.e. 3-4 years after YOA, there is a substantial positive effect on college completion of being above the admission requirement as we would expect. Individuals above the admission requirement enroll earlier on average and this translates into earlier college completion.

In the long run, the estimates show that being above the admission requirement does not have a significant effect on the probability of completing college. Thus, differences in family formation behavior may be attributed to the timing of college completion, but not to whether you ever complete college. The graph is consistent with the notion that the main effect of being above the admission requirement is speeding up the educational career, but not to alter the career path as such. The graph on labor market participation shows a similar pattern where the effects of being above the cutoff 5-7 years after YOA are positive and statistically significant.

Figure 6 also shows the estimated effects of being above the admission requirement on earnings. If individuals rank college programs according to earnings potential, and the college program

³³Labor market participation is defined as being a wage earner or self-employed and earning more than 150,000 DKK (in 2000 DKK). The earnings requirement is imposed in an attempt to primarily capture labor market participation after college.

³⁴This measure is chosen in order to have a comparable measure across college programs and to minimize problems with right censoring. Most long programs actually consist of two parts: A three-year degree and a two-year degree on top of that. The vast majority of college graduates from the long programs complete both degrees.

realization differs for individuals below and above the admission requirement, we would expect individuals above the admission requirement to end up with higher earnings. Higher earnings are usually considered to increase one's value on the marriage market. As such, the differences in timing of family formation could be caused by differences in the expected match quality of individuals below and above the admission requirement.

The graph shows that there is a naturally negative effect on earnings in the first year after YOA, since those who do not enroll typically 'take a year off' to work, implying that they have high earnings compared to college students. In addition, there are positive and more or less significant effects of being above the admission requirement on earnings 2-8 years after YOA. During this period, individuals who are above the admission requirement will be further ahead in their career. The size of the estimated effects is relatively small, and increases somewhat after 6 years when many of the individuals above the admission requirement will have graduated from college and entered the labor market. Thus, the result that being above the admission requirement speeds up family formation can to some extent be driven by differences in earnings trajectories. This may reflect a positive effect of earnings on the demand for children. In the long-run there is no significant effect of being above the admission requirement on earnings. Again this is consistent with the other evidence that we have presented and suggests that being above the admission requirement mainly affects the timing of college enrollment.³⁵

The literature on the effects of education on timing of fertility generally considers two main types of effects. First, incarceration effects arising due to the fact that individuals with more years of schooling spend more time in school and it is considered relatively costly to have children while in school. Second, human capital effects including effects caused by differences in opportunity costs. With a positive return to schooling, the opportunity cost of childbearing is higher for highly-educated individuals.

When only the timing of education varies and the level of education is constant, only the timing of education can affect the timing of fertility. First, one can think of the delayed college enrollment as generating a form of incarceration effect, since young applicants are not considering childbearing in the years close to the YOA, but will begin to consider childbearing in the latter

³⁵ Another potential explanation is that there are very small differences in the monetary returns to college programs.

years of their college program. In this sense, speeding up college enrollment leads to earlier childbearing due to the incarceration effect.

Second, individuals below the admission requirement tend to lack behind in terms of earnings, labor market participation and probably also general career progression. From a life-cycle perspective, postponed childbearing has been shown to reduce the labor market costs of childbearing for women (see, e.g., Miller (2011) and Wilde, Batchelder, and Ellwood (2010)). Taking these results at face value, women above the cutoff face lower opportunity costs of childbearing at a given point in time than women below the cutoff.

The positive reduced form effects on the timing of family formation presented in section 6.2 can therefore be hypothesized to consist of mainly two effects. Delayed college entry leads to an incarceration-type effect and an opportunity cost effect.³⁶ Both of these effects are dynamic in the sense that they arise only due to the differences in timing of college enrollment for individuals above and below the admission requirement. Our results can be seen as suggestive evidence that the effects of education on fertility timing (at least for comparable samples) may not only reflect human capital effects, but also effects resulting from the change in timing of labor market entry.

Our results in Table 5 suggest that the effects of being above the cutoff are larger for women. It is reasonable that women are more affected by institutions and policies that affect childbearing since they tend to incur the largest costs—pecuniary and non-pecuniary—of childbearing. Relatedly, Björklund (2006) argues that the family policies in Sweden create an incentive for women to delay childbearing until they have finished their education and established themselves in the labor market. This is also a valid point in Denmark where, for example, the eligibility for high maternity leave benefits is conditional on a certain degree of attachment to the labor market.

To sum up, we have presented a variety of empirical evidence that is consistent with being above the admission requirement affecting the timing of college enrollment. We cannot definitively rule out that there are no effects of being above the admission requirement on the choice of specific college program. Under the assumption that only the timing of college enrollment is affected, we can estimate the effect of delayed college enrollment on family formation decisions

³⁶If we split the probability of being a parent into two variables reflecting childbearing during college and childbearing after college completion, we find that both types of childbearing contribute to the overall effects. Childbearing during college is driving the 'early' effects, i.e. especially the effects on the probability of having a child about 4-5 years after YOA, while childbearing after college contributes relatively more to the 'late' effects.

by instrumental variables (IV).

6.4 The Effect of Timing of College Enrollment on Family Formation

Under the assumption that being above the admission requirement affects family formation only through the effect on timing of enrollment, we can estimate the effect of enrolling in YOA on later family formation outcomes. We simply instrument whether or not an individual enroll in the YOA with the indicator for being above the admission requirement. Figure 7 shows the resulting IV estimates which basically correspond to the reduced form estimates divided by the jump in enrollment. Not surprisingly, we find a pattern similar to that found for the reduced form estimates. For marriage the effects tend to be insignificant with a few exceptions. For number of children the estimated effects are generally positive, significant, and relatively large. For example, the effect of enrolling in the YOA on number of children 10 years after YOA is almost 0.3. This should be seen relative to a sample mean of about 0.5, implying that enrolling in the YOA increases the number of children 10 years later by more than 50 percent. We usually assume that responses are heterogeneous, and in this case the IV estimate can only be given a Local Average Treatment Effect (LATE) interpretation. In this case, LATE is a relevant policy parameter, since policy makers are able to change exactly the margin of exogenous variation by e.g. alleviating the capacity constraints in the different college programs.

The estimates depicted in Figure 7 show a significant effect of timing of enrollment on number of children as soon as about 4 years after YOA. This roughly coincides with the time where individuals who do not delay enrollment begin to enter the labor market. This suggests that one of the channels through which timing of enrollment affects family formation is the timing of labor market entry. One reason for this could be that individuals want to postpone having children until they have established a labor market career. This would be consistent with Del Bono, Weber, and Winter-Ebmer (2012) who find that career oriented women who are laid off after a plant closure delay having children.

The estimated drop in the age at college completion is about 0.3 years.³⁷ Back-of-the-envelope

³⁷The estimated drop in the age at college enrollment is close to 0.45 which is what we would expect if the applicants

calculations suggest that the estimated effects on childbearing and marriage correspond roughly to what we would expect by speeding up labor market entry by a whole year. Thus, family formation appears to be sped up more than actual college enrollment. Peer effects could be one of the drivers behind this as one's relative age in the college cohort³⁸ also drops at the cutoff. Relatedly, whether or not you are above the admission requirement could affect the choice of partner.

7 Conclusion

We analyze the effects of being above the admission requirement for one's preferred college program in Denmark on family formation decisions. In doing so, we establish that the primary effect of being above the admission requirement is on the timing of college enrollment. Therefore, we are able to provide evidence on 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 especially fertility 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 schooling laws that may have both timing and human capital effects.

We find strong evidence that being above the admission requirement affects the timing of later family formation decisions. The estimated effects tend to be substantial. We find that being above the admission requirement increases the number of children 8 years after YOA by about 0.1, i.e. about 40 percent. The overall pattern of the estimates suggests that being above the admission requirement speeds up family formation. We cannot observe completed fertility for this sample, but during the period for which data is currently available, we see that individuals just below and above the admission requirement tend to converge in terms of the probability of being married and being a parent. However, for number of children there appear to be more long-lasting effects.

To understand the mechanisms behind the effects of being above the admission requirement on family formation, we analyze in detail the effects of being above the admission requirement

below the threshold who delay enrollment all delay by one year. The drop in the age at college completion is probably lower due to differential dropout and study behavior of applicants below and above the cutoff.

³⁸The relative age in the college cohort is measured by the age relative to the median age in the college cohort.

on college enrollment decisions, college completion and earnings. These analyses clearly suggest that being above the admission requirement affects family formation mainly through the timing of college enrollment. Using an indicator for being above the admission requirement as an instrument for the timing of college enrollment, we can estimate the effect of enrolling in the YOA on later family formation outcomes. Again, we find substantial effects: The effect of enrolling in the YOA on number of children 10 years after YOA is about 0.3. This corresponds to an increase of about 50 percent.

The estimation sample consists mainly of young applicants for relatively prestigious college programs at the two largest universities in Denmark. Applicants tend to have high socioeconomic status and high ability. It is likely that the individuals in the sample are also more career-oriented and determined than a typical college applicant. The sample cannot be considered a representative sample, and it may be that some of the results cannot generally be applied to other contexts. However, the results do seem to fit nicely with some of the studies on the timing of childbearing and career costs that find that highly-educated women have higher incentives to delay childbearing (Miller (2011) and Wilde, Batchelder, and Ellwood (2010)).

From a policy perspective, our results highlight potential side effects of educational policies that induce delays or interruptions in the educational career, namely delayed family formation and childbearing. Many educational policies potentially affect not only the human capital formation of children and youth, but also the timing of that human capital, e.g., school entry rules, compulsory schooling laws etc.

If lowering the age at first birth and increasing fertility rates are policy objectives, our results suggest that providing incentives for individuals to progress faster in the educational system might be desirable. In the specific context of delayed college enrollment, policy makers may want to consider how to increase incentives to enroll earlier, e.g., by increasing the quality of guidance counseling in high school. On the other hand, if the effects are driven by differences in relative age in college and thereby exposure to older peers for those who enroll sooner, policies that encourage everybody to enroll sooner will have limited effects. Of course, when individuals enter the labor market, they are exposed to older peers, so even if only the relative age mechanism is important there may be some scope for these kinds of policies.

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A Tables

Table 1: SAMPLE SELECTION

Description	Number of observations	Number of distinct preferred college programs	Number of distinct college programs (any rank)
Applications to long college programs	288,531	618	1,674
First application	221,554	618	1,657
The preferred college program has a grade requirement	154,942	235	1,518
The preferred college program use a simple tiebreaking rule	80,649	170	1,287
Non-missing GPA	58,723	170	1,189
Estimation sample, window=0.3	16,610	170	831
- Young applicants (≤ 20 years)	6,349	151	586
- Old applicants (≥ 21 years)	10,261	170	735

Table 2: DESCRIPTIVE STATISTICS FOR ESTIMATION SAMPLE OF YOUNG APPLICANTS

	Below		Above		Test for jump	
	admission requirement		admission requirement		Coef.	p-value
	Mean	Std. dev.	Mean	Std. dev.		
Controls						
Female	0.673		0.657		0.005	0.805
Age in YOA	19.646	(0.537)	19.653	(0.543)	-0.003	0.935
<i>Mother's age at birth</i>						
< 25	0.161		0.168		0.024	0.236
25 to 34	0.718		0.696		-0.058	0.006***
> 34	0.109		0.124		0.025	0.048**
Missing	0.013		0.012		0.009	0.084*
<i>Father's age at birth</i>						
< 25	0.065		0.061		0.012	0.295
25 to 34	0.660		0.659		-0.003	0.908
> 34	0.246		0.242		-0.016	0.410
Missing	0.029		0.037		0.007	0.345
<i>Mother's education</i>						
Basic	0.178		0.185		0.004	0.818
Vocational	0.228		0.219		0.016	0.418
College	0.547		0.556		-0.022	0.454
Missing	0.048		0.040		0.003	0.798
<i>Father's education</i>						
Basic	0.156		0.165		0.013	0.495
Vocational	0.226		0.225		0.021	0.233
College	0.530		0.518		-0.049	0.072*
Missing	0.088		0.091		0.015	0.244
Mother missing	0.013		0.012		0.009	0.084*
Father missing	0.029		0.037		0.007	0.345
Mother's log earnings at age 18	10.657	(4.288)	10.734	(4.192)	-0.092	0.695
Mother's earnings missing	0.031		0.027		0.008	0.411
Father's log earnings at age 18	12.643	(1.021)	12.682	(0.936)	0.071	0.060*
Father's earnings missing	0.216		0.225		0.034	0.031**
Prior enrollments	0.009		0.010		0.000	0.941
Being a parent in YOA	0.000		0.001		0.000	0.990
Cohabiting in YOA	0.026		0.024		-0.007	0.339
- Missing	0.027		0.024		-0.018	0.024**

This table continues on the next page.

Table 2 – continued from previous page.

	Below		Above		Test for jump	
	admission requirement		admission requirement		Coef.	p-value
	Mean	Std. dev.	Mean	Std. dev.		
Enrollment variables						
High school GPA	8.944	(0.553)	9.181	(0.545)	0.000	0.990
<i>Preferred field</i>						
Humanities	0.245		0.283		n.a.	
Social science	0.405		0.391		n.a.	
Natural science	0.076		0.081		n.a.	
Health science	0.274		0.245		n.a.	
Enrolled in higher education in YOA	0.422		0.861		0.559	0.000***
Ever enrolled in higher education	0.987		0.993		-0.007	0.102
Enrolled in preferred education in YOA	0.126		0.706		0.503	0.000***
Ever enrolled in preferred education	0.459		0.769		-0.009	0.726
Selected outcomes						
Being a parent 5 years after YOA	0.047		0.053		0.038	0.012**
No. of children 5 years after YOA	0.051	(0.237)	0.059	(0.261)	0.040	0.027**
Married 5 years after YOA	0.037		0.034		0.011	0.188
Number of observations	3,114		3,235			

Notes:

- a) '***', '**', and '*' indicate statistical significance at the 1, 5, and 10 percent levels, respectively.
- b) In the analyses in section 6, we include indicators for age instead of the continuous variable.
- c) For a couple of the variables listed the number of observations differs from the size of the estimation sample: Mother's log earnings: 6,164; and father's log earnings: 4,950. For the selected outcomes, see Table 4.
- d) To test for a jump, each covariate is regressed on Z_i , d_i , and an interaction of the two. The coefficient on Z_i and the corresponding p-value are reported. Preferred college program-year fixed effects are included and standard errors are clustered at the college program level.

Table 3: HETEROGENEOUS EFFECTS OF BEING ABOVE THE ADMISSION REQUIREMENT ON ENROLLMENT

Enrollment	No. of obs.	College	YOA or later	Preferred college program	
		YOA		YOA	YOA or later
		Coef./Std. Err.	Coef./Std. Err.	Coef./Std. Err.	Coef./Std. Err.
<i>Estimation sample</i>					
Young applicants	6,349	0.559*** (0.033)	-0.007 (0.006)	0.503*** (0.035)	-0.009 (0.026)
Old applicants	10,261	0.260*** (0.024)	0.005 (0.009)	0.327*** (0.025)	0.071*** (0.019)
<i>Young estimation sample</i>					
Men	2,125	0.561*** (0.050)	-0.002 (0.008)	0.497*** (0.050)	-0.021 (0.046)
Women	4,224	0.559*** (0.037)	-0.015** (0.007)	0.510*** (0.037)	0.001 (0.031)

Notes:

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

b) To test for a jump, each covariate is regressed on Z_i , d_i , and an interaction of the two. The coefficient on Z_i and corresponding standard errors are reported. Preferred college program-year fixed effects are included and standard errors are clustered at the college program level.

Table 4: REDUCED FORM ESTIMATES OF THE EFFECT OF BEING ABOVE THE ADMISSION REQUIREMENT ON SELECTED FAMILY FORMATION OUTCOMES

	(1) Coef./Std.Err.	(2) Coef./Std.Err.	(3) Coef./Std.Err.	(4) Coef./Std.Err.	(5) Coef./Std.Err.	No. of obs.
Married	0.011	0.010	0.010	0.009	0.010	6,143
5 years after YOA	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	
R^2	0.001	0.004	0.010	0.010	0.015	
Being a parent	0.038**	0.038**	0.038**	0.038**	0.038**	5,718
5 years after YOA	(0.015)	(0.016)	(0.016)	(0.016)	(0.015)	
R^2	0.002	0.006	0.010	0.010	0.027	
Number of children	0.040**	0.040**	0.040**	0.040**	0.039**	5,718
5 years after YOA	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	
R^2	0.001	0.006	0.011	0.011	0.031	
Basic controls		+	+	+	+	
Parental background			+	+	+	
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 clustered at college program level.

b) Basic controls: gender and age group. Parental background: level of education, earnings, age, missing.

Indicator for prior enrollments. Family formation in YOA: cohabitation, missing, being a parent.

Table 5: HETEROGENEOUS EFFECTS OF BEING ABOVE THE ADMISSION REQUIREMENT ON SELECTED FAMILY FORMATION OUTCOMES

Outcome:	(1) Married 5 years after YOA Coef./Std. Err.	(2) Married 10 years after YOA Coef./Std. Err.	(3) Number of children 5 years after YOA Coef./Std. Err.	(4) Number of children 10 years after YOA Coef./Std. Err.
Panel A: Age				
<i>Estimation sample</i>				
Young applicants	0.010 (0.008) [6,143]	0.029 (0.029) [4,005]	0.039** (0.018) [5,718]	0.160*** (0.056) [3,223]
Old applicants	0.009 (0.010) [9,882]	-0.006 (0.019) [7,072]	-0.006 (0.018) [9,530]	-0.020 (0.043) [5,852]
Panel B: Gender				
<i>Young estimation sample</i>				
Men	0.013 (0.008) [2,059]	0.042 (0.036) [1,354]	0.009 (0.026) [1,914]	0.072 (0.108) [1,116]
Women	0.005 (0.012) [4,084]	0.032 (0.038) [2,651]	0.052** (0.021) [3,804]	0.217*** (0.074) [2,107]
Men with low initial wage level	0.011 (0.017) [882]	0.070 (0.084) [595]	0.031 (0.042) [831]	0.174 (0.148) [505]
Men with high initial wage level	0.016** (0.008) [1,163]	0.042 (0.040) [759]	0.011 (0.032) [1,069]	-0.015 (0.142) [611]
Women with low initial wage level	0.013 (0.024) [1,938]	-0.022 (0.074) [1,307]	0.032 (0.036) [1,834]	0.099 (0.120) [1,088]
Women with high initial wage level	-0.001 (0.009) [2,141]	0.071* (0.037) [1,344]	0.066*** (0.024) [1,965]	0.321*** (0.089) [1,019]

Notes:

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

b) Number of observations is in brackets.

c) The estimations include all covariates. For estimations based on initial wage level, observations with missing wage level are excluded.

B Figures

Figure 1: Probability of being a parent, being married, and number of children by YOA. 95 percent confidence bands. Sample: Young estimation sample.

Figure 2: Scatter plot of the admission requirements in year t and year t-1. The markers are weighted by the number of applicants in year t. The sample consists of first-time applicants in year t whose preferred program was a long college program with a GPA admission requirement - binding or non-binding. Data period: 1996-2006. Scatter plot is overlaid with a linear prediction based on a regression weighted by the number of applicants in year t. One cell with less than four observations is omitted to comply with Statistics Denmark data security policy. An admission requirement of 6 is non-binding.

Figure 3: College enrollment by distance from admission requirement. Scatter plots are overlaid with fitted values and 95 percent confidence bands from a linear regression on distance, an indicator for being above the admission requirement, and an interaction of the two. Sample: Young estimation sample.

Figure 4: Selected outcomes by distance from admission requirement. Scatter plots are overlaid with fitted values and 95 percent confidence bands from a linear regression on distance, an indicator for being above the admission requirement, and an interaction of the two. Sample: Young estimation sample.

Figure 5: Effects of being above the admission requirement on the timing of family formation. Reduced form estimates of the effect of being above the admission requirement on main outcomes and 95 percent confidence bands. Includes all covariates. Standard errors are clustered at the college program level. Sample: Young estimation sample.

Probability of having completed a long college program

Labor market participation

Earnings (in 2000 DKK)

Figure 6: Timing of college completion and labor market entry. Reduced form estimates of the effect of being above the admission requirement on college completion, labor market participation and earnings. 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Sample: Young estimation sample.

Figure 7: The effect of enrollment in YOA on family formation. IV estimates of the effect of enrollment in YOA on family formation outcomes. 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Sample: Young estimation sample.

C Online Appendix: Robustness Checks and Alternative Specifications

In this section we explore the robustness of our main results to alternative samples and specifications. Each subsection presents a different robustness or specification check.

C.1 Window Size

We have estimated our model with different windows ranging from 0.1 to 0.4, cf. Figure 8. Almost all estimates using different window sizes are well within the 95 percent confidence bands of the main estimates with a window of 0.3. The precision of the estimates appears to be more sensitive to the choice of window.

C.2 Placebo Analysis Using Random Cutoffs

In order to validate the main results, we also conduct a placebo analysis. In the placebo analysis, we randomly assign cutoffs to applicants from the range of observed cutoffs in the data. Figure 9 shows the resulting placebo estimates along with the baseline estimates for comparison. The graphs only show the results for up to 10 years after YOA since the confidence bands get very wide after this. The placebo estimates are generally smaller than the baseline estimates and hover around zero which is what we expect given that the empirical strategy is valid. 8-10 years after YOA the placebo estimates tend to turn negative, and in a couple of cases, they are even statistically significant.

C.3 Nonparametric Estimates

We present local linear regression estimates as a robustness check in Figure 10. The local linear regression estimates are bias-corrected and using the robust variance estimators proposed by Calonico, Cattaneo, and Titiunik (2014b) and Calonico, Cattaneo, and Titiunik (2014a). The graphs show a pattern that is very similar to that of the main results in Figure 5. If we choose a smaller bandwidth, the nonparametric estimates get very imprecise.

C.4 Donut RD Estimates

In our main analysis, we exclude all applicants whose preferred program did not have a simple tiebreaking rule. We also exclude applicants to short college programs which tend not to have simple tiebreaking rules. In the absence of a simple tiebreaking rule at the cutoff, a standard RD strategy is not feasible. We therefore adopt a so-called donut RD strategy (Barreca, Guldi, Lindo, and Waddell (2011)). In an attempt to increase sample size and precision we perform a partial donut RD using observations from all levels of college programs irrespective of tiebreaking rules. We still focus on young applicants. Since we only drop marginal applicants to programs without a simple tiebreaking rule, we refer to this as a 'partial' donut RD.

Considering applicants within 0.3 grade points of the admission requirement, the resulting donut RD sample has 15,227 observations. Figure 11 shows the resulting reduced form estimates for the three main family formation outcomes. The coefficient estimates tend to be reduced by half and precision is not improved substantially. This suggests that effects are smaller for the applicants to college programs without simple tiebreaking rules.

C.5 Sharp Sample RD Estimates

Since slots in college programs are allocated using a deferred acceptance mechanism, we can apply the 'sharp sample' RD approach used by Abdulkadiroğlu, Angrist, and Pathak (2014). For this purpose the data is organized as one observation per applicant-rank combination. The sharp sample for program k consists of two types of observations for program k :

- (i) Observations where program k is the preferred program.
- (ii) Observations where program k is ranked second or lower, but the applicant did not qualify for any of his higher-ranked programs.

Like the main estimation sample, the sharp sample consists of first-time applicants whose preferred program was a long college program with a GPA binding admission requirement. Only young applicants with a non-missing GPA are included. Only observations for ranked programs that are oversubscribed with a simple tiebreaking rule are included in the sharp sample. Thus there can be both short and long programs in the sharp sample.

The size of the estimation sample increases by about 2,000 observations to a total of 8,143 observations. Figure 12 shows the reduced form estimates based on the sharp sample. The overall pattern is similar to that of our main results in Figure 5, but both coefficient sizes and precision tend to decrease.

Abdulkadiroğlu, Angrist, and Pathak (2014) briefly mention that the construction of a sharp sample introduces the possibility that the sample composition changes discontinuously at the cutoff. Intuitively, being above the cutoff lowers the probability of being in the sharp sample for program k since it becomes more likely that the applicant qualified for a higher-ranked program. In our application this problem is likely to be more severe since many of the cutoffs for college programs in Denmark are more or less overlapping and colleges use the same running variable (high school GPA) to select applicants.

In order to check whether the probability of being in the sharp sample does indeed drop discontinuously at the admission requirement, we construct an extended sharp RD sample that mimicks the sharp sample, but includes observations where program k is ranked second or lower and the applicant *did* qualify for one of his higher-ranked programs. Figure 13 plots the probability of being in the sharp sample against distance to the admission requirement and suggests a drop at the cutoff. In conclusion, the sharp sample approach does not appear to be well-suited for this application.

C.6 Qualification Requirement Estimates

While our primary analysis focuses on the admission requirement of the preferred program (first-choice analysis), one could also choose to focus on the qualification requirement. The qualification program is the program with lowest admission requirement on the college application. One could argue that whether or not you are above this requirement is what is really important for determining college enrollment.

We construct a qualification requirement (QR) sample that consists of first-time applicants whose preferred program was a long college program with a binding admission requirement. We focus on young applicants with a non-missing GPA. We include only observations where the qualification program has a simple tiebreaking rule, i.e. everybody is admitted at the cutoff.

Qualification programs can also be short programs. By construction the qualification program will have a binding admission requirement. The QR estimation sample has 5,202 observations.

Before turning to the estimation results, we estimate the discontinuities in enrollment in college in the YOA and ever at the qualification requirement. We find that the estimated jump in college enrollment in the YOA is 0.45 (with a standard error of 0.07) which is actually smaller and less precisely estimated than the jump found in the first-choice sample, cf. Table 3. The estimate for the effect of being above the qualification requirement on ever enrolling in college is very similar to that found in the first-choice sample. This is in line with Abdulkadiroğlu, Angrist, Narita, and Pathak (2015) who actually present a comparison of first-choice and qualification instruments for charter school enrollment. In their application, the qualification instrument is also weaker than the first-choice instrument.

With these results in mind, Figure 14 shows the estimated reduced form effects of being above the qualification requirement on marriage and childbearing. The estimated effects tend to be insignificant and smaller in size than the estimates in Figure 5. Based on the smaller effects on enrollment, we would also expect the effects on childbearing and marriage to decrease.

Clearly the effects of being above the qualification requirement and the effects of being above the admission requirement of one's preferred program are not necessarily the same. Furthermore, compliers may be different in the two settings making the estimates incomparable if effects are heterogeneous. Using the admission requirement for the preferred program, compliers would be individuals who enroll in college in the year of application if they are above the admission requirement, but who do not enroll if they are below the threshold. That is compliers are likely to be applicants with relatively strong preferences for a particular program. On the other hand, individuals who have strong preferences for enrolling in college fast, but who do not have strong preferences for a particular program would likely be always-takers in this setting.

Using the qualification requirement, compliers would be individuals who enroll in college in the year of application if they are above the qualification requirement, but who do not enroll if they are below the threshold. In this case, compliers are likely to be a more composite group. At least some of these compliers will have preferences for a range of college programs and be willing to enroll in a lower ranked priority if they do not qualify for their first choice. Compliers who only

list one program will be the same in the two settings. On average we expect compliers in the QR strategy to exhibit less strong educational preferences. In this sense they may also exhibit less motivation and career orientation and therefore be affected by the timing of enrollment to a lesser extent.

C.7 Appendix Figures

Figure 8: Effects for different window widths. Reduced form effects of being above the admission requirement on family formation. 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Sample: Young estimation sample.

Figure 9: Placebo test. Reduced form effects of being above the admission requirement on family formation. 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Sample: Young estimation sample.

Figure 10: Nonparametric estimates. Reduced form effects of being above the admission requirement on family formation. 95 percent confidence bands. Local linear regression bias-corrected estimates using a triangular kernel with a bandwidth of 0.65. Standard errors are robust and clustered at the college program level. Sample: Young estimation sample.

Figure 11: Estimated effects using donut RD specification. Reduced form effects of being above the admission requirement on main outcomes and 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Donut RD sample.

Figure 12: Estimated effects using sharp sample RD specification. Reduced form effects of being above the admission requirement on main outcomes and 95 percent confidence bands. Includes all covariates and college program-year fixed effects. Standard errors are clustered at the college program level. Sharp RD sample.

Figure 13: The probability of being the sharp sample by distance from admission requirement. Scatter plots are overlaid with fitted values and 95 percent confidence bands from a linear regression on distance, an indicator for being above the admission requirement, and an interaction of the two. Extended sharp RD sample.

Figure 14: Estimated effects using qualification requirement specification. Reduced form effects of being above the qualification requirement on main outcomes and 95 percent confidence bands. Includes all covariates and qualification college program-year fixed effects. Standard errors are clustered at the qualification college program level. QR sample.