Age at Preschool Entrance and Noncognitive Skills before School
An Instrumental Variable Approach

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Abstract

We estimate the effect of age at preschool entrance on crucial noncognitive skills in the year before school starts. Using an instrumental variable approach and exploiting cut-off dates for the time at preschool entrance we find that children entering preschool earlier in life have better noncognitive skills in terms of being more assertive and being more able to form friendships. Hence, our results offer general empirical evidence for the non-linearity in the skill formation process. Moreover they show that entering preschool at an early age is an important prerequisite for the development of social school readiness.

JEL Classification: I2, J13, J24.
Keywords: Preschool; noncognitive skills; instrumental variables; entrance effects

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1 Introduction

The relevance of early childhood education for the skill formation process is widely recognized. Early formation of skills enhances positive short- and long-term outcomes such as educational attainment, earnings, and health (Belfield, 2007). This is mainly found in experimental studies from early intervention programs all set up in the United States such as the Perry Preschool Program, the Abecedarian Project, and the Chicago Child-Parent Centers (see Temple and Reynolds, 2007, for an overview), and quasi-experimental evidence, in part stemming from Head Start evaluations (Garces et al., 2002; Ludwig and Miller, 2007). Apart from individual benefits, cost-benefit analyses show that fiscal and societal returns are high compared to those from later intervention during adolescence or adulthood (Heckman, 2006; Cunha et al., 2010). The positive effects of early interventions are said to stem mainly from the malleability of behavioral, social, and emotional skills during early life, rather than from the manipulation of cognitive skills (Heckman, 2000; Heckman et al., 2006).[1] Noncognitive skills can be affected more easily in early childhood than cognitive skills (such as IQ). In addition, some noncognitive skills that are developed early are very stable across the life cycle. Such noncognitive skills might have direct effects on labor-market-relevant outcomes and their timely manipulation early on is therefore crucial, since later remediation is not possible at all, or only at higher cost (Duncan et al., 2007; Coneus and Laucht, 2011; Romano et al., 2010).

In this paper we analyze whether attendance of German preschool affects the development of noncognitive skills. In particular, we estimate the effect of age at entrance into German preschools on crucial noncognitive skills of children before school entrance. In data from the Children's Panel of the German Youth Institute (DJI-Kinderpanel) we can observe the noncognitive skills of five to six year old preschoolers; we have also information about their exact age at preschool entrance (by month). In a quasi-experimental setting, exploiting cut-off dates for the time of preschool entrance, we show that entering preschool earlier in life yields positive returns in terms of a superior ability to form friendships and being more assertive in the year before school entrance. Both are crucial indicators for the social and academic readiness of the children in our sample, who are all close to school entrance. The early formation of these noncognitive skills might have long-term effects on relevant labor market outcomes, too.

Our results contribute to the existing economic literature in the following way. In the German context this is, to our knowledge, one of the first studies that provides causal evidence of the association between age at preschool entrance and noncognitive

[1] For simplification, we henceforth consider the idea of *behavioral, social, and emotional skills* by using the term *noncognitive skills*.

skills. Further, most of the prominent U.S. studies evaluate special early programs for disadvantaged children, thereby identifying noncognitive skills as a potential channel of positive long-term outcomes. Only few studies focus on the effects of different types of preschool and use noncognitive skills as outcome variables (see below). Moreover, we are confident that we do show age-at-entrance effects of preschool on the noncognitive skills acquired before school entry. The empirical setting allows us to exclude the fact that our age-at-entrance effects stem from longer duration spent in preschool or the older age at interview of those children who enter preschool earlier in life. Our findings therefore support the theory of critical and/or sensitive periods in the skill formation process, which enables us to argue that investments in human capital are more effective when made earlier rather than later in life.

For a long time, the process of skill accumulation was a byword for the process of *cognitive* skill formation, largely neglecting the noncognitive dimension. In the meantime, noncognitive skills are part of the economic debate when discussing the effects of education policy or evaluating special educational interventions. Several papers analyze the impact of noncognitive skills on later labor-market-relevant outcomes.[2] Given the presence of predominantly positive effects of noncognitive skills identified in these studies, some papers focus on the production of noncognitive skills. Dee and West (2011) show that smaller class sizes are beneficial for the development of noncognitive skills. Rockoff et al. (2011) and Behncke (2009) reveal teacher characteristics as being crucial for the production of noncognitive skills. Others relate systemic features of school systems to the stock of noncognitive skills at age 15 (Woessmann et al., 2009; Falck and Woessmann, 2010). Recently, some programmes, explicitly targeted at the production of noncognitive skills at school level, have been set up and evaluated (Holmlund and Silva, 2009; Pema and Mehay, 2009; Martins, 2010).

Non-German economic studies directly related to the specific research question of this paper analyze the short-term association between different forms of preschool attendance and later noncognitive skills of children. However, none of the studies directly focus on the age at entrance of children who have all attended preschool for at least some time before starting school.

The Head Start Impact Study randomly assigned Head Start applicants to program attendance and to a control group who had no access to Head Start services. Puma et al. (2005) study first year effects of program participation on the cognitive and

[2]See Segal (2011) and Borghans et al. (2008) for the effects of noncognitive skills on cognitive skills. Jacob (2002), Duckworth and Seligman (2005), Heckman et al. (2006), Carneiro et al. (2007) and Duncan et al. (2007) provide evidence on the contribution of noncognitive skills to different measures of school attainment. Jencks (1979), Bowles et al. (2001), Nyhus and Pons (2005), Heckman et al. (2006) and Heineck and Anger (2010) study the effect of different noncognitive skills on earnings and/or employment. For an overview article see also Brunello and Schlotter (2011).

noncognitive development of three and four year old children. They find small positive effects in terms of less problem behavior among Head Start attendants but no overall impact on social skills (reported by the parents).[3]

Others analyze the effect of different types of preschool attendance compared to home care, family day care, or other care arrangements. Loeb et al. (2007) and Magnuson et al. (2007) study the effects of specific preschool types (such as prekindergarten or other center-based care) on cognitive and noncognitive skills in kindergarten, which is the first year of the K-12 education system in the United States. They find higher behavioral problems of children who attended center based preschool prior to kindergarten. Datta Gupta and Simonsen (2010) analyze the effects of participation in Danish preschool programs and in family day care (compared to parental care) at the age of three and a half years on noncognitive skills of children attending the first grade of primary school. They find negative effects of family day care on noncognitive skills. Further, they show that longer hours in out-of-home care are detrimental to noncognitive skills in primary school. Baker et al. (2008) evaluate the expansion of publicly provided child care in the Canadian province of Quebec and find negative effects of the expansion on several noncognitive outcomes of children, such as on motor and social skills. Analyzing preschool expansion in Argentina, Berlinski et al. (2009) find positive effects of pre-primary education on third-graders' noncognitive outcomes such as improved discipline, effort and class participation. Neidell and Waldfogel (2010) study peer effects in early education. They cannot rule out that effects of peer preschool enrollment on individual noncognitive skills exist, however, they find no significant estimates.

There is a great deal of pedagogical and psychological literature on the association between preschool attendance and noncognitive development of children. Important findings stem from studies such as the Effective Provision of Pre-School Education Project (EPPE) or the Early Child Care Study of the National Institute of Child Health and Human Development (NICHD) which are programs only marginally evaluated by economists.[4]

Across disciplines, the literature on the noncognitive effects of early childhood education shows mixed results including both positive and negative effects (Neidell and Waldfogel, 2010, p. 563).

[3]Note that all Head Start applicants come from disadvantaged families. The effects can therefore not be generalized across the whole population.

[4]An insightful overview of this strand of literature is provided by Roßbach and Weinert (2008) and the herein cited studies. Belsky et al. (2007) show negative medium-term effects on noncognitive skills from the NICHD program, thereby also reviewing existing evidence from this program on short-term noncognitive outcomes.

Two main features of our econometric strategy make us confident that our effects really hint at a causal relationship between the age at preschool entrance and the stock of noncognitive skills in the year before school starts. First, whether children enter preschool at their third birthday (the earliest entrance age codified by law) or later is to some extent determined by a cut-off date, and therefore it depends on their month of birth. We can exploit this partial correlation between age at preschool entrance and month of birth, and thereby avoid biased estimates arising from the endogenous decision of parents about the age at which they send their children to preschool. Second, while we cannot solve the crucial collinearity problems that arise with estimating age-at-entrance effects, we nevertheless think that our effects clearly hint at a pure age-at-entrance effect. Methodologically, we share the identification issues of all other research using the month-of-birth instrument: It is difficult to disentangle age-at-entrance effects identified with the month-of-birth instrument from pure age and/or duration effects (see Black et al., 2011). In our sample we face this same problem, since the children entering preschool at an earlier age (as they are born in the months before the cut-off) are those who are younger at the time of the interview. While we are, due to prefect collinearity, not able to control for duration spent in preschool and age of the children at the interview simultaneously, an age effect should, according to the bulk of the literature, favor the older children in our sample. We interpret the positive effect of early entrance for the younger children as a lower bound to the causal effect of the age at entrance on our noncognitive skill measures.

This paper proceeds as follows. Section II provides a brief overview of the German preschool system and gives some qualitative reasoning in favor of our instrument. Section III presents our estimation strategy and describes the Children's Panel of the German Youth Institute (DJI-Kinderpanel). Section IV shows some first stage results of our IV approach, second-stage results of the effect of preschool entrance age on noncognitive skills, and several robustness checks. Section V concludes.

2 Germany's Preschool System and the Month of Birth Instrument

The structure of Germany's preschool system is complex and not very transparent. Several actors at different levels participate both in the financial and organizational process (Textor, 1998). We focus on the German kindergarten, that is, the preschool institution that children can attend from the age of three until their school entrance. In contrast to the United States, the German kindergarten (including the kindergarten year before school starts) is not integrated within the school system, but is part of the

non-compulsory preschool system.[5] The latter is historically characterized by large structural differences between West and East Germany (the former German Democratic Republic). In West Germany, preschool was historically a private matter and the state was only marginally involved (Rauschenbach, 2006). Mothers, grandparents, relatives, and neighbors were the most important people responsible for the care of children from birth to school entrance. Even by the late 1980s many parents still cared for their children at home or used other private, informal care arrangements. Mostly, the mothers cared for their children (Tietze and Roßbach, 1991). However, the former German Democratic Republic has always provided institutional care for all children between one and six years old. While this was mainly due to the emphasis on state-controlled education in socialist countries such as the German Democratic Republic, East-West differences in supply and demand for preschool are still observable in the unified Germany.

Several factors induced a change in Germany's attitude towards institutional care systems before school entrance. On the one hand, the share of well-qualified women who wanted to participate in the labor market increased over time. Private child care arrangements, with the mothers as the main actors, had to be complemented with a better public supply to facilitate the labor market re-entry of mothers and to tackle the problem of declining birthrates. The trade-off for young mothers in deciding on family or career, and the expected demographic consequences, revealed the social and economic problems arising from a poor preschool system (Rauschenbach, 2006, p. 12).

On the other hand, there was a paradigm shift in attitudes towards care arrangements before school entrance. Preschool was no longer considered as the necessary evil to reconcile work and family life. The children themselves, along with their benefits from preschool, have become central in the discussion (Rauschenbach, 2006, p. 17). The importance of this period for child development has been increasingly recognized and is regarded as a crucial part of the educational process. The discussion was no longer simply about care for children before school entrance, but also about care systems that recognize and cope with the challenges of an educational system.

The expansion of the public preschool supply was a long process. The situation improved substantially after reunification in 1990. At that time, West Germany provided places in preschool to about 69 percent of children aged three, whereas in the East German states there was already universal provision (Rauschenbach, 2006, p. 13-14). It was clear that an adjustment process up to the East German level (at least for children aged from three up to the age of school entrance) was the goal. In this context, the crucial step was the introduction of a legal claim for a place in preschool

[5]To simplify matters, we use the term *preschool* instead of *German kindergarten* in this paper.

(Rechtsanspruch auf einen Kindergartenplatz) by the German federal government; it became effective in 1996. From that year onward, every child has been assured of a place in a center-based preschool from their third birthday until their school entrance.

There was a sharp increase in child care attendance for three and four year old children in West Germany in the years after the introduction of the legal claim in 1996. Similarly, the new law had literally no effect on child care attendance in the East German states, since coverage was always very high in this region. However even in West Germany, child care attendance rates, particularly for three year old children, still remained far below being universal in the years after 1996 (see Figures 2 and 3).[6]

The incomplete coverage is partly due to the fact that the implementation of this new law turned out to be a difficult process. While the German legislature at the federal level passed the new law, the states and especially the municipalities were responsible for its organizational and financial implementation. Decision-makers at the municipal level were confronted with a completely new law and were unable to produce the necessary expansion of the supply of preschool places at short notice. As a consequence, by the end of 1995 the German Federal Parliament (Deutscher Bundestag) adopted a legislative initiative proposed by the Federal Council of Germany (Bundesrat) and introduced cut-off rules. Municipalities applying the cut-off rule could voluntarily decide on a fixed kindergarten starting date (which was in August or September and it mostly coincided with the school start in the respective federal state). As a consequence, children could not enter kindergarten in the month of their third birthday. The entrance decision was now based on whether they were at least three years old in a specific cut-off month.[7]. If so, they could enter at the next kindergarten start in August or September. For example, a child born in July and living in a federal state with kindergarten starting in August could enter at the age of 37 months; a child born after the cut-off in September could not enter in September but had, at worst, to wait a year for the start of the next kindergarten year. By this means, the municipalities applying the cut-off rules were partly relieved of pressure and they were able to take more time to provide the required supply for all children from age three until school entrance.

This transition period should have finished by the end of 1998 (see Bundesgesetzblatt I, 2010, p. 3022, §24a), but the use of cut-off dates for preschool entrance has

[6]Figures 2 and 3 stem from the 12. Kinder-und Jugendbericht (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2005, p. 197, in the version as Bundestagsdrucksache 15/6014). Special thanks go to the German Youth Institute (DJI) and the Dortmunder Arbeitsstelle Kinder-und Jugendhilfestatistik who kindly provided the underlying data from the German Mikrozensus in order to replicate these figures.

[7]We use July as our main cut-off month. However, we also show specifications that are robust to other cut-off months, for example cut-offs that exactly coincide with the start of the kindergarten year in a federal state (see Table 8)

remained a common practice in many municipalities until recent years. When looking at preschool attendance rates for the different age cohorts from three to six, the lowest rates are still among three year old children (Konsortium Bildungsberichterstattung, 2006, p. 38). According to the 12. Kinder-und Jugendbericht (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2005, p. 197), this partly reflects the ongoing use of cut-off-rules in several municipalities. There was less than full compliance with this regulation. Some municipalities could offer places in preschool for all children aged from three up to school entrance and they did not have to apply the cut-off rule. Moreover, demand-driven reasons enabled families to place their child in preschool in the month of their third birthday even though the child should, in accordance with the cut-off rule, be older when entering. Others could ignore the rule and decide to wait until their children were older for preschool entrance. However, the official existence of this rule until the end of 1998—and its implicit persistence in later years—allows us to identify a causal effect of the age at preschool entrance on our outcomes of interest for the group of children who complied with the cut-off date. Thus, we can interpret our results as a local average treatment effect (LATE) (Angrist et al., 1996).

3 Empirical Strategy and Data

This section describes our estimation strategy to identify the causal effects of the age at preschool entrance on noncognitive skill measures before school entrance. Further, we provide a detailed insight into the data we use for our analysis.

3.1 Estimation Strategy

The stock of noncognitive skills that a child has generated up to the year before school entrance results from an accumulation process during the child's first years of education (that is, preschool) and several other input factors. Thus, we use an education production function to formalize the relationship between the age at preschool entrance and noncognitive outcomes before school entrance:

$$noncogskill = \alpha + \beta_1 * entryage + \beta_2 * covariates + \epsilon \tag{1}$$

The dependent variable, *noncogskill*, is the noncognitive outcome for the child before school entrance. Our explanatory variable of interest is *entryage* and it indicates the age (in months) at which the child enters preschool. The vector *covariates* includes a set of other control variables measuring several determinants that probably have an effect on the noncognitive skill stock before school entrance. These are several family

and other background characteristics of the child, such as indicators for the highest school degree of the mother, a dummy variable for whether the child has siblings, an indicator for the migrant status of the child, and the sex of the child (for an overview of all of the variables we use see Table 1). The zero-mean error-term, ϵ, accounts for stochastic, random influences of any other factors on our outcome variable. Two additional important factors determining the stock of noncognitive skills are the age of the children at the time of the interview and the duration spent in preschool. We cannot control for both of these factors because of the following identity:

$$age_{interview} = entryage + duration \tag{2}$$

The variable $age_{interview}$ is perfectly determined by the sum of *entryage* and *duration* and can therefore only be considered as a control variable if we omit the duration spent in preschool. This is a general problem of the literature dealing with age-at-entrance effects. Observing (at the same point in time) outcomes of children with different entrance age and the same duration spent in preschool necessarily involves variation in the age at the interview of these children. Likewise, controlling for the age at the interview in a regression framework as in Equation (1) raises the problem that these children will have spent different durations in preschool (Black et al., 2011). Most of the relevant studies allow for differences in the age at interview. They observe children with different school starting ages who have spent the same duration in education, and they show that a higher relative age at school entrance is associated with better academic achievements in a given grade (Bedard and Dhuey, 2006; Puhani and Weber, 2007). In such a setting it is hard to show whether this is due to the relatively older age of a child in their learning environment (that is, a peer effect), their higher absolute age at the time of the interview, or whether this really reflects an age-at-entrance effect/mature-learning effect. The latter argument means that children who start school at older ages learn more—conditional on having spent the same time in school—than those who started school at a younger age do.

With our data structure we can account for duration spent in preschool and age differences. In a discontinuity sample we compare children of the same age and allow for systematic differences in the time that these children spent in preschool. In the full sample we control for duration in preschool and allow for age differences between children. In Section 4 we discuss the results of our estimations and make a case for how to tackle the above-mentioned identification problem.

The crucial condition for getting an unbiased and consistent estimate for the effect of the age at preschool entrance on our noncognitive skill measure is the exogeneity of our variable *entryage* with respect to *noncogskill*, conditional on all other control

variables. If any other factors exist which we cannot completely control for, and which are both correlated with *entryage* and our outcome *noncogskill*, we will get biased estimates for *entryage*. Previous studies show that the age at which a child enters preschool is endogenous and depends on many factors for which we are unlikely to be able to control and which may also affect noncognitive skills before school entrance.[8] Moreover, one could imagine that pre-existing noncognitive skills affect the age at entrance rather than the other way round (reverse causality), or that the two variables are simultaneously determined.

In the German case, preschool attendance is correlated with several family characteristics and, to a large extent, is a matter of parental choice. Concerning the age at entrance, a study of the German Youth Institute shows several factors that cause preschool entrance to occur before at the age of three, instead of at an older age (Fuchs and Peucker, 2006). The most important predictor of early entrance—besides regional supply that we use as our instrument—is the employment status of the mother. Children whose mothers are working have a significantly higher probability of already attending preschool at the age of three instead of later (Fuchs and Peucker, 2006, pp. 77-78). Mother's labor supply, in turn, can be a predictor of both high and low family status. On the one hand, the economic literature is in general agreement about the positive relationship between women's labor supply and the level of their education (Schultz, 1990). On the other hand, the increase in women's labor market participation could also stem from the necessity for them to earn the family's income—an indicator of rather low socio-economic status.[9] Such family background factors are crucial determinants of the stock of noncognitive skills (Cunha and Heckman, 2008) and we are not able to capture them fully; as argued above, it is not clear a priori whether this causes an upward or a downward bias in simple estimations, or whether the results are similar to quasi-experimental estimates.

Fuchs and Peucker (2006) emphasize that there is a tendency to favor children from a lower social background with working mothers if the places in preschool for three year old children are limited. If this is true, we will probably find a downward bias in the age-at-entrance effect, as our regressions cannot fully capture all other characteristics of this selected group of families and children. Additionally, other unobserved child characteristics could also be indicators of earlier or later entrance age and therefore be possible sources of selection bias.

[8] See, for example, Loeb et al. (2007) who try to estimate causal relationships between pre-kindergarten attendance and some behavioral noncognitive outcomes at the start of kindergarten (which is equivalent to the first grade of primary school in Germany). They use many relevant covariates and still have doubts about causality.

[9] This could be a result of bad employment opportunities for the husband (Juhn and Murphy, 1997) but might also be a consequence of being a single mother who is forced to work.

We address this possible endogeneity problem by exploiting exogenous variation in the age at preschool entrance that is due to German policies in this area. In some municipalities, entrance age is not left to parental choice or a matter of child characteristics. The existence of cut-off rules—designed to facilitate the transition to satisfy requirements arising from the introduction of the legal claim for a place in preschool in 1996—leads to a correlation between age at entrance and month of birth. Children can enter preschool only at the beginning of the preschool year (in August or September) and not at the time of their third birthday. Wherever the regulation is binding, a child born in July enters preschool at the age of 37 or 38 months, a child born in August has, in the worst case, to wait one year longer and enters at the age of 48 or 49 months (that is, in August or September of the following year).[10] We get some variation in the age at preschool entrance that can only be attributed to the month of birth. Formally, this leads to the estimation of the following first stage model:

$$entryage = \alpha + \beta_3 * entryage_{theor} + \beta_4 * covariates + \mu \tag{3}$$

where $entryage_{theor}$ is the theoretical age at preschool entrance of a child.[11] The variable *entryage* from Equation (1) will then be replaced by the predicted value of Equation (3). This type of instrument variable is a common tool in earlier literature that deals with age-at-entrance effects and which tries to account for the endogeneity of the entrance decision. However, it is mostly related to variation in age at school entrance instead of age at preschool, and it exploits the cut-off rules in different countries for the start of schooling.[12]

Recent papers raise several concerns over the exogeneity of the month of birth with respect to important outcome variables. This literature argues that there is a direct effect of a child's month of birth on several outcomes (health, educational attainment, or future earnings) that does not operate through their age at entrance. This research overwhelmingly shows that children born in winter have, on average, poorer outcomes. The relevant studies present different drivers of this correlation, one

[10]There is not full compliance with the cut-off and even if municipalities apply the rule, parents can manage to get their children into preschool at the age of three or even younger. Others can (voluntarily) decide to send their children later. In addition the existence of a privately operated care market (which is, however, still very small in Germany) makes families independent of the cut-off, as these centers are unregulated.

[11]For example, a child born in June has a theoretical age at preschool entrance of 38 or 39 months, whereas a child born in October (that is, after the July cut-off) has a theoretical age at entrance of 46 or 47 months. Children born in July are those who enter at the youngest possible age.

[12]See for example Fertig and Kluve (2005) and Puhani and Weber (2007) for Germany, Fredriksson and Oeckert (2005) for Sweden, Strom (2004) and Black et al. (2011) for Norway, Crawford et al. (2007) for England, McEwan and Shapiro (2008) for Chile, and Elder and Lubotsky (2009) for the United States.

of them being that children born in specific seasons are conceived by mothers with particular socio-economic characteristics (see Buckles and Hungerman, 2008, for an overview) and therefore suffer worse outcomes.[13] We consider this potential source of endogeneity and address it in Section 4.

3.2 Data on Preschool Entrance and Noncognitive Skills

The data for our analysis come from the Children's Panel of the German Youth Institute (DJI-Kinderpanel), which is a data source rarely used by economists.[14] In this panel study, two cohorts of children were tracked across three periods. Originally, the data were collected to identify transition periods between German preschool and school entrance (for the younger cohort), and elementary and secondary school (for the older cohort).[15] Sampling took place at the federal level. We only use information on the younger cohort. For these children, data were collected at three points in time: first, at the ages of five and six (in 2002), that is, before school entrance, then 1.5 and 3 years later, after the children entered German primary schools. For our purpose, we only need the first wave when children were observed before school entrance in the year 2002. All the information we use on the children at this stage comes from a questionnaire answered by their mothers. In addition to information about month and year of birth of the children, we know whether the children currently attend preschool and the date of their preschool entrance (month and year).[16] We also have background information about the children, their parents, and their homes, which were also reported by the mothers. They were asked about child and family characteristics, their own education, and their home environment.

The data set contains information about several noncognitive skills of the children as reported by the mother. We are aware of possible concerns about using the mother's valuation of the skills of her children and, obviously, there will be some measurement error in these rankings. If available, measures from a sociometric test or from personnel in the preschool would be preferable. We believe that the mother's assessment is a valid predictor of a child's noncognitive skills. Due to our identification strategy, over-

[13] In contrast to earlier literature in the natural and social sciences that mostly speculates about the reason for the direct effects of month of birth on later outcomes, Buckles and Hungerman (2008) show with U.S. census data that children born in winter are more likely to be born to women who had a teenage childbirth or who only have a low school degree.

[14] To our knowledge, only two papers have used that data set: Cinnirella et al. (2011) and Felfe and Lalive (2011).

[15] See a description and a graphical illustration of the data set at www.dji.de/kinderpanel/. Furthermore, the scientific-use files of the data set can be downloaded from the website of the German Youth Institute (www.dji.de).

[16] From all children of the first wave, where we have information from the mothers' questionnaire, 92.6 percent attend preschool. This is quite in line with administrative data on preschool attendance in the year before school entrance, and shows the representativeness of our sample.

or undervaluation by the mother would only be a problem if it was systematically related to the month of birth of the child. Several indices used by psychologists are based on mothers' responses (see, for example, the use of the Behavior Problem Index by Cunha and Heckman 2008). We use two noncognitive skill measures that are both important for school readiness and later life outcomes. These are the ability to form friendships and assertiveness.[17]

The capacity to get along with peers and form friendships are regarded as important indicators of academic readiness and therefore are crucial factors for school readiness. Support and collaboration with friends are conducive to successful school performance (Ladd et al., 1997). Assertiveness is also one of the most important predictors of early school success among various social and noncognitive skills (Pianta and McCoy, 1997; La Paro and Pianta, 2000). In the German context, the applied pedagogical literature explicitly addresses assertiveness as a crucial mental prerequisite for school readiness. Among the social indicators, the ability to establish contacts (that is, forming friendships) is also indicated (see, for example, a checklist of school readiness indicators by Rothkegel (2004) in the Grundschulmagazin). Both indicators can be interpreted as important components of the Big Five personality traits that are usually used by psychologists (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism). According to these characteristics, the ability to form friendships is closely related to Extraversion and Agreeableness, while assertiveness will be part of a less neurotic personality.

Our sample consists of 875 preschool children born between October 1996 and September 1997. More than 97 percent of the children entered preschool between 1999 and 2001, that is, in the years directly after which the cut-off rules (by law) were no longer effective, but were implicitly applied. We merge our child observations with information about the month of school start in German states in the years in which the children entered preschool. Data on that stem from historic holiday calendars published on the website of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (Kultusministerkonferenz, 2010). As presumed, most of the children (about two-thirds) entered preschool in August or September. Entrance in other months is equally distributed at about 5 percent (Figure 4). We separately analyze preschool entrance in states where school starts in August and in September in the year in which the children enter preschool. The pattern becomes even clearer. Most children enter in the month in which school starts in their state of residence (Figures 5 and 6). The interviews with the mothers were carried out between September 2002 and January 2003 (with more

[17]For the friendship variable there exist two response categories for the mother, and four in the case of assertiveness. We describe this in detail in Section 4.

than 90 percent of the interviews held in October, November, and December 2002). The descriptive statistics for all of the variables we use can be found in Table 1. Figures A1 and A2 provide graphical illustration of the sample distributions by month of birth and German state.

4 Results

This section presents both first stage results and estimations of the effects of age at preschool entrance on our noncognitive skill measures, followed by robustness checks.

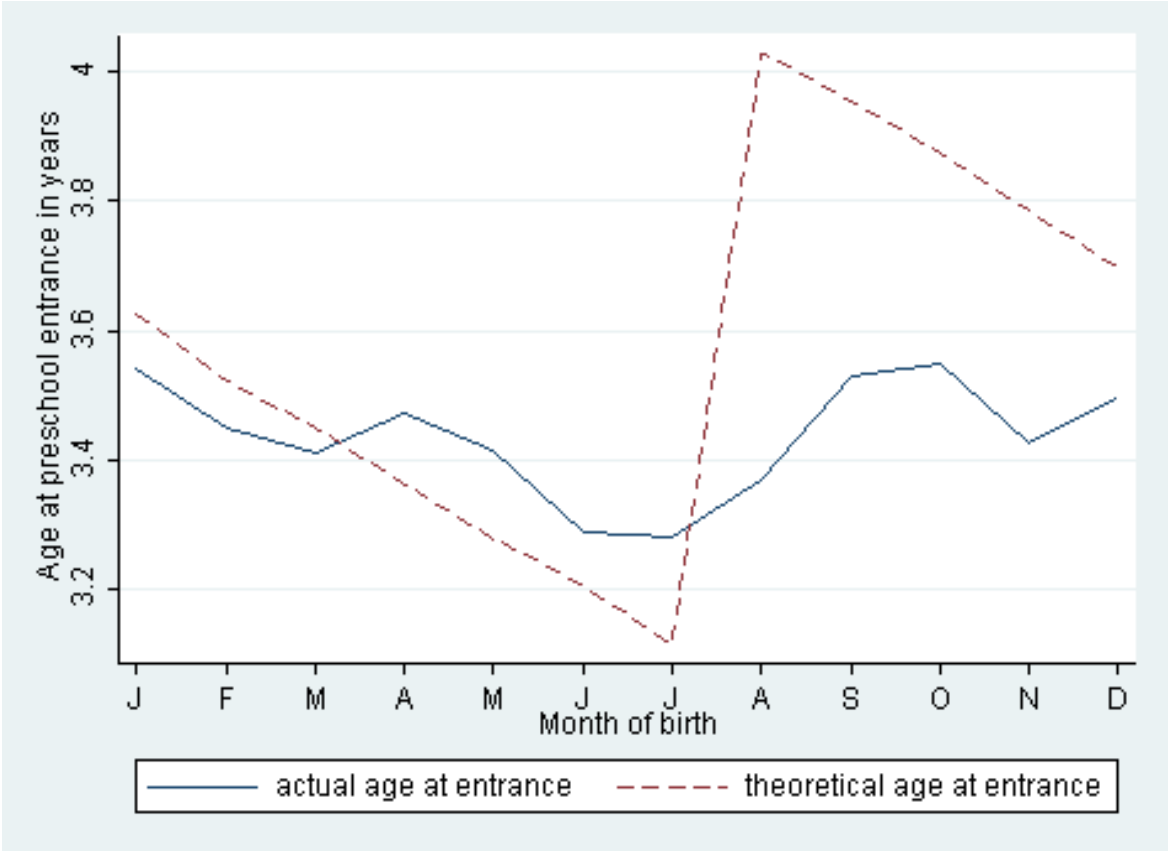
4.1 First Stage Results

In order to gain a first impression of the empirical relevance of our instrument, Figure 1 provides an illustration of the actual age at preschool entrance compared to the theoretical one, that is, the age that would result from compliance with the cut-off rule. If a child's third birthday is in July they enter preschool at the next school start in their state of residence (which is in August or September). Children born after July have to wait until the school starts in the next year [18]

Figure 1 indicates an association between the actual and the theoretical age at preschool entrance. We see, however, that children born in the months before the cut-off, on average, enter preschool somewhat older than the regulations prescribe, and those born in the months after the cut-off enter preschool younger. This is in line with the picture resulting from a comparison of the actual with the theoretical age at school entrance in Germany (see Puhani and Weber, 2007). Later entrance is more frequent than early entrance, and at around the cut-off (in August and September) parents try to get their children to preschool at younger than the age determined by the cut-off. The somewhat fuzzy picture could also be in line with a cut-off in August and not in July. We discuss results of an alternative cut-off in Section 4.3. Table 2 presents first stage regressions of the actual age at preschool entrance on the theoretical entrance age, and this supports the evidence in the graph by showing a significant positive correlation in Columns (1) and (2). Removing the state dummies (in Column (2)) does not change the first stage results. The point estimates remain fairly stable between 0.14 and 0.17. The first stage F-statistic on the excluded instrument is above 10 in both specifications, suggesting that we do not suffer from the problem of weak instruments (Bound et al., 1995). Our results indicate that an increase in the theoretical age at

[18] So we assume that children born by 31 July can enter preschool in August or September at the age of 37 or 38 months, whereas those born in August have to wait one year longer and have a theoretical age at entrance of 48 or 49 months.

Figure 1
Actual and Theoretical Age at Preschool Entrance by Month of Birth



The figure shows the average actual age at preschool entrance observed in the Children's Panel (blue solid line) and the theoretical age at preschool entrance (red dotted line) by month of birth. For the calculation of the theoretical age at entrance we assume the cut-off to be in July. The start of the kindergarten year is supposed to coincide with the start of the school year in the respective year and federal state. Own calculations based on our sample of children from the Children's Panel of the German Youth Institute (DJI-Kinderpanel).

preschool entrance by one month leads, on average, to a higher actual age at preschool entrance by one sixth of a month. To sum up, the theoretical age at preschool entrance seems to be a valid instrument for the actual age at preschool entrance.

The correlation between actual and theoretical age at preschool entrance is positive and highly significant, but low in magnitude compared to the relationship between actual and theoretical age at school entrance (see Puhani and Weber, 2007; Fertig and Kluve, 2005). This reflects the fact that this transitional rule—which should help the municipalities to cope with the requirements of the legal claim for a place in preschool—was by construction less binding than the nationwide school cut-off dates. Municipalities were not forced to apply the rule if they were already able to deliver a sufficient supply of places. Furthermore, the children in our sample entered preschool between 1999 and 2001 when the rule was no longer effective by law, but was implicitly

adopted where municipalities still had problems in delivering a sufficient supply of places for children from their third birthday on (see Fuchs and Peucker, 2006). With a sample of children entering preschool during the official transition period (that is, between 1996 and the end of 1998), we would probably find a higher compliance with the cut-off rule.

4.2 Effects of Age at Preschool Entrance on Noncognitive Skills

This section addresses the main question of the paper, that is, the effects of age at preschool entrance on the children's noncognitive skills before school entrance. As a baseline result, we present in Table 3 simple regressions of the noncognitive skill measures reported by the mother on the actual age at preschool entrance. The first Column presents probit estimations with the dependent variable friendship. The mother is asked whether the child is able to form friendships or not (1=yes, 0=no). Column (2) shows results of ordered probit regressions. In this case, the mother reports on a scale from 1 to 4 whether the child is assertive (1=not assertive at all; 4=assertive). For both variables we find very small insignificant coefficients close to zero. This indicates that there is no effect of the age at preschool entrance on our noncognitive skill measures.[19] This result could be biased by selection into early or late entrance.

We turn to our preferred specification and apply a two-stage approach accounting for the endogeneity of age at preschool entrance, and using the theoretical age at preschool entrance as an instrument. Table 4 presents results of an IV-probit estimation (for friendship) in Columns (1) and (3), and two-stage ordered probit estimations with one endogenous regressor (for assertiveness) in Columns (2) and (4). The dependent variables are modeled as described above; the regressor of our main interest is the actual age at entrance. First, in Columns (1) and (2) we present estimates from a discontinuity sample where we use only the children born in the two months before and after the cut-off (that is, from June to September 1997). In this specification—which resembles a Regression Discontinuity Design rather than an IV-Estimation—the children are roughly the same age, but they systematically differ in the duration spent in preschool.[20] In these estimations, we find a significant positive effect of an earlier age at preschool entrance on friendship and assertiveness. A one month decrease in the entrance age increases the ability to form friendships (as reported by the mother)

[19]The probit estimation already presents marginal effects at the mean, whereas the marginal effects for the ordered probit estimations (estimated with Stata's prchange command) yield very small effects (close to zero) and thus are similar to the coefficient presented in the table.

[20]Those born before the cut-off (that is, in June and July 1997) attend preschool for one more year when complying with the rule. Ideally, we would prefer to include only children born in the two months July and August 1997, but this is not possible due to our small sample size.

by 4 percentage points and the probability of being assertive (that is, to reach the best category, as reported by the mother) by 2.8 percentage points.[21]

The results in the first two columns corroborate our assumption that an earlier age at preschool entrance has positive effects on the stock of noncognitive skills acquired before the start of school. The estimates show that—conditional on the same age—children who enter preschool earlier in life have better noncognitive skills before they start school. The findings also imply that the results of the simple estimations in Table 3 probably stem from early selection into preschool. One could suppose that early entrance is predominantly characterized by two groups. One group comprises those who are in special need and who at the same time have a lower level of noncognitive skills; the other is a group of children with more favorable backgrounds and high noncognitive skills where the parents are aware of the advantages of early entrance. This could affect the downward bias towards zero in the effects of age at entrance in the simple model. Point estimates in the simple estimations reported in Table 3 are significantly smaller (more than ten times) than are the respective estimates in the IV specifications in Table 4. However, given this preliminary result, we are still not able to identify the channel of this relationship exactly. We do not know whether this effect can be interpreted as a return to the longer duration spent in preschool, or whether it even holds when children have the same duration of exposure to preschool. If so, we could identify a pure age-at-entrance effect. This would contribute to the assumption of non-linearity in the skill formation process, where the same investments in education can be differentially productive, depending on whether they are made early or late in life.

We turn to Columns (3) and (4) of Table 4 based on the whole sample, controlling for duration spent in preschool and neglecting the fact that the children of our sample (born between October 1996 and September 1997) differ in age when we observe their noncognitive skills. The estimates confirm the significant relationship between age at preschool entrance and our noncognitive skill measures found in Columns (1) and (2). Entering preschool one month earlier increases the ability to form friendships (as reported by the mother) by 5.6 percentage points (see Column (3) of Table Table 4) and the probability of being assertive by 4.4 percentage points (marginal effects for assertiveness are calculated as described above).

However, the children born in the months before the July cut-off (that is, in 1997) are those who enter preschool earlier in life and are—with the exception of those

[21]Marginal effects for the ordinal variable assertiveness are calculated by predicting the response probability of reaching the best category for every observation and computing the average over all observations. The low F-statistic of the first stages in Panel A of Table 4 could be a concern, as this indicates a weak instrument problem. We tackle this problem in our robustness checks in Section 4.3.

born directly after the cut-off (in August 1997 and September 1997)—younger at the time of the interview than are those born after the cut-off (that is, in 1996 and the first months of 1997). Due to perfect collinearity it is not possible to additionally control for the children's age at the interview (see Equation (2)). However, if the results in Columns (3) and (4) only reflected an age effect and not, as presumed, an age-at-entrance effect, we would have to argue that younger children have a higher stock of noncognitive skills. That is, they are better at forming friendships and are more assertive. To the best of our knowledge, there is no explicit literature on age effects on the stock of noncognitive skills, but it remains at least doubtful to assume that relatively younger children attending preschool perform better in noncognitive skills than those in the older group do. Together with most results using cognitive skills as outcome variables that show a positive correlation between age and cognitive development (see Bedard and Dhuey, 2006; Puhani and Weber, 2007), the assumption

$$\frac{\partial noncogskill}{\partial age_{interview}} > 0 \tag{4}$$

seems plausible. If the pure age effect, however, favored the relatively older children, the effects of age at preschool entrance would be underestimated, and estimates in Columns (3) and (4) of Table 4 would present a lower bound to the causal effect of age at preschool entrance on noncognitive skills before school entrance.

To sum up, in a setting where a joint consideration of age and duration effects is not possible, the combination of the estimates with the whole sample (where we control for duration spent in preschool and find positive effects for younger children), and the specifications with the discontinuity sample using children of roughly the same age justifies an assumption of a causal influence of age at preschool entrance on our noncognitive skill measures.

4.3 Robustness Checks

One major concern related to the exogeneity of the month of birth instrument is the assumption of a direct effect of the instrument on our outcome variables. Several studies find a positive correlation between the season of birth and socio-economic outcomes of individuals (Buckles and Hungerman, 2008). Although this exclusion restriction is not directly testable (Angrist et al., 1996), the use of the discontinuity sample, where we focus on children born within two months before and after the cut-off (between June and September 1997), gives us reason to assume that this is not a crucial pitfall. We can still identify effects of the age at entrance if we include only the children born in one season.

Problems could arise with respect to the weakness of our instrument, as the F-statistics are not uniformly above the suggested value of 10 in all our specifications. The IV-results could therefore be systematically different to the true parameter of interest. In a robustness check we estimate the reduced form, by regressing our outcome variables directly on our instrument, that is, the theoretical age at entrance. We circumvent a two-stage regression and can identify an effect that is proportional to the causal effect of interest (Angrist and Krueger, 2001). Results are presented in Table 5. They show that the relationship between the theoretical age at entrance and friendship-forming ability and assertiveness holds qualitatively compared to the two-stage effect. We find that reducing the theoretical age at preschool entrance by one month increases the probability of being able to form friendships by 0.9 percentage points in the discontinuity sample and in the full sample. For assertiveness, a one-month reduction in the theoretical age at preschool entrance increases the probability of receiving the best outcome (assertiveness=4) by 0.9 percentage points in the discontinuity sample and by 0.7 percentage points in the full sample (calculated with Stata's prchange command).

The smaller size of the marginal effects is due to the fact that the reduced form only shows an intention to treat effect (ITT), instead of the 2SLS LATE from above in which we identify the causal effect only for children who comply with the cut-off rule.[22]

Further robustness checks in Table 6 and Table 7 show the results of Linear Probability Models. Although standard errors become larger, the point estimates qualitatively coincide with our results of Table 4. The magnitude of the marginal effects is also similar.[23]

So far, we assumed the cut-off to be the end of July. According to Figure 1 one could also assume a cut-off in August or a rule that differs by the start of the kindergarten year in the respective state.[24] Such alternative rules would only affect the preschool entrance of complying children born in August and September. Theoret-

[22]The estimates from our linear models show the proportionality between 2SLS estimates and reduced form estimates. The linear reduced form point estimates from Table 7 divided by the first stage coefficients from Columns 3 and 4 in Table 4 equal the linear Late coefficients from Table 6. For friendship: -0.009/0.161=-0.056.

[23]Coefficients on *Actual age at entrance (in months)* in Columns (2) and (4) of Table 6 and on *Theoretical age at entrance (in months)* in Columns (2) and (4) of Table 7 show the probability of reaching a one category higher level of assertiveness (induced by a one-month reduction of the actual and theoretical age at preschool entrance respectively).

[24]An August cut-off would mean that children born in August can still enter in the year of their third birthday. A mixed cut-off would mean that children born before August can enter in the year in which they become three years old in states with kindergarten starting in August; children living in a state with kindergarten starting in September can still enter if their third birthday is in September.

ical age at entrance of children born in the other months remains the same.[25] We therefore estimate a reduced form including only the children born between May and July 1997 and children born between October and December 1996 (Table 8).[26] We find significant results for the probability of forming friendships (in Columns (1) and (3) of Table 8) that do not significantly differ from the non-linear and linear reduced form results based on the whole sample (Table 5 and Table 7). In the specifications of Columns (2) and (4) in Table 8, the point estimate on theoretical age at entrance is about the same as in the respective full sample specifications of Table 5 and Table 7; however, the coefficients are no longer significant, due to higher standard errors in the reduced sample. Table 9 shows results from a placebo first stage using March as the cut-off. In both discontinuity samples around March in Columns (1) and (2) of Table 9, coefficients on the theoretical age at entrance are significant but negative. This indicates that our cut-off in summer is well chosen and not simply an artifact of our data.

Although some coefficients are more imprecisely estimated and are no longer significant, our robustness checks mainly corroborate the significantly positive effect of an earlier age at preschool entrance on children's ability to make friendships and their assertiveness.

5 Conclusion

We exploit month of birth variation to identify the effect of age at preschool entrance on noncognitive skills prior to school entrance. We use the fact that the delayed introduction of the legal claim to a place in preschool following a child's third birthday (Rechtsanspruch auf einen Kindergartenplatz) led to the adoption of cut-off rules in several municipalities and therefore to a correlation between the actual age at preschool entrance and the child's month of birth. Observing five to six year old children who provide information on their age at preschool entrance and several noncognitive skill measures (as reported by the mother), we show in a discontinuity sample (that is, using children born in the same year two months before and after the cut-off) that entering preschool one month earlier in life increases the probability of being able to form friendships by 4.0 percentage points and the probability of being assertive by 2.8 percentage points.

[25] Complying children born in July always enter preschool at the age of 37 or 38 months (depending on the respective month of school starting), independent of the exact cut-off rule. Likewise, children born in October always enter at the age of 46 or 47 months.

[26] These two groups of children differ in age by about 7 months on average.

Since these effects could be due to both longer duration in preschool and/or younger age at entrance, we estimate specifications using the whole sample of preschoolers (born between October 1996 and September 1997) and control for duration spent in preschool. Thus, we allow for variation in the age at the interview and find positive age-at-entrance effects for the younger children of our sample. As we assume that the pure age effect on noncognitive skills tends to benefit older preschoolers, we are confident that we can identify a lower bound for the causal effect of age at entrance on being able to form friendships and on assertiveness.

Our results show evidence of the general importance of preschool attendance in the production of noncognitive skills. Children, observed at the same age, who enter preschool earlier in life have a higher stock of noncognitive skills (that is, they are more sociable and more assertive) before school entrance. Moreover, we provide hints that there is a pure age-at-entrance effect which is independent of duration spent in preschool and age at interview effects. The absolute age at preschool entrance matters, as several skills can be more effectively accumulated at specific periods in life. This empirical result is in line with the theory of the skill formation process and indicates the existence of sensitive and/or critical periods of skill formation in the life cycle.

Educational policy should promote early preschool entrance, since it is crucial from an individual point of view. The accumulation of noncognitive skills such as making friendships and assertiveness seems to be more productive then than in later periods. Perhaps, a later catch-up process is not even possible. In the long-run, the shift of educational investments to early interventions also unburdens fiscal budgets and makes educational policy more efficient. Our results may suggest that this is not only true for disadvantaged children. In our analysis, we do not explicitly focus on children with less favorable family backgrounds, as compliance with the cut-off rule is not automatically a pointer to families with special needs. This is especially important in the German context. Very few children never attend preschool, and those children do indeed come from lower socio-economic backgrounds. However, according to our results, not only *pure* attendance but also *early* attendance is crucial. This requires a focus on cohorts of three and four year old children. At this age, non-attendance remains greater and also includes non-disadvantaged, better-off children. Future research should extend our analysis to a broader range of noncognitive skills and better measurement in order to get a more comprehensive picture of the importance of that skill dimension.

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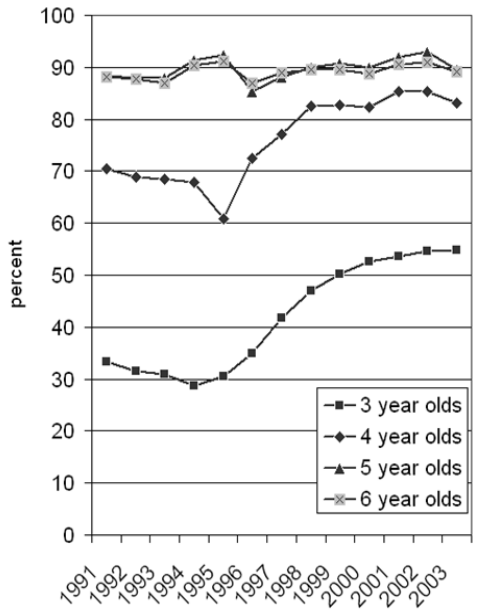
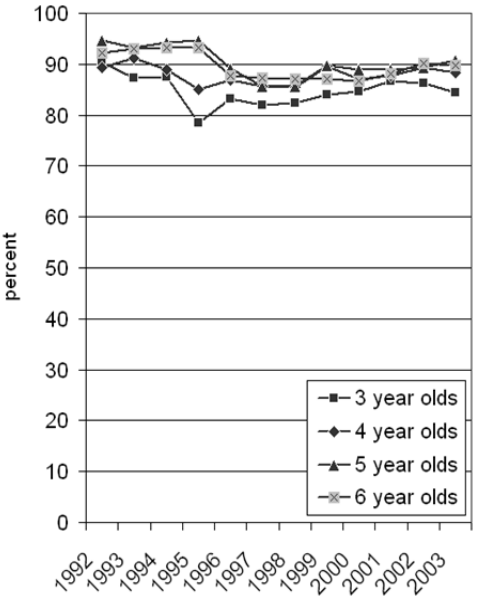
Figure 2
Preschool Attendance Rates by Age Groups: West Germany



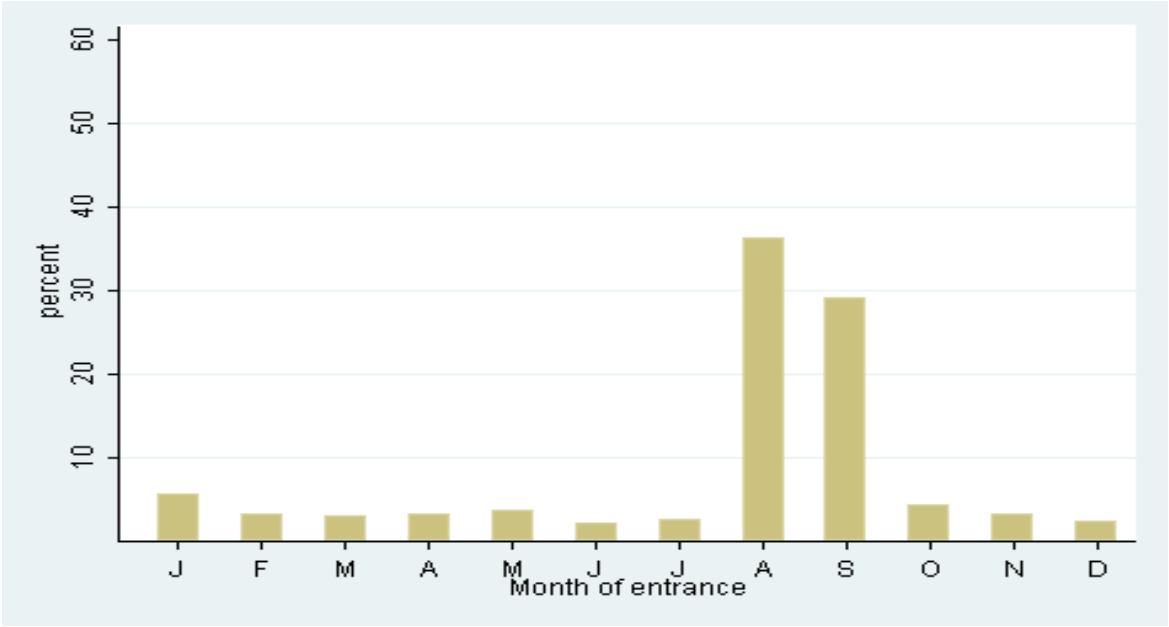
Preschool attendance rates by age groups over time for West Germany. Data: German Mikrozensus (see Bundesministerium für Familie, Senioren, Frauen und Jugend, 2005, p. 197).

Figure 3
Preschool Attendance Rates by Age Groups: East Germany



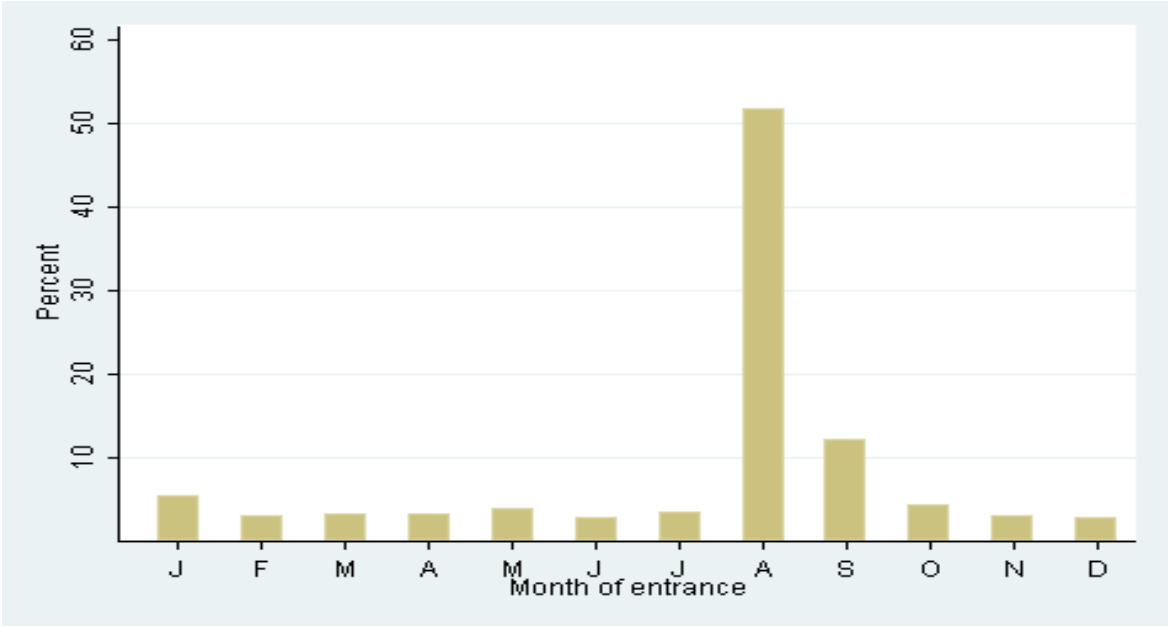
Preschool attendance rates by age groups over time for East Germany. Data: German Mikrozensus (see Bundesministerium für Familie, Senioren, Frauen und Jugend, 2005, p. 197).

Figure 4
Preschool Entrance by Month



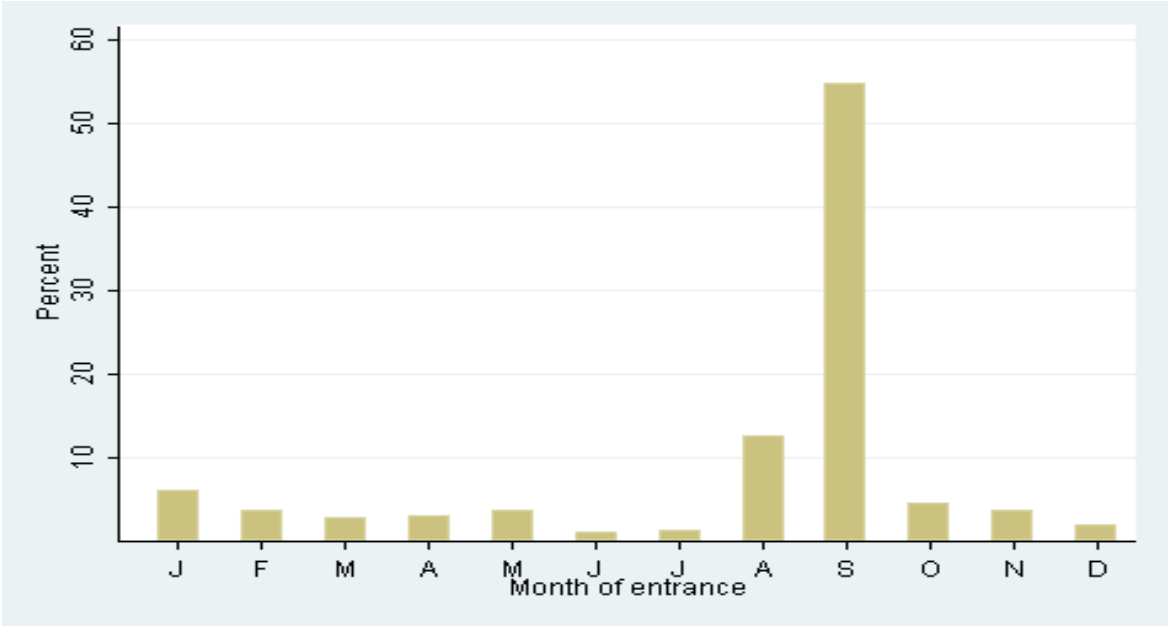
Month of preschool entrance of children (reported by the mothers). Data: Children's Panel of the German Youth Institute (DJI-Kinderpanel). Own Calculations.

Figure 5
Preschool Entrance by Month: School Start in August



Month of preschool entrance of children who live in a federal state in which school starts in August in the year in which they enter preschool (reported by the mothers). Data: Children's Panel of the German Youth Institute (DJI-Kinderpanel). Own Calculations.

Figure 6
Preschool Entrance by Month: School Start in September



Month of preschool entrance of children who live in a federal state in which school starts in September in the year in which they enter preschool (reported by the mothers). Data: Children's Panel of the German Youth Institute (DJI-Kinderpanel). Own Calculations.

Table 1
Descriptive Statistics

Explanatory variables	Mean	Std.Dev.
Child characteristics:		
Age at preschool entrance (in years)	3.435	0.667
Age at interview (in years)	5.603	0.294
Preschool duration (in years)	2.168	0.712
Speaking German with the child	0.837	
Not speaking German with the child	0.109	
Speaking German with the child missing	0.055	
Child has siblings	0.776	
Child has no siblings	0.153	
Sibling information missing	0.071	
Child male	0.522	
Child female	0.478	
Mothers' highest school degree		
Basic school	0.223	
Middle school	0.383	
Upper secondary technical school degree	0.077	
High school	0.290	
No school degree	0.021	
School degree missing	0.007	
Outcome variables		
Friendship		
Easy at forming friendship	0.823	
Not easy at forming friendship	0.174	
Friendship missing	0.003	
Assertiveness: 1st category=lowest assertiveness; 4th category=highest assertiveness		
Child is assertive 1st category	0.014	
Child is assertive 2nd category	0.166	
Child is assertive 3rd category	0.543	
Child is assertive 4th category	0.268	
Child's assertiveness is missing	0.009	
Number of observations	875	

We drop those children who do not attend preschool at the time of the interview and the few observations where we cannot observe the age at preschool entrance. Std. Dev.: Standard deviations are reported only for continuous and discrete variables. Missing values in all categorical family background variables (*Speaking German with the child*, *Child has Siblings* as well as *Mothers' highest school degree*) have been imputed with a missing category dummy. The different sample sizes in the regressions stem from the few missing observations in our dependent variable (in the full sample regressions).

Table 2
First Stage Results

	(1)	(2)	(3)
Theoretical age at entrance (in months)	0.163***	0.143***	
	(0.037)	(0.037)	
Speaking German with the child	–0.028	–0.040	
	(0.031)	(0.031)	
Child has siblings	–0.011	–0.003	
	(0.027)	(0.028)	
Sex (male=1)	0.023	0.020	
	(0.018)	(0.018)	
Mothers' highest school degree	Yes	Yes	
Preschool duration	Yes	Yes	
State dummies	Yes	No	
Observations	875	875	
First stage robust F-statistic	18.84	14.82	

Dependent Variable: Actual age at preschool entrance (in months). Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 3
Simple Estimations

	Friendship	Assertiveness
	(1)	(2)
Actual age at entrance (in months)	–0.003	–0.001
	(0.004)	(0.012)
Speaking German with the child	0.055	–0.354***
	(0.048)	(0.131)
Child has siblings	0.046	–0.148
	(0.038)	(0.107)
Sex (male=1)	–0.087***	0.074
	(0.025)	(0.076)
Mothers' highest school degree	Yes	Yes
Preschool duration	Yes	Yes
State dummies	Yes	Yes
Observations	872	867

Dependent Variables: Column (1): Ability to form friendships (reported by the mother), binary outcome: 1=yes, 0=no; Column (2): Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. The small discrepancies between the full sample (875 observations) and the sample sizes presented here in Columns (1) and (2) derive from dropping the few observations where information on the respective dependent variable is missing; The probit estimation of Column (1) presents marginal effects at the mean. Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 4
2SLS Stage Results

	Discontinuity Sample (June 1997 - September 1997)		Whole Sample	
A) First stage:				
	Actual age at entrance (in months)			
	(1)	(2)	(3)	(4)
Theoretical age at entrance (in months)	0.232**	0.265***	0.161***	0.159***
	(0.092)	(0.088)	(0.031)	(0.037)
First stage robust F-statistic	6.35	9.06	26.32	25.60
B) Second stage:				
	Friendship	Assertiveness	Friendship	Assertiveness
Actual age at entrance (in months)	–0.040***	–1.130***	–0.056***	–1.442**
	(0.012)	(0.351)	(0.022)	(0.713)
Speaking German with the child	–0.190**	0.133	0.034	–0.274**
	(0.078)	(0.251)	(0.049)	(0.140)
Child has siblings	0.188**	–0.290	0.037	–0.121
	(0.087)	(0.233)	(0.039)	(0.107)
Sex (male=1)	– 0.085	-0.165	–0.070**	0.030
	(0.060)	(0.129)	(0.029)	(0.079)
Mothers' highest school degree	Yes	Yes	Yes	Yes
Preschool duration	No	No	Yes	Yes
State dummies	Yes	Yes	Yes	Yes
Observations	270	292	872	867

Dependent Variables in the second stage: Columns (1) and (3): Ability to form friendships (reported by the mother), binary outcome: 1=yes, 0=no; Columns (2) and (4): Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. Panel A presents first stage coefficients from the corresponding 2SLS estimations presented in Panel B. The small discrepancies between the full sample (875 observations) and the sample sizes presented here in Columns (3) and (4) derive from dropping the few observations where information on the respective dependent variable is missing. The IV-probit estimations of Columns (1) and (3) already present marginal effects at the mean. The specifications of Columns (2) and (4) present coefficients from a two stage maximum likelihood estimation with one endogenous regressor, the respective marginal effect for our regressor of main interest, that is, *Actual age at entrance (in months)*, is reported in Section 4. Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 5
Reduced Form Results

	(1)	(2)	(3)	(4)
Theor. age at entrance	–0.009**	– 0.021*	–0.009**	–0.031**
	(0.004)	(0.011)	(0.004)	(0.015)
Speaking German with the child	0.058	–0.354**	–0.142***	–0.114
	(0.049)	(0.144)	(0.049)	(0.259)
Child has siblings	0.048	–0.148	0.060	0.093
	(0.038)	(0.100)	(0.067)	(0.176)
Sex	–0.090***	0.078	–0.130***	–0.092
	(0.025)	(0.077)	(0.041)	(0.136)
Mother's highest school degree	Yes	Yes	Yes	Yes
Preschool duration	Yes	Yes	No	No
State dummies	Yes	Yes	Yes	Yes
Observations	872	867	270	292

Dependent Variables: Columns (1) and (3): Ability to form friendship (reported by the mother), binary outcome: 1=yes, 0=no; Columns (2) and (4): Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. The small discrepancies between the full sample (875 observations) and the sample sizes presented here derive from dropping the few observations where information on the respective dependent variable is missing; The probit estimations of Columns (1) and (3) present marginal effects at the mean. The specifications of Columns (2) and (4) present coefficients from an ordered probit estimation, the respective marginal effects (for our regressor of main interest, that is, *Theoretical age at entrance (in months)*, are reported in Section 3.4. Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 6
Linear Probability Models: 2SLS Results

	Whole Sample		Discontinuity Sample	
	(1)	(2)	(3)	(4)
Actual age at entrance (in months)	–0.056**	–0.081*	–0.043*	–0.100*
	(0.026)	(0.049)	(0.025)	(0.054)
Speaking German with the child	0.035	–0.190*	–0.110**	–0.098
	(0.049)	(0.103)	(0.055)	(0.167)
Child has siblings	0.036	–0.077	0.053	0.067
	(0.044)	(0.071)	(0.066)	(0.110)
Sex (male=1)	–0.071**	0.021	–0.128***	–0.060
	(0.029)	(0.052)	(0.041)	(0.090)
Mothers' highest school degree	Yes	Yes	Yes	Yes
Preschool duration	Yes	Yes	No	No
State dummies	Yes	Yes	Yes	Yes
Observations	872	867	295	292

Dependent Variables: Columns (1) and (3): Ability to form friendships (reported by the mother), binary outcome: 1=yes, 0=no; Columns (2) and (4): Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. All columns report second stage results of a 2SLS regression. Robust standard errors in parentheses. Significance levels: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table 7
Linear Probability Models: Reduced Form Results

	Whole Sample		Discontinuity Sample	
	(1)	(2)	(3)	(4)
Theoretical age at entrance	–0.009**	– 0.013*	–0.008*	–0.019*
(in months)	(0.004)	(0.007)	(0.005)	(0.010)
Speaking German with the child	0.054	–0.225**	–0.119**	–0.073
	(0.047)	(0.093)	(0.057)	(0.168)
Child has siblings	0.043	–0.088	0.054	0.063
	(0.039)	(0.063)	(0.067)	(0.111)
Sex (male=1)	–0.088***	0.049	–0.130***	–0.058
	(0.025)	(0.048)	(0.042)	(0.088)
Mothers' highest school degree	Yes	Yes	Yes	Yes
Preschool duration	Yes	Yes	No	No
State dummies	Yes	Yes	Yes	Yes
Observations	872	867	295	292

Dependent Variables: Columns (1) and (3): Ability to form friendships (reported by the mother), binary outcome: 1=yes, 0=no; Columns (2) and (4): Assertiveness of the child (reported by the mother), Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. All columns report results from linear probability models. Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 8
Robustness Check: Alternative Cut-off

	Reduced Form Results			
	Non-linear models		Linear models	
	(1)	(2)	(3)	(4)
Theoretical age at entrance	–0.014***	– 0.016	–0.013**	– 0.010
(in months)	(0.005)	(0.016)	(0.005)	(0.010)
Speaking German with the child	0.083	–0.429**	0.063	–0.270*
	(0.070)	(0.218)	(0.063)	(0.143)
Child has siblings	0.117*	–0.262*	0.103*	–0.160*
	(0.063)	(0.153)	(0.062)	(0.096)
Sex (male=1)	–0.108***	0.186	–0.102***	0.114
	(0.036)	(0.113)	(0.036)	(0.071)
Mothers' highest school degree	Yes	Yes	Yes	Yes
Preschool duration	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes
Observations	408	422	426	422

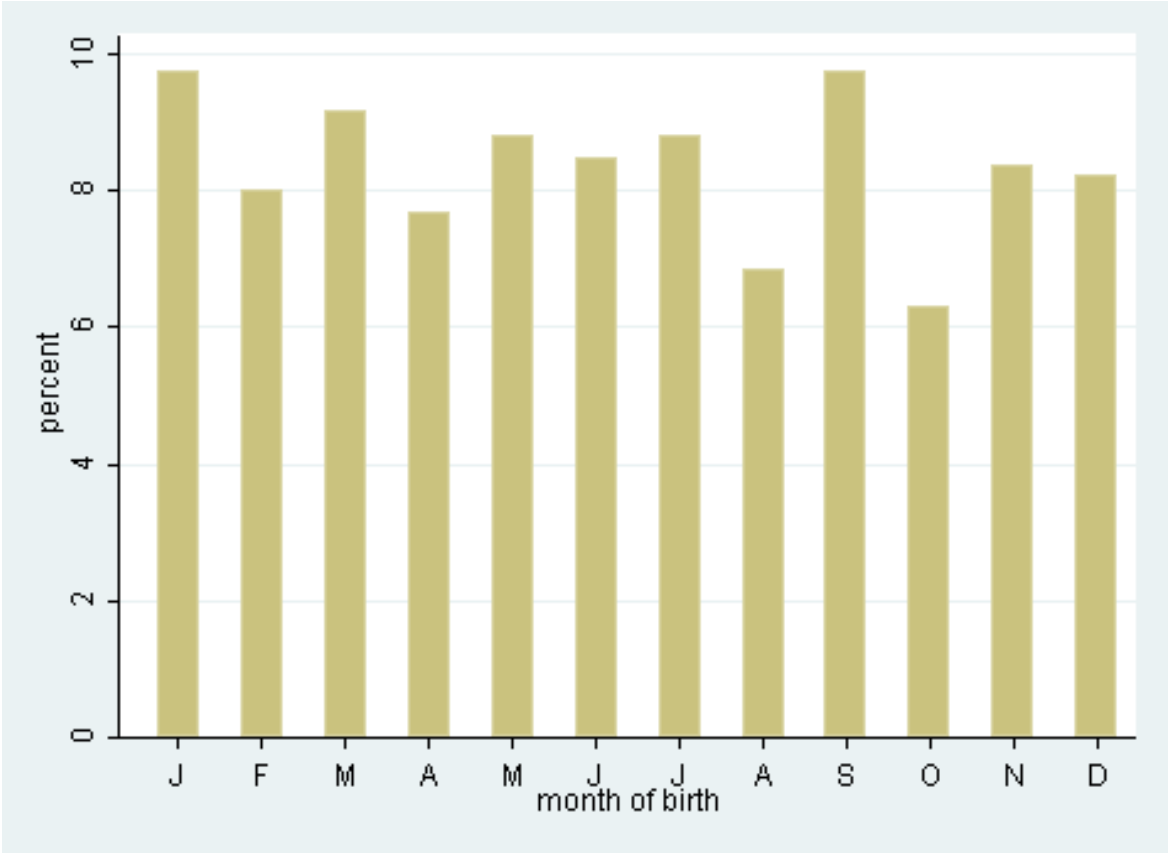
Dependent Variables: Columns (1) and (3): Ability to form friendships (reported by the mother), binary outcome: 1=yes, 0=no; Columns (2) and (4): Assertiveness of the child (reported by the mother), categorical variable: 1=not assertive at all to 4= assertive. The sample only includes children born from May to July 1997 and from October to December 1996. Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table 9
First Stage Results: Placebo Cut-off in March

	Children born February 1997—May 1997 (1)	Children born January 1997—June 1997 (2)
Theoretical age at entrance (in months)	–0.182***	–0.295***
	(0.013)	(0.015)
Speaking German with the child	–0.017	–0.015
	(0.019)	(0.019)
Child has siblings	–0.004	–0.000
	(0.014)	(0.016)
Sex (male=1)	–0.009	–0.004
	(0.011)	(0.011)
Mothers' highest school degree	Yes	Yes
State dummies	Yes	Yes
Observations	294	453

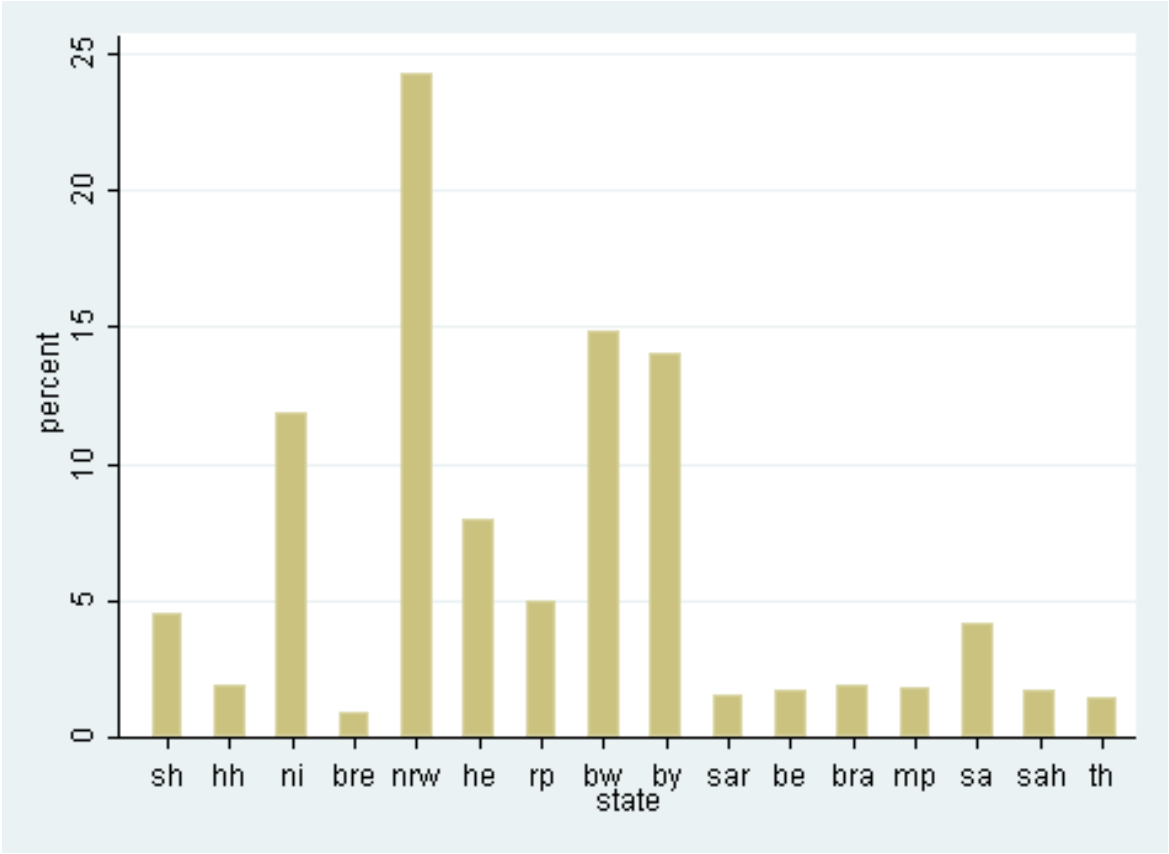
Dependent Variable: Actual age at preschool entrance (in months). Robust standard errors in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Figure A1
Sample Distribution by Month of Birth



Children by month of birth. Data: Children's Panel of the German Youth Institute (DJI-Kinderpanel). Own Calculations.

Figure A2
Sample Distribution by State



Children by German states of residence: sh=Schleswig-Holstein, hh=Hamburg, ni=Lower Saxony, bre=Bremen, nrw=North Rhine Westphalia, he=Hessen, rh=Rhineland Palatinate, bw=Baden Wurttemberg, by=Bavaria, sar=Saarland, be=Berlin, bra=Brandenburg, mp=Mecklenburg-West Pomerania, sa=Saxony, sah=Saxony Anhalt, th=Thuringia. Data: Children's Panel of the German Youth Institute (DJI-Kinderpanel). Own Calculations.

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