The Effect of Compulsory Preschool Education on Maternal Employment: Evidence from Brazilian education reform

Hanbyul Ryu*

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Abstract

Using the compulsory school reform in Brazil, I examine the effects of lowering compulsory school attendance age on mothers' labor market outcomes. In 2009, the Brazilian government lowered the school starting age from six to four years old and required that children who turned 4 years old by March 31st be enrolled in preschool education. I exploit a discontinuity in the school eligibility rule and found that preschool enrollment significantly increased the time spent working rather than performing household chores among mothers in single-family households without younger children. Moreover, these mothers exhibited the transition from informal to formal employment. I found no effects among mothers who had an additional younger child or were living with other relatives. Taken together, the findings reveal a potential benefit of lowering school entry age in a context where limited availability of early childhood education constrains mothers' labor market activities.

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*Economics Department, University of California, Riverside. Email: hryu004@ucr.edu

1. Introduction

In recent periods, several countries have implemented school reforms that lower the school entry age.[1] The major arguments in favor of such reforms was the provision of more equal educational opportunities with potential benefits to students' subsequent academic performance, particularly for those from disadvantaged backgrounds. It is important to note, however, that mothers represent an additional group of people who may be impacted by such a policy. Increased school enrollment among younger children can be a channel that mothers become more available to engage in labor activities. This potential benefit expects to be more prominent in countries where the children have limited access to early childhood education, but it has often been neglected in the consideration of policy implementation.

The current study examined how maternal labor outcomes were affected by Brazil's 2009 reform that made preschool education compulsory. The Brazilian government lowered the school entry age to six in 2006, and not long after it mandated that the compulsory school entry age be lowered to four years old in 2009.[2] According to the new legislation enacted in 2009, students who turned four years old by March 31st should be enrolled in their first year of preschool education. This eligibility rule generated a significant discontinuity in the probability of school enrollment around the cutoff date. I employed a regression discontinuity approach based on the eligibility rule to examine the effect of preschool enrollment on maternal labor outcomes.

There are several reasons that the eligibility rule for preschool enrollment could generate positive and significant effects on maternal outcomes in Brazil. First, there is limited space available in the public daycare centers that students can attend before preschool begins. A recent survey in Brazil[3] showed that 45% of families with children younger than four years old wish to enroll their children in daycare or preschool. In the families sampled, 85% of primary-care providers were mothers. Therefore, it is likely that a nontrivial share of mothers wished to enroll their children

[1] For example, Mexico and Brazil have lowered the school entry age to 4 years old in 2004 and 2008, respectively, and France recently lowered the school starting age to 3 years old in 2018. The governments in each country announced the policy in the stated years, but the deadline to fully implement the policy differed by country.

[2] The Brazilian government announced the policy in 2009 and required to complete the process by 2016.

[3] Pesquisa Nacional por Amostra de Domicílios (PNAD) in 2015.

in daycare or preschool, perhaps in order to engage in labor market activities. Second, the compulsory school reform mostly increased the enrollment rates in public preschools where education is provided free of charge. This fact may have eased the concern of mothers surrounding tuition, which is required by private preschools and many daycare programs. For these reasons, mothers whose children were eligible for school entry may have transitioned to the labor market sooner as a result of the lowered entry age to compulsory education.

This study separately evaluates the effect of preschool enrollment on mothers inhabiting two types of households: 1) where a 4-year-old child is the youngest in the family member and no other relatives cohabit, and 2) where either a 4-year-old child is not the youngest in the family member or other relatives, such as grand-parents or brothers/sisters cohabit. The samples were divided into two groups because mothers' labor market outcomes in the first group could be affected more than those in the second group when their 4-year-old child enrolled in preschool. For example, having an additional younger child to take care of may restrict mother's labor supply even after the preschool enrollment of their 4-year-old children. In addition, mothers who previously used informal childcare provided by grandparents or other relatives may not show a change in their labor market activities if their child's informal care is merely substituted for preschool. Informal childcare may be particularly important in Brazil because the recent study (Attanasio et al. (2017)) showed that grandparents play a relatively important role as caregivers.

I found that the 4-year-old students who were born before the cutoff date were approximately 10 percentage points more likely to enroll in school. Considering that the enrollment rate of 4-year-olds in Brazil was approximately 60% in 2011, this was about 17 % increase in probability in relation to the base value. The effect of the eligibility rule on preschool enrollment was similar between single families without an additional younger child and its complementary group. Despite the significant discontinuity in school enrollment rate, there was no significant effect of preschool enrollment on the maternal labor market outcomes if the child was not the youngest member of the household or there were other relatives present. By comparison, statistically significant changes in maternal labor outcomes were observed among mothers whose 4-year-old child was the youngest

and live with no other relatives.

Reduced form estimates indicate that the mothers whose children were eligible for preschool education spent 2.3 more hours for working and at the same time reduced the number of hours for household chores by 1.6 hours. Moreover, these mothers were approximately four percentage points more likely to work characterized by formal labor contracts. This finding is particularly important because formal labour contracts guarantee employees' rights and benefits. Second-stage estimates indicate that when eligible 4-year-old children were induced to enroll in preschool due to the eligibility rule, the mothers were approximately 40 percentage points more likely to take jobs with formal labor contracts. In addition, average working hours per week also increased about 22 hours and the number of hours spent for household chores decreased by 15 hours.

The current study is related to a number of previous studies that examined the effect of school enrollment on maternal labor market outcomes. Previous studies have reached different conclusions depending on the existing labor market conditions for mothers, the availability of alternative child care, or pre-school enrollment rates prior to policy implementation. Several studies (Fitzpatrick (2010); Havnes and Mogstad (2011); Bettendorf et al. (2015) and Baker et al. (2008)) found a small or no effect of preschool enrollment, and attributed their finding to the pre-existing high maternal employment rate, substitution of informal childcare for preschool, or low elasticity in the female labor supply. By comparison, a set of studies (Fitzpatrick (2012); Goux and Maurin (2010); Cascio (2009) and Carta and Rizzica (2018)) found a positive effect of preschool enrollment on labor market activities among a subset of mothers who were single or who did not have a second, younger child. Lastly, other studies (Bauernschuster and Schlotter (2015); Berlinski and Galiani (2007); Berlinski et al. (2011); and Nollenbergera and Rodriguez-Planas (2015)) found a significant effect of preschool enrollment on their entire sample of mothers.

Unlike previous studies that were mostly conducted in the context of developed country, the current study provides new evidence to the existing literature by examining the impact of compulsory schooling reform in a developing country context.[4] Considering the increasing female labor

[4]Among the studies introduced in the previous paragraph, Berlinski and Galiani (2007); Berlinski et al. (2011); Attanasio et al. (2017) are the only ones that evaluated the effect of children's school enrollments on maternal labor

force participation in developing countries, it is important to learn how preschool enrollment may affect the maternal labor market outcomes in such a setting. Several important factors such as female labor supply elasticity or alternative childcare options for preschool, which impacted the main findings of other studies, might be different in developing countries. In addition, using the detailed descriptions of the works that mothers took in a reference week, this study was able to show that preschool enrollment of children not only increased maternal working hours, but also the type of jobs that mothers take.

Moreover, the current study evaluates a policy that mandated preschool education. This distinguishes the current study from previous studies that mostly evaluated the programs, such as subsidized child care policies, construction of childcare facilities, or universal childcare programs. First, the current policy has potential to increase of school enrollment of children whose mothers have no intention to participate labor market activities because all mothers were supposed to enroll their children in preschool. Second, the policy was not directly intended to affect maternal labor market outcomes. The finding that lowering the school entry age had a positive effect on maternal labor outcomes could be considered another potential benefit when similar policies are implemented in other countries.

2. Context

Brazil is one of the few countries in the world that has lowered the entry age of compulsory education to 4 years old. The original compulsory education in Brazil started at age 7 and had duration of 8 years. This system has undergone several changes from 2006 in an effort to provide more equal educational opportunities for every child. The first major reform was introduced in 2006; the Brazilian government lowered the minimum age of school entry from 7 to 6 years old and increased the duration of education from 8 to 9 years. Then, not long after, the government made

outcomes. Attanasio et al. (2017) is more closely related to the current study as they examined the effect of having acess to free daycare program on maternal employment in Rio de Janeiro, Brazil. While their study evaluated the lottery program for daycare access in one state of Brazil, the current study evaluates the school reform and include more than half of the Brazilian states.

the second educational reform in 2009 and lowered the compulsory school entry age even more to 4 years old. The current study examined the effect of the second educational reform on maternal outcomes. First reform is less likely to make an impact on maternal outcomes because primary school enrollment was almost universal for students in ages 6 and 7.

In the initial stage of the reform, the school legislations lacked of exact definition for school entrance age. Instead, the initial school reform legislations stated that students need to turn 6 by the beginning of the school year. To reduce the confusion and problems stemming from the interpretation of the cutoff date, the government announced in 2009 a unified cutoff date of March 31st; students who turn 6 or 4 before this cutoff date had to begin their first year of primary and preschool education. This decision sparked a large controversy instantly, particularly among the parents of children who barely missed the opportunity to begin their compulsory education (i.e., those born just right after March 31st). Several states also believed that enforcement of cutoff date violates the educational rights of children who barely missed the cutoff date.

As a result, some state governments successfully appealed the federal government's decision to impose March 31st cutoff date and chose different cutoff dates for preschool enrollment. For example, the state government of Sao Paulo chose June 30st. Then, in 2013, the state government of Minas Gerais changed its cutoff date from March 31st to June 30st. The cutoff dates for these two states, therefore, were rescaled to be compatible with the cutoff dates of other states.[5] However, few states were not included in the analysis because their cutoff dates were either much later than newly enforced the cutoff dates or leniently enforced.[6]

Lastly, initial Preschool enrollment rates in Brazil varied by region. Several states in Northeast region show much higher school enrollment rates compared to the other states located in relatively wealthier regions due to the municipality priorities or local demand for schools (Evans and Kosec (2012)). Preschool eligibility rule did not make an effect on school enrollment rate in such states

[5] I made the distance between students' birth dates and the cutoff date equal to zero on June 30th if students reside in states of Sao Paulo and Minas Gerais.

[6] For the current study, I checked the state legislation or state government reports to verify that the March 31st cutoff date was enforced in a particular state. For those states whose legislation was not available, I assigned the default cutoff date to March 31st.

because students were enrolled in schools regardless of their eligibility status. Therefore, the current analysis excluded a few states in Northeast region such as Maranhão, Piauí, Ceará, and Rio Grande do Norte, which had the average school enrollment rate between 2011 and 2015 higher than 80%. In these regions, average school enrollment rate for the students who turned 4 between February and May was 83%, while the average enrollment rate for other states was 64%.

3. Data and Descriptive Statistics

The major dataset for the analysis is from PNAD, national household sample survey data in Brazil. It collects socio-demographic characteristics of household information over 300,000 individuals and 10,000 households every year. Because the data provide every household member's exact birthday with the identifier of mother for each child, I could identify the child that is eligible for preschool entry, and his/her mother. In addition, the data provide detailed information about mothers' labor market outcomes such as the average number of hours spent working and on chores each week, as well as whether or not the mother worked during a given reference week.[7] In terms of the status that mothers had worked in a reference week, I further divided it based on whether they worked with and without formal labor contracts.[8] It is important to examine whether mothers took a job characterized by a formal labor contract because employees without one often do not receive employees' benefits or face the unfairness on their jobs.

For the main analysis, I included the women in ages between 17 and 50 and have at least one child in the age of 4. The children had entire year of birth months from October to September, but they become the age 4 in different months.[9] They enroll in preschool or daycare programs depending on their eligibility for preschool and availability of school spaces. Given the limited spaces of daycare programs and tuition of private preschool programs, children born between October and

[7]Monthly income was not used because it is available only for particular occupations.

[8]Mothers who worked as public employees, self employed, and employers are separately analyzed in appendix but the school eligibility rule did not make significant changes in these status. Additionally, mothers who worked in military, worked to produce for own consumption, worked as construction workers to repair their own house, and had unpaid jobs were not analyzed because they represent less than 5% of the entire sample.

[9]Children in Sao Paulo and and those in Minas Gerais after 2012 have birth months from January to December because the cutoff for preschool entry was June 30th in those states.

March were more likely to enroll in school because they were eligible for preschool entry under the school reform. By comparison, children born between April and September were not eligible for preschool entry and therefore less likely to enroll in school. Note that students not eligible for preschool entry were occasionally enrolled in preschool or still could be enrolled in daycare designed for children in between age 0 and 3.

Table 1 shows the summary statistics of the samples used in the current analysis. The columns are first divided by the two groups of the samples explained earlier; single families where a 4-year-old child is the youngest and the households where a 4-year-old child is not the youngest or relatives present. Each column is then further divided by the birth months of children; children become 4 years old before the cutoff date, March 31st (older children), and after the cutoff date (younger children). In the group of single families without any younger child, the probability of children being enrolled in preschool or daycare is approximately 20 percentage points higher among older children. Predetermined mothers' characteristics such as education, race, or age show similarity between mothers who have older and younger children. The smoothness of these characteristics around the cutoff date is tested analytically and graphically in the next section. Family size, number of children in different age groups, and number of observations also show the similarity between the two groups.

The summary statistics for the households, in which 4-year-old child is not the youngest or other relatives present, show generally similar patterns as those in the single-family households without an additional younger child. Preschool enrollment rate is approximately 24 percentage points higher for eligible children whereas predetermined mothers' characteristics generally do not show much difference. Continuities of maternal characteristics for this group are also tested both analytically and graphically in the next section.

4. Empirical estimation

The current study uses a regression-discontinuity design to find a causal relationship between children's preschool enrollment and maternal employment. Conventional OLS estimation that measures this relationship could be potentially problematic as mothers often simultaneously decide their children's school enrollment and participation in labor force. In addition, more career-motivated women possibly decide to send their children to schools and participate in workforce.

To delve into the causal relationship, the cutoff date for preschool entry enforced by Brazilian government is used as an instrumental variable. Specifically, the following estimation strategy is used in the first stage:

$$C_{ist} = \beta_0 + \beta_1 1[D_{ist} \leqq 0] + f(D_{ist}) + X_{ist}\theta + \mu_t + \gamma_s + \varepsilon_{ist} \tag{1}$$

where C_{ist} is a variable indicating whether a child is enrolled in school. It is assigned one if he/she enrolled in preschool or daycare and otherwise zero.[10] $1[D_{ist} \leqq 0]$ is an indicator variable, which is equal to one for the students born between October 1st and March 31st and zero for the students born between April 1st and September 31st. Students are more likely to enroll in school if the indicator variable equals to one as they are eligible for preschool entry under the compulsory school reform. $f(D_{ist})$ is a quadratic polynomial function of the running variable D_{ist} that can vary on either side of the cutoff date. The running variable indicates the distance between child's birth day and the school cutoff date. For example, D_{ist} is -191 for the children born in Oct 1st as they were 191 days far away from the cutoff date, March 31st. Similarly, +190 is assigned for D_{ist} if the children were born in September 31st.[11]

The primary coefficient of interest is β_1, as it captures the discontinuity in the probability of school enrollment. As students who were born before March 31st were more likely be enrolled

[10] I constructed a dependent variable that includes both daycare and preschool enrollments because still nontrivial share of eligible students were enrolled in daycare programs. However, the discontinuity around the cutoff date is only observed in preschool enrollment rates.

[11] The running variable is assigned differently for Sao Paulo and Minas Gerais because Sao Paulo had June 30th cutoff date from 2011 and Minas Gerais switched the cutoff date to June 30th in 2013.

in school, β_1 is expected to be positive. However, the estimate will be smaller than one, which indicates the fuzzy regression discontinuity design. There are several possibilities that this cutoff does not completely bind for the groups of the students, before and after the cutoff date. First, children who became 4 years old after the cutoff date still could enroll in daycare or occasionally in preschool. Furthermore, the children who were eligible for preschool entry might delay their entrance for different reasons, such as slower development or availability of other care options, such as grandparents.

In the second stage, I restrict samples to the women in ages between 19 and 50 whose children were analyzed in the first stage equation and estimates the following equation:

$$Y_{ist} = \delta_0 + \delta_1 \hat{C_{ist}} + f(D_{ist}) + X_{ist}\rho + \mu_t + \gamma_s + v_{ist} \tag{2}$$

Where Y_{ist} represents labor market outcomes of the women, such as working status in a reference week, average working hours per week, and average hours spent for house chores. $\hat{C_{ist}}$, school enrollment of 4-year-old child, is predicted by an instrumental variable using school cutoff date. δ_0 represents local average treatment effect of child being enrolled in preschool on maternal employment rate.

The underlying assumption for validity of above strategy is that maternal outcome variables would be continuous if there was no discontinuity of school enrollment around the cutoff date. This assumption could be violated if mothers were able to manipulate the children's birth month for their preschool enrollment. In the next sections, I conducted several tests to test the assumption. First, I used the McCrary test whether there exists a discontinuity in share of the mothers whose children are four years old around the cutoff date. Also, to confirm that mother's socioeconomic or household characteristics do not change around the cutoff date, I tested analytically and graphically whether there exist changes of mother's year of schooling, number of household members, or residence regions around the cutoff date.

5. Estimation Results

5.1 Graphical analysis

This section first presents graphical evidence supporting the validity of regression discontinuity design. What follows is a visualization of how preschool enrollment rates and maternal labor market outcomes were affected by the cutoff date. To test the validity of empirical estimation, I examined whether there was a discontinuity in mothers' predetermined characteristics (e.g., years of education, race, and age). I also used the McCrary test to check whether there was a discontinuity in the distribution of mothers around the cutoff date. These validity tests were conducted for the following subsamples: single families without a younger child and the complementary group (i.e., families with an additional younger child and/or other relatives in the household). In each graph, I used the second order local polynomial approximation with a bandwidth of 120 days and rectangular kernel weights. Dotted lines indicate the 95% confidence interval, and each dot is the average value of the outcome variable in 7 days of birthday bins.

First three graphs in Fig 1.(a) show the continuity in the predetermined maternal characteristics in single families without a younger child. There is no evidence that any of the observable characteristics differed before and after the cutoff date. Also, the McCrary test for the same subgroup does not show any discontinuity in the distribution of mothers across the cutoff dates. These results suggest that mothers in the single families were less likely to manipulate their children's birth dates. The next three graphs show the trends of the same maternal characteristics in families with an additional younger child or other relatives. Unlike the trends observed in the first group, mothers' years of education and age show discontinuities across the cutoff date, whereas the share of white mothers show a smooth trend over the running variable.

The potential concern regarding the finding among mothers living with an additional younger child or other relatives is the possibility that more educated and younger mothers manipulated the eligibility. However, this is less likely to be a concern for several reasons. First of all, the discontinuity observed in the second group of mothers is not supported by the analytical analysis,

which will be discussed in the next section. In addition, we do not see the same trend among mothers in single families without a younger child, which consists of much larger share of the sample. If younger and more educated mothers had manipulated eligibility, the same trend should have been observed in the other mothers' group. However, there was no such sign in the first three figures in Fig 1.(a).

Next, if eligibility had been manipulated, there should have been higher density in mothers' population before the cutoff date. The McCrary test in Figure 2 shows the opposite result; there was higher density after the cutoff date. This finding reduces the concern that a greater number of educated and younger mothers changed their children's birth dates to ensure preschool eligibility. Lastly, any potential problems associated with sample selection or eligibility manipulation might have exaggerated the effect of preschool enrollment on mothers' labor market outcomes. However, there was no effect of preschool enrollment among mothers living in multi-families or living with an additional younger child. As will be shown in the next section, I found significant effects on mothers' labor market outcomes only among mothers living in single families without an additional younger child, which had no discontinuities in any of the pre-determined maternal characteristics. Given the listed reasons, the discontinuities observed in some of the mothers' characteristics are less likely to bias the estimates of the current study.

Next, Figures 2 and 3 illustrate the discontinuity in school enrollment rates and maternal labor outcomes at the cutoff date. In Figure 2, the upper figure presents the school enrollment rates among 4-year-olds in single families without an additional younger child, and the lower figure shows the school enrollment rates among 4-year-olds who are not the youngest in the household or live with other relatives. Both figures show a clear discontinuity in school enrollment rates around the cutoff date, regardless of the type of households that 4-year-olds reside. Students who turned 4 after the cutoff date were much less likely to be enrolled in preschool or daycare compared to their older counterparts. Given that preschool education became compulsory for every 4-year-old child we do not expect to observe different trends in preschool enrollment rates across the two groups. This expectation was confirmed in Figure 2.

Figure 3 presents the relationship between the maternal labor market outcomes and the birth dates of children. Fig 3. (a) show suggestive evidence that child's preschool enrollment affected maternal outcomes among mothers who do not have an additional child or live with other relatives. If their children were available for preschool entry, the mothers were more likely to take a job with formal labor contract and less likely to take a job without the contract. They also spend longer hours for working whereas spending less hours on household chores.[12] By comparison, Fig 3. (b) present that the cutoff eligibility rule did not influence the labor market outcomes of the mothers who have an additional younger child or live with other relatives. All of the maternal labor outcomes showed a continuous trend across the cutoff date. Despite the significant effect eligibility rule on school enrollment rates in both types of households, Figure 3 show that maternal outcomes exhibit discontinuity only among mothers in the first group.

5.2 Regression results

Previous sections provided a graphical analysis for the validity of regression discontinuity design and the relationship between preschool eligibility rule, school enrollment rates, and maternal labor market outcomes. This section provides analytical evidence that supports the results shown by graphical analysis. Like previous graphical analysis, separate estimates were drawn for each labor market outcomes between two different groups of mothers; those who live in single families where a 4-year-old child is the youngest and those who live with relatives or have an additional younger child.

First, Table 2 shows the results that compared the observable characteristics of mothers across the cutoff date. Eq. 1 is used to test the smoothness of predetermined characteristics. As confirmed in graphical analysis, most of the observable characteristics do not change significantly across the cutoff date. Although graphical analysis suggested the possibility that mother's education and age have discontinuities around the cutoff date among one group of mothers, none of the estimators show statistically significance. Overall, Table 2 does not support that mothers with certain observ-

[12]The probability of working as public employees or employers did not change.

able characteristics manipulate children's birthdates around the cutoff date.

Table 3 reports the estimates in the first stage of regression and reduced form estimates. All the estimates were calculated with state and year fixed effects and the control variables such as mothers' years of education, age, and race. First column in Table 3 reports the estimates for the effect of school eligibility rule on school enrollment rate for each group of mothers. As shown in graphical analysis, both estimates show that the eligibility rule for preschool entry significantly increased the school enrollment rate for preschool-eligible children. A child that turned 4 years old before the cutoff date is approximately 12 percentage points more likely to enroll in preschool or daycare compared the child who turend 4 years old after the cutoff date. Considering that the average school enrollment rate between 2011 and 2015 for non-eligible children was 54%, the estimates indicated around 22 percentage increase of the enrollment rate. Given that school eligibility rule increased only the preschool enrollment rates,[13] the discontinuity of school enrollment rate observed around the cutoff date measures the increase of preschool enrollment rates.

Next columns from (2) to (5) show the reduced form estimates, which indicate intent-to-treat effects. Despite the significant discontinuity in school enrollment rate, there was no significant effect of the preschool eligibility rule on maternal labor market outcomes if the child was not the youngest member of the household or there were other relatives present. This finding indicates that either mothers still faced constraints due to the presence of a younger child, or informal childcare was substituted by preschool enrollment. By comparison, statistically significant effects on maternal outcomes were observed among the mothers in single families without an additional younger child. They are approximately 4 percentage points more likely to work with formal labor contract in a reference week and less likely to work without formal labor contracts. Although there is almost one to one relationship between these two variables, it is important to note that this result is not guaranteed as mothers might have different occupations in a reference week such as public employees or self-employed. Given that there was no significant changes in the participation of such occupations, this finding suggests that mothers potentially transition from informal to formal

[13] Daycare enrollment rates do not change significantly around the cutoff date. This result will be included in the appendix.

employment when their children were eligible for preschool entry.

There were also statistically significant changes of average working hours per week and weekly hours spent for household chores among mothers whose 4-year-old children were the youngest and no other relatives present in the household. When children were eligible for school entry, mothers were 2.2 hours more likely to work and spend approximately 1.5 hours less for household chores. Given that the average weekly hours spent on working and household chores are 19 and 32 hours, respectively, preschool enrollment increased working hours about 13% and decreased hours on chores by 10%.

Table 4 rescaled the intent-to-treat effect by the estimate obtained in the first stage result. There was again the statistically significant effect of preschool enrollment only in the first group of mothers. When 4-year-old children were induced to enroll in preschool due to the eligibility rule, the mothers were approximately 33 percentage points more likely to take the jobs with formal labor contracts. They were also less likely to take the jobs without formal contracts by similar magnitude. Moreover, average working hours per week increased by 19 hours and hours spent on household chores decreased by 12 hours. Given that the preschool program in Brazil usually offers 4 hours of instruction per day and 20 hours for a week, 20 hours increase in working hours and decrease in hours spent for household chores is consistent with the time that freed for eligible mothers. Also, the results revealed that after mothers became more flexible to choose working hours, they not only increased working hours but also tended to transition from informal to formal employment. By comparison, there was no evidence for the change of maternal labor outcomes if the child was a 4-year-old, but not the youngest, or other relatives cohabit in the households.

5.3 Heterogeneous effects

Table 5 reports the heterogeneous effects of preschool enrollment on maternal labor market outcomes based on education, age, and survey year. Given that there were significant effects of preschool enrollment only among the mothers in single families without a younger child, this section focuses on this group of mothers. Every specification includes individual maternal characteris-

tics with state and year fixed effects. The first two columns represent the effect of preschool enrollment based on the completion of compulsory education. Although not statistically significant, the estimates suggest that mothers with higher education were more likely to take the jobs with formal contract and spent a significantly higher number of hours working during a reference week if their children were eligible for preschool. Columns (3) and (4) present the heterogeneous effects based on maternal age. Most estimates were statistically significant only for younger mothers, but older mothers also tended to have larger changes in their participation in jobs without formal contracts and the number of hours spent on chores.

Lastly, I measured the heterogeneous effects depending on the survey year. There are several reasons why the effect of preschool enrollment could differ by survey year. For example, it is possible that the cutoff date was loosely enforced at the beginning stage of educational reform and then was more strictly enforced as 2016 neared, given that this was the year set by the government to complete the transition. Also, municipalities or state governments could have more rapidly increased the school capacity during the years approaching the deadline for universal preschool education. Despite these possibilities, the estimates in the first-stage based on survey year did not show much difference.[14]

In later survey years, we also might expect the increase of preschool enrollment of the children whose mothers have no intention to participate in labor market activities as the reform mandated preschool education compulsory. Unlike many other studies, all the preschool eligible children had to enroll in preschool in this study regardless of mothers' motivation. The last important factor is economic recession, which plagued Brazil in 2014. The country experienced one of the most severe economic downturns in its history, and this could have suppressed the response of mothers' labor market outcomes in later years. Considering all these factors, there exist possibilities that the effects of preschool enrollment in earlier years to be different than those in later years. The columns (5) and (6) support the hypothesis that the effect of preschool enrollment was largely driven by the observations in earlier years. The effects of preschool enrollment on maternal outcomes were

[14]The results are available upon request.

statistically significant and large in magnitudes among the mothers surveyed in earlier years.

5.4 Robustness checks

This section provides multiple robustness checks to show that the results of the study are robust to alternative specifications. I test the robustness of the results with varying polynomial degrees and window sizes of samples. In addition, I conduct placebo tests by running the same analysis for three-year-old children and assigning multiple false cutoff dates.

I first test the results with varying window sizes. I started the analysis with mothers whose children were born 30 days before and after the cutoff date, then reran the analysis with more individuals by adding 15 days to each side of the cutoff date. Figure 4 presents the second-stage coefficients for each outcome variable over the number of days from each side of the cutoff date. Overall, the results show that the estimates were robust to different sample sizes. The estimates were somewhat larger and had wider confidence intervals with the first 30 days of observations from each side of the cutoff date. However, as more observations were included in the analysis, the estimates became more similar and had smaller confidence intervals. There were very little differences in the magnitudes of the estimates after the samples with 60 days from each side of the cutoff date were included.

In the next step, I obtained the estimates for each outcome with different polynomial degrees of the running variable. The main specification used the second polynomial degrees, but I tested whether the estimates were robust to the alternate polynomial degrees. Figure 5 shows that the estimates for each outcome were robust to the use of different polynomial degrees. Furthermore, I checked whether the cutoff date for preschool education had an effect on daycare enrollment rates for three-year-olds and their mothers' labor outcomes. This served as a placebo test because I expected to observe no discontinuity in daycare enrollment or maternal outcomes around the same preschool cutoff date. It is known that some daycare programs, which were designed for children between the ages of 0 and 3, apply the same eligibility rule for their enrollments; however, this decision is more likely to be optional as there is no legislation mandating the same cutoff date

for enrollment. To compare the main outcomes of the study, this robustness check used mothers whose three-year-old children were the youngest in the household and there were not other relatives present.

Figure 6 shows the graphical results of the first and second stage for 3-year-old children and maternal outcomes, respectively. Figure 6. (a) shows that school enrollment rates did not change significantly around the cutoff date of March 31st. Although some public daycare programs used the same cutoff date, there is no evidence that the children who turned 3 before March 31st were more likely to enroll in daycare than three-year-olds who turn 3 after March 31st. Next, Figure 6.(b) examines maternal labor market outcomes over the distance between three-year-old children's birth dates and the cutoff date. As expected, there was no discontinuity in maternal outcomes. Average weekly hours on chores appeared to have discontinuity around the cutoff date, but the estimate for the discontinuity was not statistically significant and was not robust with the inclusion of different polynomial degrees.

Lastly, I conducted multiple sets of placebo tests by assigning false cutoff dates. For each regression, I used a one-year window with 6 months before and after the cutoff date. I ran the analysis with this true cutoff date, then reran it 180 times with the false cutoff dates, which increased by one day from the true cutoff date until September 31st. Figure 7 shows the distribution of all estimates for each outcome obtained from the placebo test. For the distribution of every outcome variable, it was clear that the estimate obtained from assigning the true cutoff date was distinguishable from other estimates that were obtained from assigning the false cutoff dates. The true estimates always indicate the largest effect on maternal outcomes, which suggests that the results of the current study were less likely to be driven by chance.

6. Conclusion

The main purpose of lowering the entry age to compulsory education is to provide equal educational opportunities for children. Although the main focus of the policy is on students' outcomes, there are potential effects on maternal labor outcomes that result from increasing school enrollment rates

among younger children. The current study revealed such indirect benefits of the policy.

In Brazil, the policy of lowering the school starting age from 6 to 4 and mandating preschool enrollment among children who turned 4 by March 31st significantly increased school enrollment rates of all eligible 4-year-old children. Consequently, mothers were more likely to take a job with formal labor contracts, to increase their weekly hours of working, and to decrease their hours spent on chores if their preschool-eligible 4-year-old children were the youngest family members and no other relatives were cohabiting in the household. By comparison, there were no effects of preschool enrollment if the child was not the youngest or other relatives were present in the households. To support the main findings of the paper, I also ran a battery of robustness checks and did not find evidence that the results were driven by the particular setting of the RD design.

The present study was limited by the inability to evaluate the effect of the reform on students' outcomes. In Brazil, there is currently no available data that assesses outcomes (i.e., academic performance or emotional stability) for preschool or early primary school students. To evaluate the impact of the policy on the main targeted group, more time is needed for the treated students to advance to the point that the data for their outcomes is available. Previous studies have shown inconclusive results regarding the impact of lowering the school starting age on students' short-and long-term outcomes. Moreover, the effect could vary significantly depending on the context or the extent to which the entry age is lowered. Therefore, future studies should examine how this policy affected students' outcomes.

Despite the study's limitations, the present research provides important insights into the substantial indirect effects of the policy on maternal labor outcomes. Considering that developing countries with limited availability of early childhood education often lower the school starting age, it is possible that mothers in these countries are significantly affected by such a policy. Therefore, this finding adds an important piece of evidence for cost-benefit analysis in policy decision-making.

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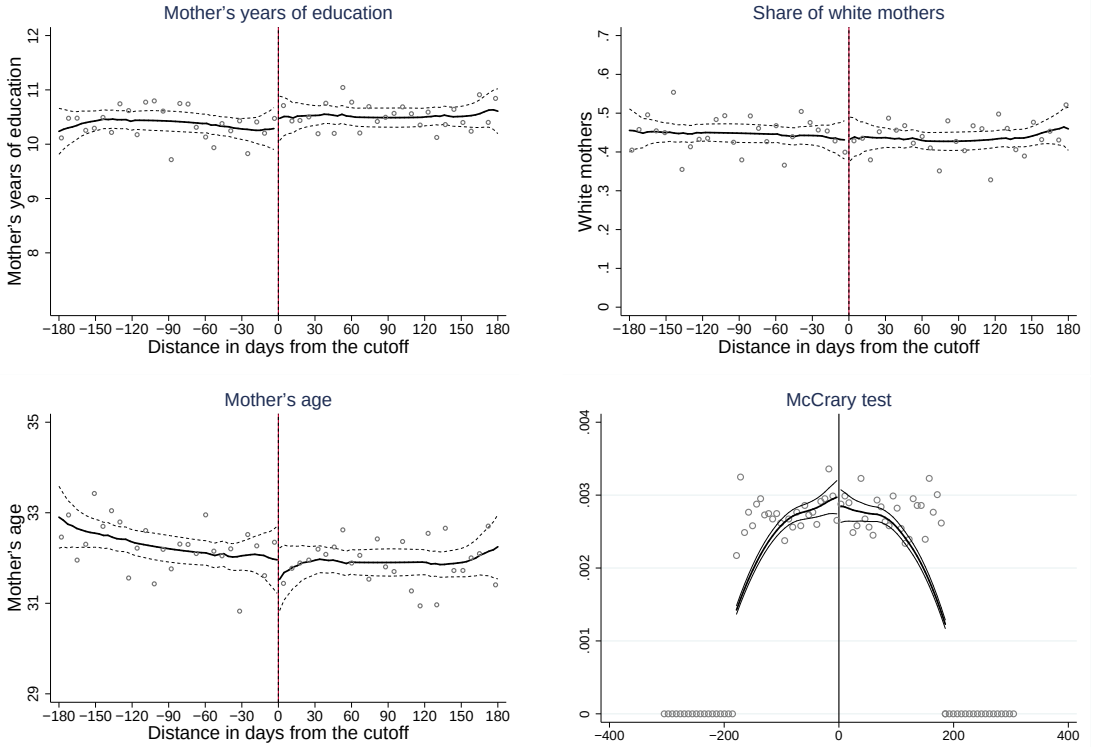
(a) Youngest child and no other relatives



(b) Not youngest child or other relatives present

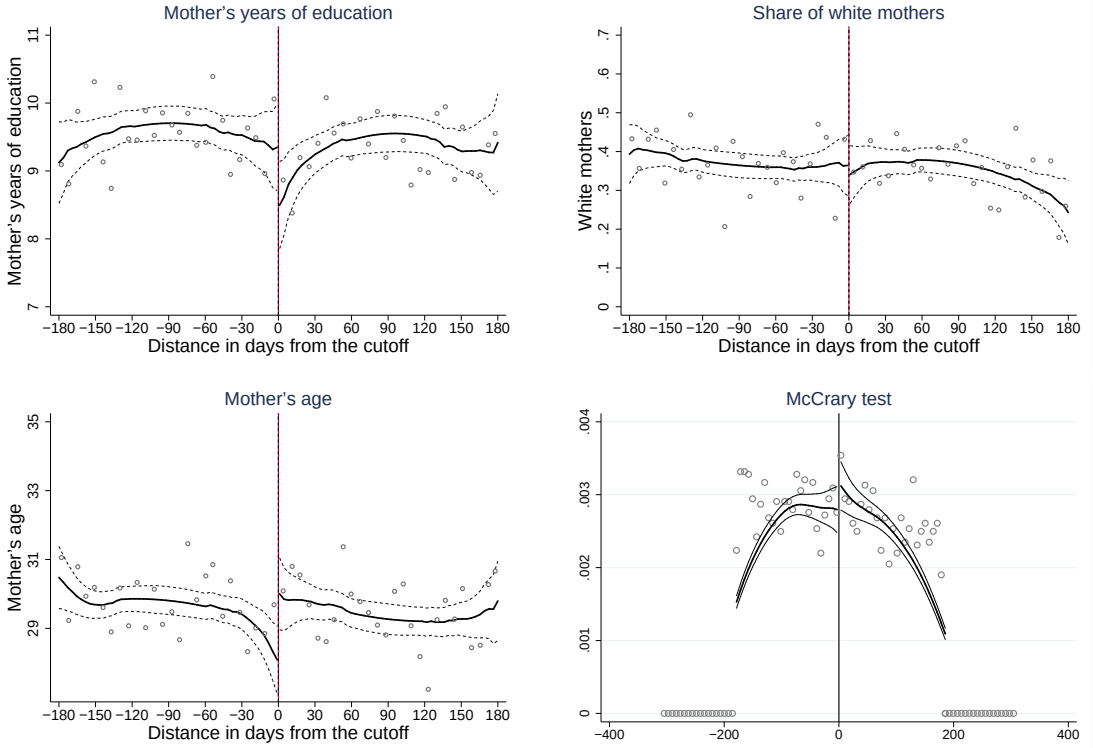


Figure 1: Validity of regression discontinuity design

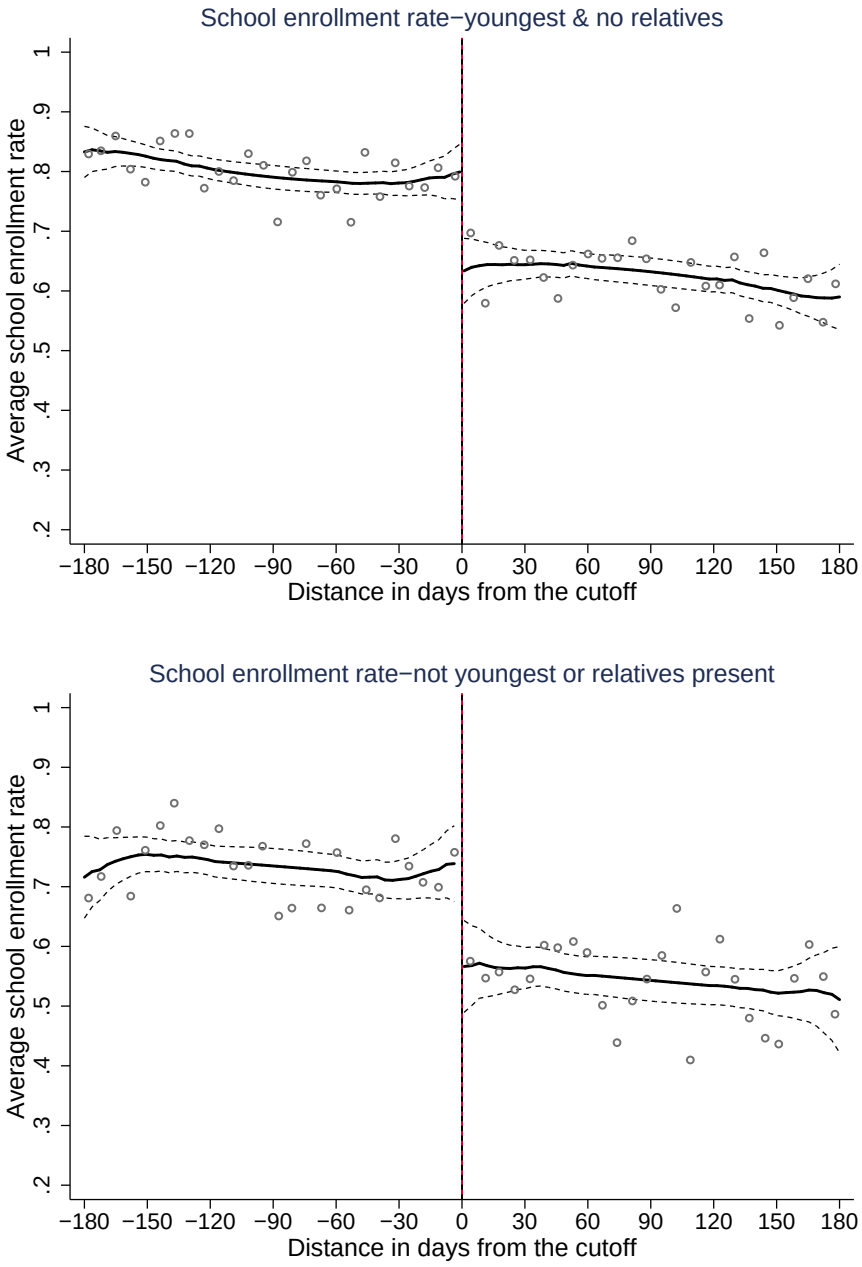
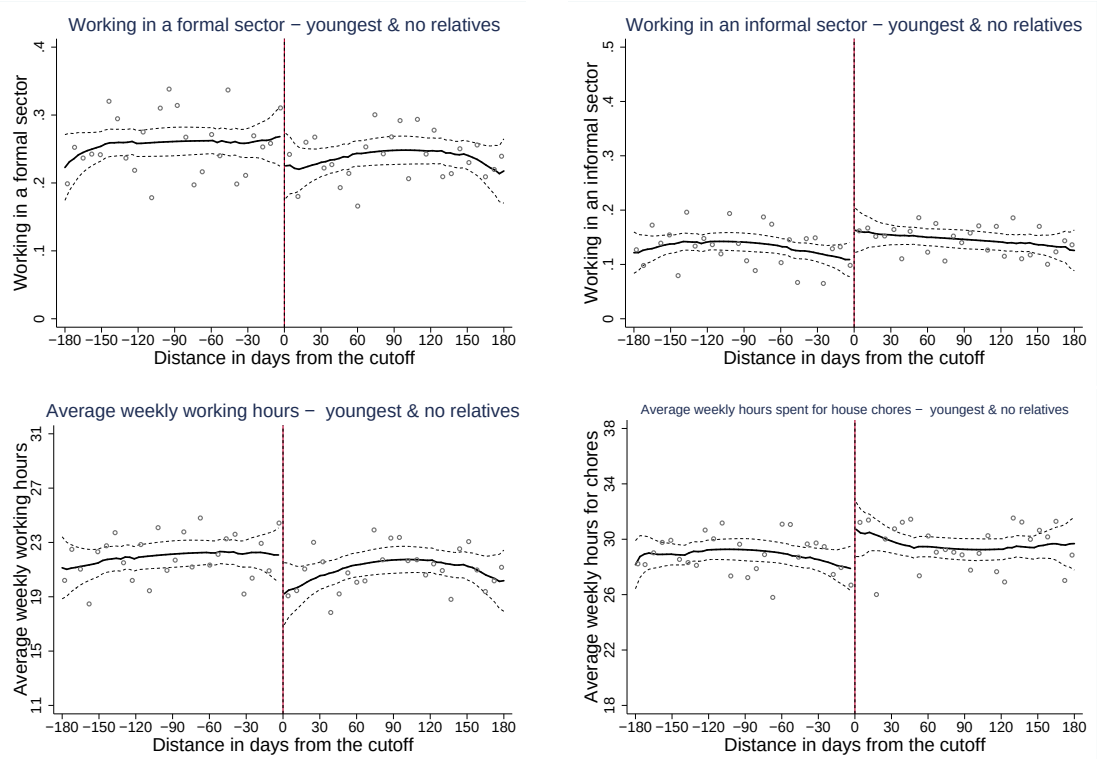
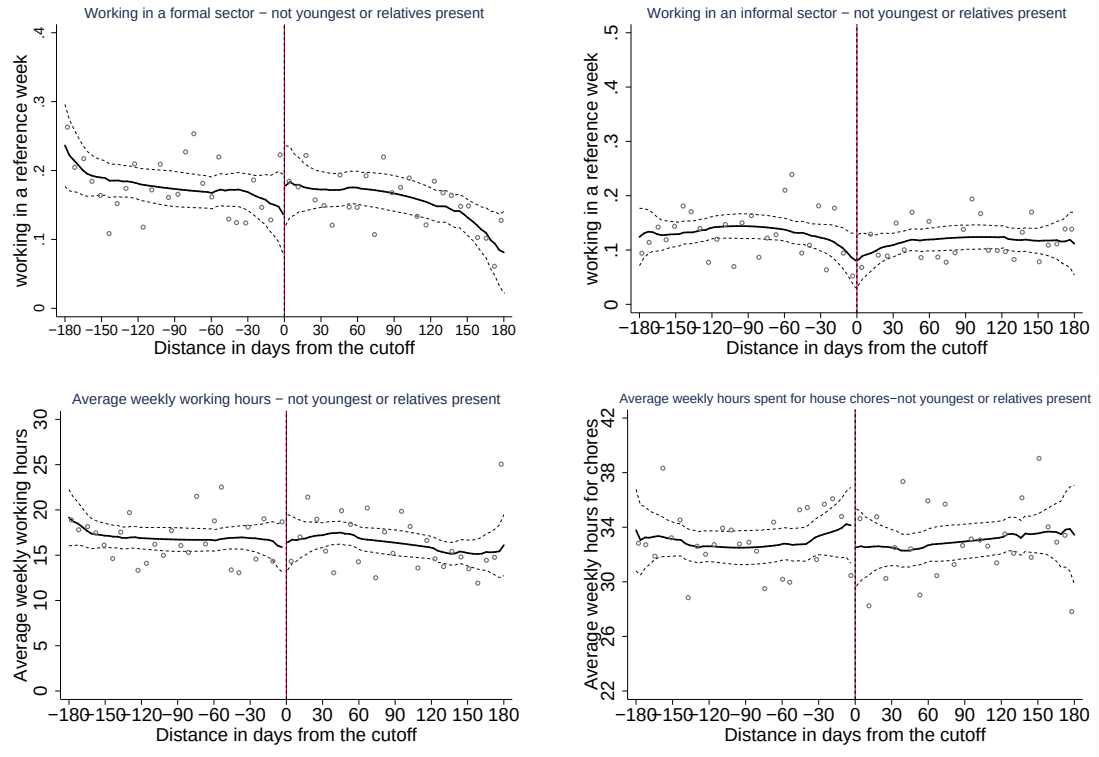


Figure 2: First Stage-graphical analysis



(a) Youngest child and no other relatives



(b) Not youngest child or other relatives present

Figure 3: Second stage-graphical analysis

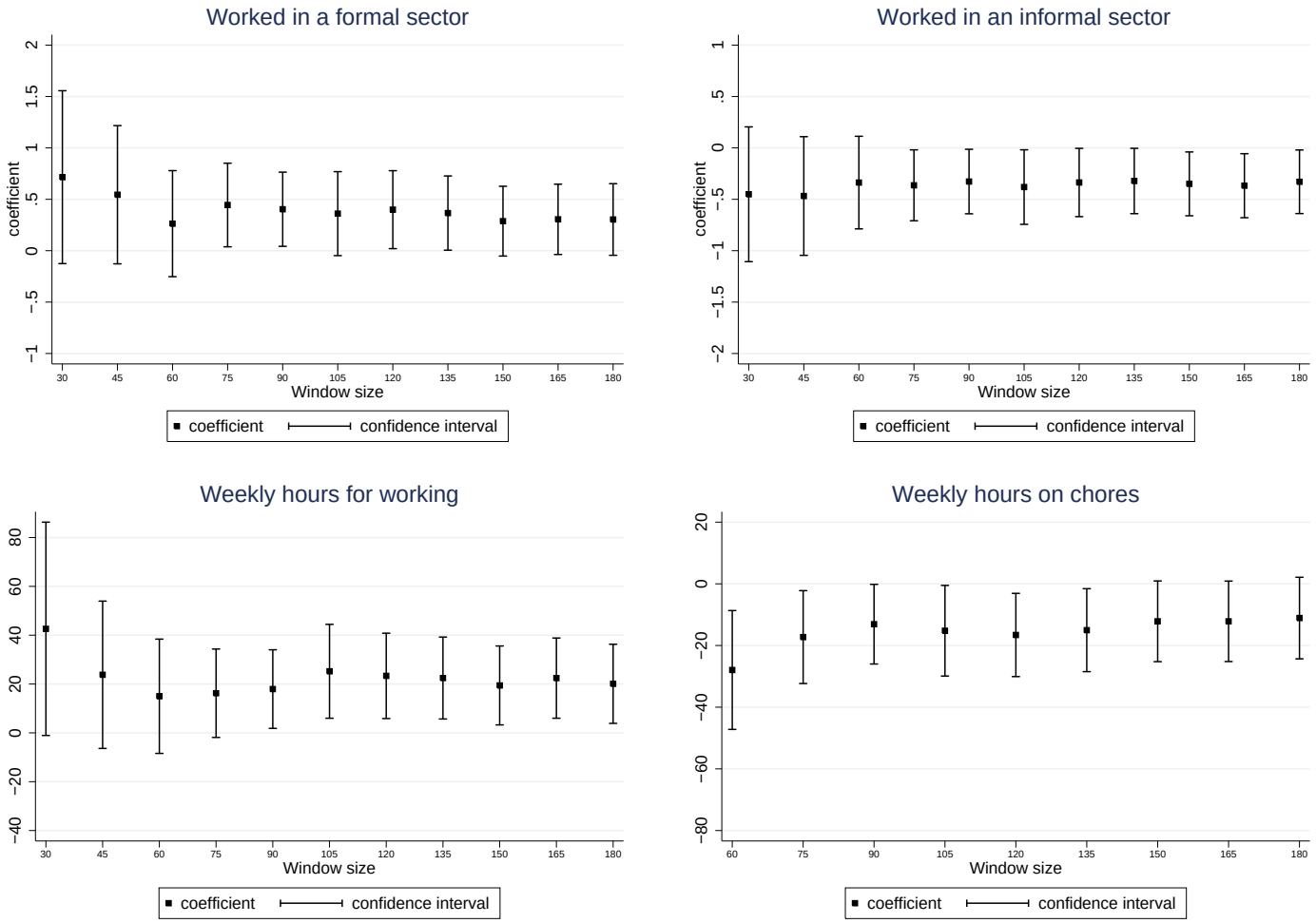


Figure 4: Specification-different window sizes

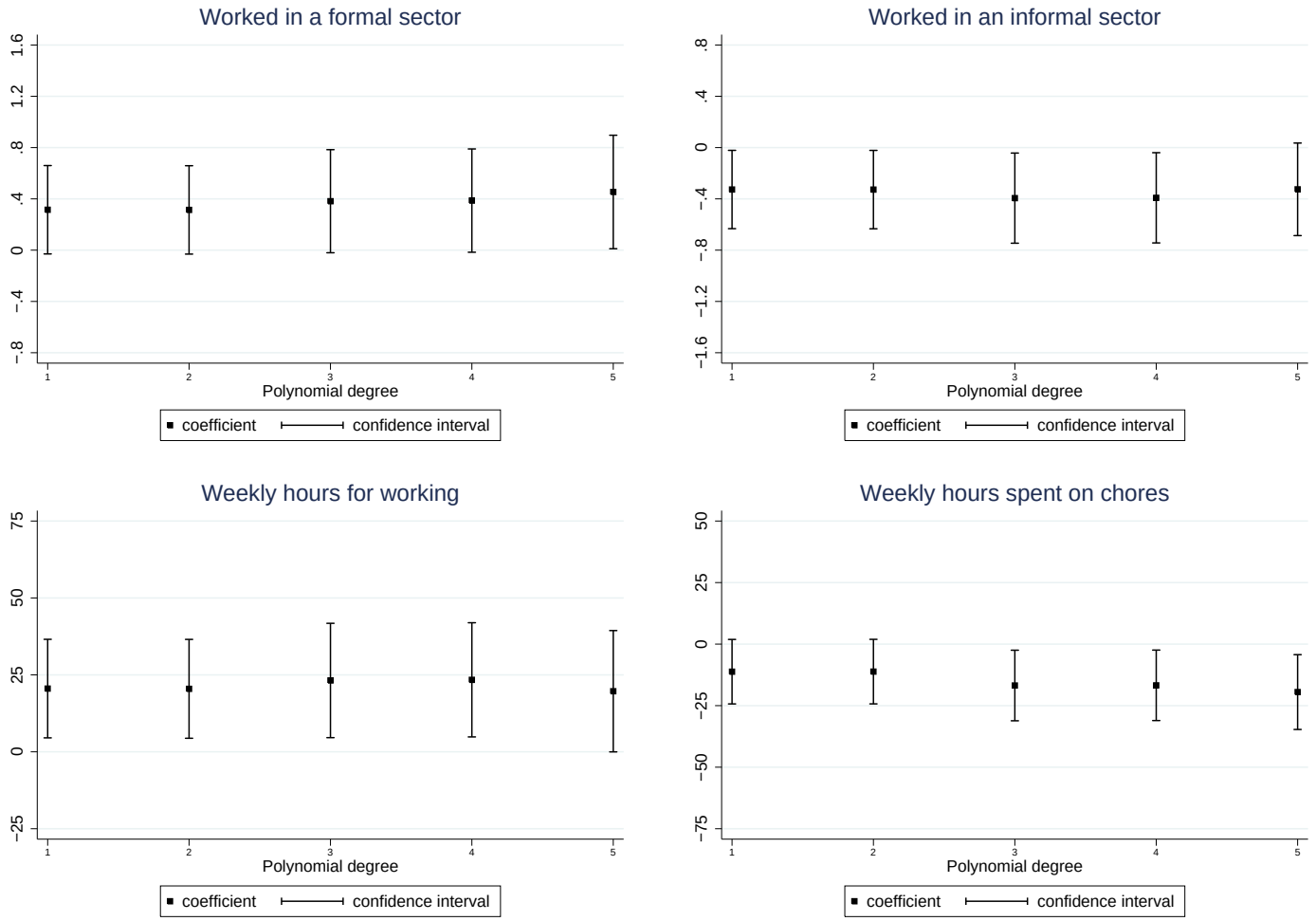
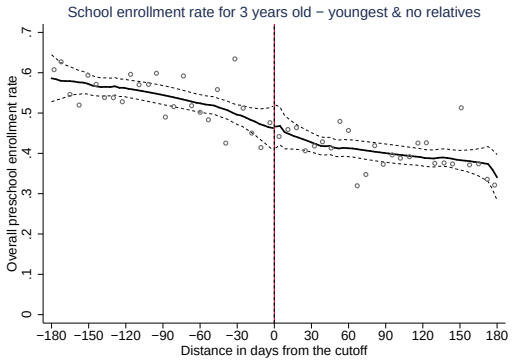
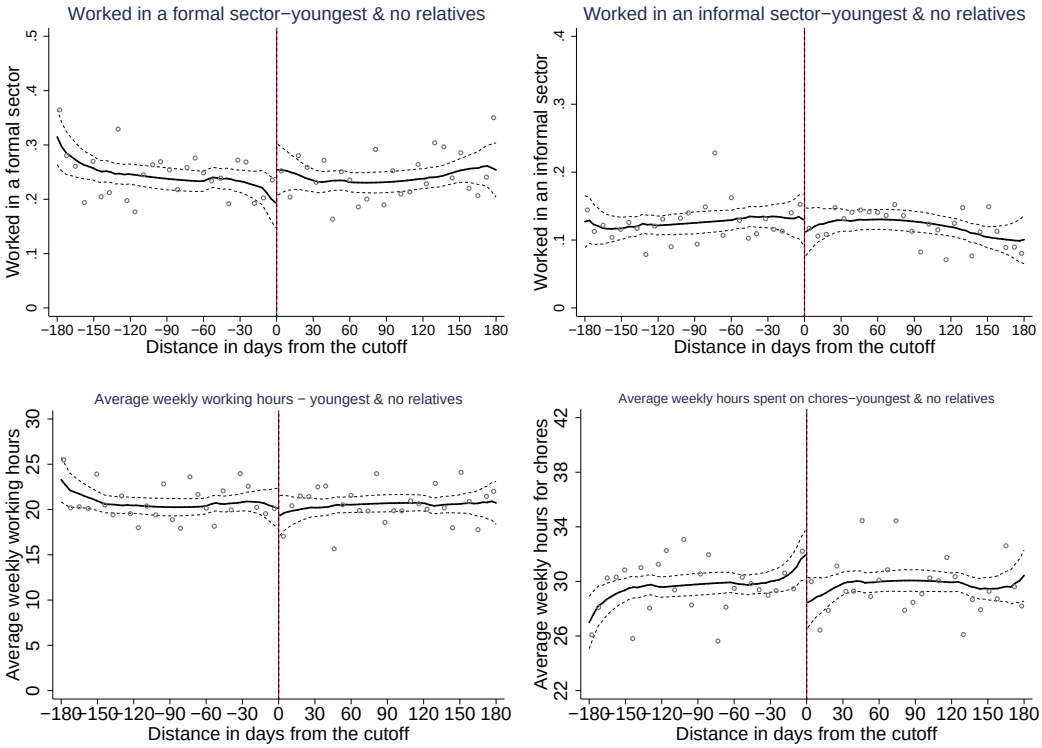


Figure 5: Specification-polynomial degrees



(a) school enrollment rates for three year olds



(b) Labor market outcomes of mothers

Figure 6: Effects of the school enrollment of 3-year-olds on maternal outcomes

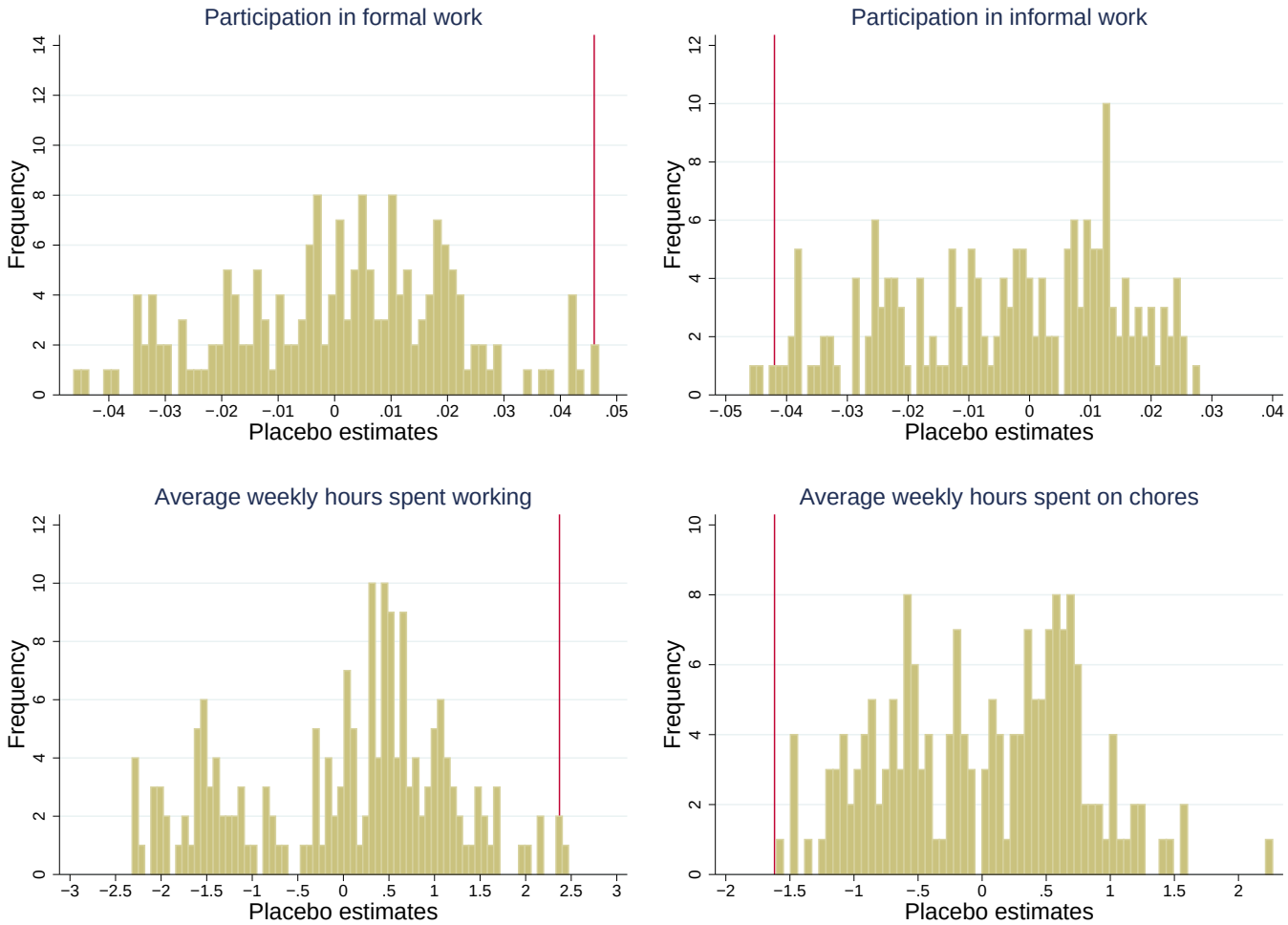


Figure 7: Placebo estimates of preschool enrollment

	Youngest & no other relatives		Not youngest or relatives present	
	Born Oct.1st - Mar.31st (1)	Born Apr.1st - Sep. 31st (2)	Born Oct.1st - Mar.31st (3)	Born Apr.1st - Sep. 31st (4)
Child enrolled in school	0.80 (0.40)	0.62 (0.48)	0.72 (0.45)	0.53 (0.50)
Mother's years of education	10.37 (3.85)	10.52 (3.70)	9.56 (4.00)	9.23 (3.98)
White mother	0.45 (0.50)	0.44 (0.50)	0.37 (0.48)	0.35 (0.48)
Mother's age	32.28 (6.26)	31.92 (6.26)	29.07 (5.64)	28.53 (5.77)
Family Size	3.84 (1.11)	3.81 (1.09)	4.87 (1.34)	4.96 (1.40)
Number of children younger than 3 years old	. (.)	. (.)	1.12 (0.34)	1.10 (0.30)
Number of children with ages between 5 and 15	1.35 (0.64)	1.32 (0.61)	1.56 (0.87)	1.62 (0.92)
Number of days to cutoff	21.94 (20.35)	21.05 (20.33)	14.74 (18.84)	13.39 (18.41)
Number of observations	3872	3825	1346	1197

Table 1: Summary statistics

	Mother's years of education (1)	Mother's age (2)	White mothers (3)
Youngest & no relatives			
Preschool enrollment	-0.363	0.179	0.018
	(0.262)	(0.443)	(0.035)
N	7697	7697	7697
Not youngest or relatives present			
Preschool enrollment	0.598	-1.253	0.010
	(0.376)	(0.857)	(0.043)
N	3833	3833	3833
Control variables	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Table 2: Validity of RD design

	First stage	Reduced form			
	Preschool enrollment (1)	Worked in a formal sector (2)	Worked in an informal sector (3)	Average hours working (4)	Agerage hours on chores (5)
Youngest & no relatives					
Cutoff date	0.119***	0.039*	-0.041**	2.258**	-1.493*
	(0.021)	(0.021)	(0.018)	(0.959)	(0.784)
First stage F-stat	32.90				
N	7697	7697	7697	7697	7450
Not youngest or relatives					
Cutoff date	0.117***	-0.034	0.015	-1.150	0.926
	(0.030)	(0.024)	(0.023)	(1.423)	(1.525)
First stage F-stat	15.30				
N	3833	3833	3833	3833	3712
Control variables	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Table 3: First stage and reduced form results

	Worked in a formal sector (1)	Worked in an informal sector (2)	Average hours working (3)	Average hours on chores (4)
Youngest & no relatives				
Cutoff date	0.328*	-0.345**	18.954**	-12.507*
	(0.178)	(0.158)	(8.232)	(6.637)
N	7697	7697	7697	7697
Not youngest or relatives				
Cutoff date	-0.296	0.132	-9.854	7.818
	(0.214)	(0.201)	(12.417)	(12.916)
N	3833	3833	3833	3712
Control variables	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4: Second stage results

	Mother's education		Mother's age		Years	
	Low	High	Less than 33	Higher than 33	Before 2014	After 2014
	(1)	(2)	(3)	(4)	(5)	(6)
Worked in a formal sector						
Cutoff date	0.162	0.525	0.320*	0.361	0.487**	0.124
	(0.158)	(0.353)	(0.171)	(0.540)	(0.243)	(0.279)
N	2800	4862	4646	3016	4578	3084
Worked in an informal sector						
Cutoff date	-0.328	-0.357	-0.247	-0.719	-0.418*	-0.260
	(0.216)	(0.227)	(0.158)	(0.571)	(0.228)	(0.229)
N	2800	4862	4646	3016	4578	3084
Average working hours						
Cutoff date	9.770	28.087*	18.389**	19.340	23.651**	12.320
	(8.835)	(15.346)	(8.165)	(24.273)	(11.751)	(12.338)
N	2800	4862	4646	3016	4578	3084
Average hours on chores						
Cutoff date	-15.037	-8.709	-7.003	-30.119	-16.082*	-7.084
	(9.196)	(9.835)	(6.431)	(22.359)	(9.668)	(10.624)
N	2732	4685	4528	2889	4412	3005
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Heterogeneous effects of preschool enrollment