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Are economic preferences shaped by the family context? The relation of birth order and siblings' gender composition to economic preferences

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Abstract

The formation of economic preferences in childhood and adolescence has long-term consequences for life outcomes. We study in an experiment how both birth order and siblings' gender composition are related to risk, time, and social preferences. We find that second-born children are typically less patient, more risk-tolerant, and more trusting. However, siblings' gender composition interacts importantly with birth order effects. Second-born children are more risk-taking only with same-gender siblings. In mixed-gender environments, children seem to identify with the gender stereotype that boys are much more willing to take risks than girls, irrespective of birth order. For trust and trustworthiness, birth order effects are larger with mixed-gender siblings. Only for patience, siblings' gender composition does not matter.

Keywords Birth order · Siblings' gender composition · Economic preferences · Experiment

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1 Introduction

Economic preferences largely shape the outcomes of one's life. For instance, time preferences are related to school performance and thus educational achievements, implying that they affect labor market outcomes and lifetime income (Alan & Ertac, 2018; Backes-Gellner et al., 2021; Castillo et al., 2011; Golsteyn et al., 2014; Heckman et al., 2006; Moffitt et al., 2011). Risk preferences have an influence on financial behavior (Meier & Sprenger, 2010, 2013), and social preferences, like trust and reciprocity, are important for labor market success or the functioning of markets (Fehr et al., 1993; Kerschbamer et al., 2017; Knack & Keefer, 1997; Kosse & Tincani, 2020; Zak & Knack, 2001).

Promoting a better understanding of the formation of economic preferences promises to provide insights into the sources of heterogeneity in economic preferences and lifetime outcomes among subjects, and therefore also reveals potential anchor points for policy interventions to mold economic preferences. While some studies show that the variation in economic preferences can at least partly be explained by genetic variation (Cesarini, 2009; Zyphur et al., 2009), large parts of differences in economic preferences still require additional explanations that are related to different environments in which subjects grow up and make economic choices. Besides looking at the influence of schools and peer groups, the impact of the family has naturally captured particular attention in the literature. For instance, several studies have addressed the influence of the socio-economic status of parents on children's economic preferences, typically finding that higher socio-economic status of parents goes along with more patient children who are also more risk-tolerant, more often prosocial and more competitive (Dohmen et al., 2012; Kosse & Pfeiffer, 2012; Bauer et al., 2014; Almås et al., 2016; Falk et al., 2021; Chowdhury et al., 2022). While acknowledging the influence of parents, it is straightforward to hypothesize that siblings may have an impact on each other as well.

In fact, there is rich and influential literature showing that birth order and siblings' gender composition affect *outcomes*. For example, later-born children have lower IQ (Bjerkedal et al., 2007; Black et al., 2011), lower non-cognitive abilities (Black et al., 2018), lower education (Black et al., 2005; Booth & Kee, 2009; Härkönen, 2014), higher mortality risks (Barclay & Kolk, 2015; Modin, 2002), they earn less (Behrman & Taubman, 1986; Björklund & Jäntti, 2012; Kantarevic & Mechoulan, 2006), are more likely to smoke (Argys et al., 2006; Black et al., 2016) and are more likely to be disciplined in school and enter the criminal justice system (Breining et al., 2020). Mixed-gender dyads of siblings lead to more gender-stereotypical college major specialization (Anelli & Peri, 2015), more traditional gender norms (Brenøe, 2022), and more pronounced gender differences in labor market outcomes (Brenøe, 2022; Peter et al., 2018). Moreover, the development of cognitive skills and educational attainment is substantially influenced by older siblings (Dai & Heckman, 2013; Joensen & Nielsen, 2018).

Interestingly, there is not so much evidence (in particular in economics, less so in psychology) on how birth order *and* siblings' gender composition affect *economic preferences*, although the latter have an impact on economic outcomes and might help to explain the origins of differences in outcomes between siblings. Moreover, the related literature on economic preferences—discussed below in more detail—typically focuses on birth order effects and puts little emphasis on siblings' gender composition (that refers to whether siblings have the same gender or are of different genders).

Siblings—and thus birth order and the gender composition of siblings—can be expected to have an impact on economic preferences because siblings compete for parental attention. As a consequence, children may differentiate their behavior from siblings' behavior to capture more parental attention (Hertwig et al., 2002; Sulloway, 1996). Thereby, differentiation could either be driven by birth order position or gender differences. Yet, besides this tendency to show different behavior than one's siblings, siblings may also have the opposite effect of assimilating behavior, because siblings can learn from each other through imitation (Rust et al., 2000). The extent of learning may depend on the gender of one's sibling, however, as learning may be more intense from a same-gender sibling than an opposite gender sibling. Overall, birth order and sibling's gender composition may therefore affect economic preferences by either potential imitation and/or differentiation (Whiteman et al., 2007), and it is ex-ante not clear how birth order and sibling's gender interact.[1]

In the present paper, we are going to study how birth order and siblings' gender composition are related to three key domains of economic preferences, namely time, risk, and trust preferences. A major contribution of this study is to disentangle the effects of birth order and of siblings' gender composition and, in particular, to investigate whether these effects also interact with the own gender of the child. We present an experiment in which 525 adolescents in 10th grade and an average age of 16 years participated. The experiment was run during regular school hours, thus minimizing drop-outs and self-selection issues. The experimental elicitation of time, risk, and trust preferences was incentivized, and questionnaire data allows us to relate experimental choices to the family context, in particular to both birth order and siblings' gender composition.

We focus in our study on adolescents and do this for several reasons. First, this age is of immense practical importance and of scientific interest, as it is right at the border between having to accept the decision of one's parents and making one's own (significantly influential) life decisions for the first time. Second, adolescence is a phase in life that sets the cornerstone for life outcomes such as educational choices, or the creation of habits that are known to be hard to change once acquired (like smoking, drinking, or an unhealthy diet).[2] Third, adolescents are still integrated into their family context and, therefore, the family composition should not be diluted by later developments in life after leaving the parents' house. Fourth, work on siblings' role in gender development suggests that the differentiation of siblings (in relation to

[1] From a theoretical point, birth order effects might only be present in single-sex environments as children only differentiate by birth order in that environment. That might also be the reason why many studies find birth order effects, as they focus specifically on all men samples (Black et al., 2018; Sulloway & Zweigenhaft, 2010). If both genders are present among siblings, it might be that birth order effects are not found anymore, since differentiation, as argued by us, is different in mixed-gender environments compared to single-gender environments.

[2] For example, smoking during adolescence, even infrequently, is a highly significant predictor of later regular smoking, up to the point that those who did not smoke during adolescence will most likely never start smoking (Buchmann et al., 2011).

other siblings) sets in during adolescence as youths focus on developing their unique identities (Grotevant, 1978; McHale et al., 2001).

The broad set of economic preferences investigated here, the opportunity to speak to both the importance of birth order and siblings' gender composition, as well as their interaction, and the ability to disentangle the relative effects of both factors sets our paper apart from previous studies.[3] In general, research in economics regarding birth order, siblings' gender composition, and economic preferences is still limited.[4] A first strand of studies focuses on the influence of the family context on economic preferences. Dohmen et al. (2012) show that firstborn children are more similar to their parents in terms of risk preferences than later-born children, while the evidence for time preferences is mixed (e.g., Andreoni et al., 2019; Kosse & Pfeiffer, 2012). A second strand of literature focuses on field behavior or non-incentivized survey items finding mixed evidence with regard to birth order or sibling's gender. Analyzing field behavior data, later-born children have been found to be less risk-averse than firstborns (Gilliam & Chatterjee, 2011; Sulloway & Zweigenhaft, 2010; Yiannakis, 1976). Using a large Swedish survey sample of adults, Lampi and Nordblom (2011) relate both time and risk preferences to birth order, finding that later-born children are less patient than firstborns. Conzo and Zotti (2020) use the British Household Panel Survey and a self-reported measure for trust and find a negative effect of birth order on trust, with later-borns trusting less than their older siblings. Dudek et al. (2022) study the impact of the sibling's gender on risk, time, and trust preferences, using large samples from nine countries that include both adolescents and adults. They find overall no effect of the sibling's gender on economic preferences. The measurement of economic preferences was in all these cases hypothetical and not incentivized, however. Moreover, the analysis by Lampi and Nordblom (2011) and Conzo and Zotti (2020) did not take into account the siblings' gender composition, while Dudek et al. (2022) focus only on the sibling's gender, and not on any order effects. The third strand of literature that investigates birth order effects uses incentivized experiments and is therefore most relevant for our study. The evidence presented in Courtiol et al. (2009), Okudaira et al. (2015), Lejarraga et al. (2019), and Rohrer et al. (2017) does not perfectly align with each other. Courtiol et al. (2009) found in a sample of French students that firstborn children are less trusting and reciprocate less than later-born children in a standard investment game (Berg et al., 1995). On the contrary, Lejarraga et al. (2019) used self-reported and incentivized measures for risk-taking and found no effect of birth order on risk preferences. Rohrer et al. (2017) also reported no meaningful effects of birth order on risk-taking, patience, trust, and reciprocity, having incentivized measures for a subsample of their study. In comparison to our paper, none of these studies

[3] Black et al. (2018) study the effects of birth order and siblings' gender composition on personality traits and non-cognitive skills. Our focus on economic preferences sets our work apart from theirs.

[4] There is a wide range of literature in psychology discussing the effect of birth order on personality traits, like Big Five personality traits. The literature so far seems to have produced mixed results. Some studies point in the direction that birth order has no effect on personality traits (Boccio & Beaver, 2019; Damian & Roberts, 2015; Dudek et al., 2022; Rohrer et al., 2015). However, Goldsteyn and Magnée (2020) find an effect of the sibling's gender on agreeableness for a British sample of adolescents, while Dudek et al. (2022) find overall no effect of the sibling's gender using data combined for adolescents and adults for nine countries.

related their findings to siblings' gender composition, which may, however, interact with birth order effects for the reasons laid out above. Furthermore, while we studied adolescents for the reasons explained above, Courtiol et al. (2009) let adult university students participate in their study, and Lejarraga et al. (2019) and Rohrer et al. (2017) both studied the adult population in the German Socio-Economic Panel (GSOEP). Okudaira et al. (2015) examined competitive behavior and reported no birth order effects. Yet, they found that the siblings' gender composition matters. In their Japanese high school sample, men with older sisters were less competitive than men with older brothers. In our paper, we consider a different and larger set of economic preferences by focusing on risk, time, and trust preferences.

We find that birth order is related to all three preferences. Moreover, the siblings' gender composition is significantly correlated with trust and risk preferences, which constitutes a novel insight. Firstborn children are in general more patient and trust less than second-born children. However, while patience is independent of the siblings' gender composition, trust increases for boys in mixed-gender families. Additionally, second-born children are significantly more risk-taking when all siblings have the same gender. In the case of mixed-gender siblings, children vary in their risk preferences with regard to gender: Boys are more risk-taking in mixed-gender families, but there is no birth order effect, implying that the siblings' gender effect dominates any potential birth order effects. Additionally, we find that spacing between first and second-born children interacts differently with birth order and siblings' gender composition effects.

In the following section, we present a conceptual framework and potential mechanisms. We show that different theories have rather conflicting implications for the relation between birth order, siblings' gender composition, and preferences. In Section 3, we introduce the experimental design of our study. Section 4 presents our results in detail. Section 5 discusses the results and relates them in particular to the theoretical framework. Section 6 concludes the paper.

2 Conceptual framework

Birth order position and siblings' gender composition may affect economic preferences mainly for two reasons. First, parental investments differ among siblings, and, second, the presence of siblings also influences the development of children. The direction of the effect of both mechanisms is ex-ante not clear and might lead to opposing effects on the development of preferences such that one can get partly contradicting predictions. This shows that the relation between birth order position and siblings' gender composition to economic preferences is interesting from both an empirical and a theoretical point of view and that both—birth order and siblings' gender composition—should be taken into account simultaneously. In the following, we describe how both mechanisms can influence the development of preferences and which effects we expect from this influence.

With respect to the differing parental investment among siblings, Sulloway (1996) stressed that firstborn children usually have access to more family resources than later-born ones, in particular so if the spacing between firstborn and second-born children is larger. For example, it has been shown that firstborn children spend more quality time with their parents than second-born children, even when parents try to divide their time equally between their offspring (Hertwig et al., 2002; Price, 2008). They also benefit from an early absence of sibling rivals for a share of parental investment (Jacobs & Moss, 1976), including higher parental human capital investments (Black et al., 2018). Additionally, parents' level of cognitive support and their disciplinary restrictions decline with birth order (Hotz & Pantano, 2015). Lehmann et al. (2018) also observed systematic differences in maternal behavior during pregnancies and in the first year of children's lives and a broad shift in maternal attitudes and behavior toward their later-born children. Not only birth order has an impact on parental treatment, but also the siblings' gender composition is important. In general, it has been found that the involvement of parents differs according to the child's gender (e.g., Brenøe & Epper, 2022). Some find that parents favor the child of their own gender such that mothers spend the least time with their children if they have only boys (Crouter et al., 1995; McHale et al., 2000). This differentiated parental treatment is especially apparent in mixed-gender dyads of siblings, where mothers and fathers tend to spend relatively more time with the child of their own gender and their treatment tends to differ more between boys and girls. Gender-specific treatment can lead to an enforcement of gender socialization and gender stereotypical behavior of children, which is more pronounced in mixed-gender dyads. It has been shown, for example, that boys who spend more time with their fathers comply more with gender stereotypes (Lawson et al., 2015) and that girls with brothers do on average more housework (Crouter et al., 1999; McHale et al., 1999, 2000).

As a second mechanism, in addition to the differentiated parental investment, the presence of siblings as such plays an important role in child development. Children react to siblings and do this, broadly speaking, in two different ways (e.g., Whiteman et al., 2007). First, children compete as aforementioned over parental attention. To reduce direct competition and to get a share of parental time children try to find their own niche to make it difficult for parents to compare them. This attempt to differentiate oneself from other siblings is known as de-identification (Sulloway, 1996). The de-identification process can depend on the birth order (Sulloway, 1996) and is in general more pronounced if siblings have different gender (Feinberg et al., 2003). Second, children learn from their siblings and copy their behavior, making for example girls with brothers more masculine and boys with sisters more feminine (Rust et al., 2000). This process can be especially important for younger siblings due to the tendency of imitating higher-status models (Joensen & Nielsen, 2018; Rust et al., 2000) and for same-gender dyads due to higher intimacy (e.g., Buhrmester, 1992; Hetherington, 1991; Tucker et al., 1997). Social learning increases the likelihood that children who have an older sibling of the other gender have less stereotyped gender role concepts (Rust et al., 2000; Stoneman et al., 1986).

Differential parental investment and siblings' interaction mechanisms could have a potentially different impact on the formation of economic preference. They could either be additive or subtractive, and it is therefore important to investigate the effect of both combined. In our study, we focus on time preferences, risk preferences, trust, and trustworthiness as these preference domains have a large impact on field behavior (e.g., Kosse & Tincani, 2020; Sutter et al., 2013). In Appendix C we show that also in our sample there is a significant correlation between economic preferences and field behavior. Here, in the main paper, we focus on birth order and siblings' gender composition effects, however, and put field behavior aside. For birth order, the finding that firstborn children tend to spend more quality time with their parents (Price, 2008) and, therefore, to conform more with parental values than their younger siblings (Sulloway, 1995, 1996), suggests that the impact of the parents' preferences is stronger for firstborn children than for second borns. Additionally, firstborn children may receive more parental resources by occupying the niche of a surrogate parent (Sulloway, 2001). In the case of time preferences, this would lead to firstborn children being more patient than their younger siblings given that adults have been found (in Western societies) to be in general more patient than adolescents (Lahav et al., 2010). This effect would be augmented if second-born children followed the aspect of de-identification or attenuated if social learning dominated. Also, for risk preferences, it can be expected that due to differential parental investment the impact of parents' preferences is stronger for firstborn children than for second borns. Indeed, Dohmen et al. (2012) found that firstborn children are more similar to their parents in terms of risk preferences than later-born ones. As the willingness to take risks decreases with from childhood to adolescence (Sutter et al., 2019), firstborn children should therefore be relatively risk-averse while second-born children should be more risk-tolerant due to de-identification. Compared to time and risk preferences, social learning is a particularly important mechanism for trust behavior. Children learn from their siblings, especially younger siblings from their older siblings (Rust et al., 2000). Older brothers and sisters are more likely to reciprocate than younger children and thus younger siblings experience more instances of positive reciprocity than do older siblings (Hardin, 2001) and therefore learn from these role models. This is in line with the finding that trust and trustworthiness increase from early childhood to early adulthood and that children trust older children, in general, more than children of their own age (Sutter & Kocher, 2007).

The impact of the gender composition of siblings on economic preferences depends on the potential gender differences in given economic preferences and stereotypical assumptions about these preferences. Time preferences show in general no clear pattern with regard to the gender of the child.[5] Therefore, parental behavior should not be different in this matter, nor should social learning and de-identification differ between single-gender and mixed-gender siblings.

However, risk preferences have been found to differ between boys and girls (Cárdenas et al., 2012; Croson & Gneezy, 2009; Falk et al., 2021) and parents have been found to differ in their treatment of girls and boys, especially in the encouragement of gender-typed activities (Lytton & Romney, 1991). We, therefore, presume that the results in families with single-gender or mixed-gender siblings will be different. First, studies found that the de-identification process is more pronounced with mixed-gender siblings compared to same-gender siblings (Feinberg et al., 2013). So, children in families with mixed-gender siblings might rather try to differ from their siblings by acting in line with the gender stereotype than by differing with respect

[5] For example, Dohmen et al. (2010) and Falk et al. (2018) found that boys are more patient than girls, while studies by Bettinger and Slonim (2007) and Castillo et al. (2011) found that girls are more patient than boys.

to birth order, implying that girls will tend to be more risk-averse and boys more risk-seeking, independent of their birth order position. Moreover, and in contrast to the previous effect, studies show that children copy their siblings' behavior (e.g., Koch, 1956; Sutton-Smith & Rosenberg, 1970). Therefore, gender differences could be smaller with mixed-gender siblings as boys and girls converge in their behavior under these circumstances.

For trust, the impact of the social learning process might differ with regard to the gender composition of siblings. While men trust in general more, women reciprocate more (Buchan et al., 2008). So, if boys have sisters, they learn that they can trust (their sisters) and be trustworthy, while girls with brothers learn the opposite. Therefore, we expect to find differences in the trust level between mixed-and single-gender siblings.[6]

3 Experimental design

Our study was carried out in 27 classes from eight secondary schools in the German state of Schleswig-Holstein, including 525 students who were all attending 10th grade in school.[7] The schools included three different types of secondary schools that vary in level and length of schooling.[8] Having different school types offered us the possibility to get students with different socio-economic and intellectual backgrounds. The study was approved by the Ministry of School and Professional Education of Schleswig-Holstein and the principals and teachers of the participating schools gave permission to conduct the experiments during regular school hours. Parents were informed about the experiment and also gave their permission. Participation of students was, of course, also voluntary, but none opted out.

[6] The hypotheses were not-preregistered as it was not common to do so in 2015 when the experiments were conducted.

[7] The results reported here were part of a larger study in which in addition to the discussed experiments a social preference task and a lying game were administered. Results of these experiments, that included further variables of interest for the specific project, are reported elsewhere (see Lima de Miranda, 2019). Generally, the inclusion of further experiments in our design should not have had an impact on our results as we used the random-selection payment methods and also randomly ordered the sequence of experiments to delete order effects.

[8] The school types are Gymnasium (3 schools), Gemeinschaftsschule (3 schools), and Regionalschule (2 schools). Since 2014, the education act of Schleswig-Holstein (Schleswig-Holsteinisches Schulgesetz) intends a two-tier secondary education system with community schools (Gemeinschaftsschule) and academic high schools (Gymnasium), which start after four years of elementary school. We also have two regional schools (Regionalschule) in our sample, a school type that was discontinued after 2019. The main differences between the different school types are the following. In a community school all educational qualifications of secondary education can be acquired in a common educational framework. This is the first general education qualification ("Erster allgemeinbildender Schulabschluss") after the 9th grade, the "Mittlere Reife" after the 10th grade, which both qualify for vocational training, and in addition the "Abitur" after the 13th grade, qualifying for university admission. High schools prepare students for higher education. In the majority of high schools, students can achieve their "Abitur" after the 13th grade. Regional schools terminate after the 10th school year, thus they cannot qualify for university admission. Information from this paragraph is based on the state's website (Landesportal Schleswig-Holstein, 2017).

The experiment was computerized, using the mobile Kiel Econ Lab and z-tree (Fischbacher, 2007). Experimental sessions were conducted with up to 25 participants per session in dedicated classrooms and lasted about 45 minutes. Since the experiment was run during regular school hours, we minimized dropouts and self-selection. All students got the same set of explanations, decision tasks, questionnaires, and payoff structures. Inside a classroom, all students faced the same sequence of decision tasks, but the sequence was randomized across classes in order to account for possible order effects. The experiment was incentivized and each subject was paid according to her or his choices. At the end of an experimental session, one decision task was randomly selected to become payment relevant for the entire classroom. Each student was paid according to her or his choice in that task. It was explained that the choices were anonymous and that payments would be handed out in sealed envelopes, which one experimenter would prepare and another experimenter would distribute to the participants in a double-blind procedure. Payments were on average €4.32.[9] Students were directly paid in cash,[10] except if future payments became necessary in the time preference task, in which case a sealed envelope was handed to the teacher who was instructed to hand it to the according subject on the determined date in the future. The teachers had no information regarding the task and could therefore draw no inference about the behavior of the children.

3.1 Time preferences

Time preferences were elicited through a choice list of 20 binary choices (similar to the lists used in Bettinger & Slonim, 2007, or Sutter et al., 2013, who also worked with children and who reported a good understanding of children). In the list presented in Table 1, subjects were asked to choose between a payment today and a payment in three weeks. The early payment remained fixed at €4.00 and the delayed payment increased monotonically in €0.10 steps from €4.00 to €5.90. To calculate the future equivalent, we take the switching point between the last immediate payment and the first delayed payment. The choice lists were designed so that it was impossible to switch more than once from the left to the right-hand side in each list, a procedure that has been used in other experiments as well (e.g., Dohmen et al., 2010). In the example in Table 1, the future equivalent would be €4.25. Higher levels of the future equivalent indicate a higher level of impatience.

[9] Students could earn up to €10 in the experiment. This equals their average weekly pocket money.

[10] We were able to pay all children in cash, except for one school. In this school, the children could earn coupons for the cafeteria, which was perceived as equivalent to cash because students could spend their coupons on whatever they liked in the canteen, for example lunch or sweets.

Table 1 Example: Choice list for time preferences

1)	€4.00 today	☒	or	€4.00 in 3 weeks	☐
2)	€4.00 today	☒	or	€4.10 in 3 weeks	☐
3)	€4.00 today	☒	or	€4.20 in 3 weeks	☐
4)	€4.00 today	☐	or	€4.30 in 3 weeks	☒
5)	€4.00 today	☐	or	€4.40 in 3 weeks	☒
…	…		…	…	
20)	€4.00 today	☐	or	€5.90 in 3 weeks	☒

3.2 Risk preferences

We elicited risk preferences by using the design of Eckel and Grossman (2002). This design has been shown to be easy to understand for a broad range of socio-economic groups with diverse mathematical skills (Dave et al., 2010), making it suitable also for our study with children. The students had to choose one out of the six lotteries that are displayed in Fig. 1. In each lottery, the chances to win a high or low prize were equal to 50%. The lotteries increased in risk and expected value, starting from the top of Fig. 1 with a sure gain of €4 and continuing in clockwise order to the two last lotteries with an expected value of €5. Overall, risk aversion decreased from the first to the last lottery. Note that the two last lotteries had the same expected value, but the lottery with prizes of €9 or €1 was riskier than the penultimate one with prizes of €8 or €2. For the analysis, the lottery at the top will be coded as Lottery 1, and the following lotteries in clockwise order as lotteries 2–6. Higher lottery numbers imply therefore more risk-taking.

3.3 Trust and trustworthiness

Trust and trustworthiness were elicited with the investment game by Berg et al. (1995). Both players in this game were endowed with €2 in the beginning. The sender could then transfer an amount between €0 and €2 to the receiver. The transfer was tripled and the receiver could return any amount between zero and the tripled transfer to the sender. Participants played in both roles (strategy method). If this game became payout relevant, one of the two decisions was randomly selected and paid out.

3.4 Further variables of interest

In addition to the experimental tasks on time, risk, and trust preferences, the subjects had to solve ten Raven's matrices as an indicator for fluid intelligence. At the

Fig. 1 Risk preference task

Lottery	Payoff 1 (50%)	Payoff 2 (50%)
1	€4.00	€4.00
2	€5.00	€3.50
3	€6.00	€3.00
4	€7.00	€2.50
5	€8.00	€2.00
6	€9.00	€1.00

end of the experiment, a questionnaire with demographic questions as well as questions regarding individual field behavior was administered (see Appendix A for all items). Demographic questions included age, gender, height, weight, number of siblings, age of siblings and siblings' gender, as well as information about their parents. Furthermore, the socio-economic background was measured with the family affluence scale (FAS) (Currie et al., 1997), which has been specially developed for children and builds on self-reported information on a subject's household (own room, holidays, number of books, cars, and computers). Higher levels thereby indicate a higher socio-economic background (Boyce et al., 2006).

4 Results

Table 2 presents an overview of the descriptive statistics and the experimental choices. In our complete sample of 525 students, 50.3 percent are male. The average age is 15.95 years and 40 percent of students attend an academic high school ("Gymnasium"), which matches the German average of 40 percent (Statistisches Bundesamt (Destatis), 2019). On average, the students have 1.51 siblings (1.16 biological siblings); 12.57 percent of them are only children, 47.81 percent have one sibling and 23.81 percent have two siblings. Of those who have siblings, 39.22 percent are firstborn, 38.13 percent are second-born, 15.47 percent are third-born, and 7.19 percent are fourth- or later-born children.

The gold standard for analyzing birth-order effects is the data collection from siblings of the same family and the employment of family-fixed effects such that results are driven by within-family variation only (Black et al., 2005). This procedure has two key advantages: (i) The correlation between birth order and family size (which, in turn, is correlated with various other aspects of family background) does not bias results and (ii) it reduces noise in the data analysis if the family background has a systematic impact on all siblings of one family. Since we usually only have an observation from one child of a family, the employment of family-fixed effects is impossible with our data. In order to address the problem (i), we base our analyses not only on (a) the complete sample but also on (b) a restricted sample with families with two and three children only in which we solely consider first and second born children. Potential endogenous selection into family size should be controlled in the restricted sample (b) such that results seem to be unbiased.[11] Point (ii) does not challenge the validity of our results as long as our second-born children do not come by chance systematically from different family types than our firstborn children, which seems unlikely. However, compared to studies employing fixed effects we potentially have more noise in our data which makes it more difficult to detect significant results.

[11] To address the problem of omitted variable bias by reducing the sample, the limit analysis of Oster (2019) was adopted for the full and restricted sample with and without controls, to check whether results remain stable in both samples. We show that this holds true for the main results on both samples. Results can be provided upon request.

Table 2 Descriptive statistics

Variable	Complete Sample					Restricted Sample (Families with 2 or 3 children)					Diff. (Prob > |z|)
	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	
Male	525	0.50	0.50	0	1	323	0.52	0.50	0	1	0.689
Age	525	15.95	0.64	15	18	323	15.93	0.65	15	18	0.681
Academic high school ("Gymnasium")	525	0.40	0.49	0	1	323	0.43	0.50	0	1	0.434
FAS	525	11.34	2.29	4	16	323	11.44	2.27	4	16	0.477
Raven test	525	7.09	1.09	0	10	323	7.09	1.15	0	10	0.912
Pocket money[a]	524	37.82	36.79	0	587	322	37.13	40.49	0	587	0.510
Mother's age at birth	524	30.37	4.77	15	48	323	45.65	4.33	32	57	0.053
Father's age at birth	521	33.07	5.6	18	60	322	48.20	5.34	35	75	0.030
No. Siblings	525	1.51	1.09	0	5	323	1.22	0.42	1	2	0.002
Spacing in years (1st/2nd)						322	3.32	2.05	0	13	
Firstborn[b]	525	0.35	0.48	0	1	323	0.50	0.50	0	1	0.000
Second-born[b]	525	0.33	0.47	0	1	323	0.50	0.50	0	1	0.000
Single-gender[c]	459	0.45	0.5	0	1	323	0.57	0.50	0	1	0.002
Experimental choices											
Future equivalent	525	4.90	0.62	4	5.9	323	4.89	0.61	4	5.9	0.814
Risk	525	2.60	1.69	1	6	323	2.71	1.73	1	6	0.373
Trust	525	1.31	0.60	0	2	323	1.30	0.60	0	2	0.784
Trustworthiness	525	0.70	0.38	0	1.69	323	0.68	0.38	0	1.69	0.628

Note: We test differences between samples by using the Wilcoxon ranksum test.

[a]Pocket money is measured in Euros per month.

[b]Fraction of children who are first, respectively, second-born (conditional on having siblings).

[c]The number of observations excludes families with only one (single) child.

Our approach yields a complete sample of 525 adolescents and a restricted sample of 323 adolescents. The summary statistics of the restricted sample are shown on the right side of Table 2.[12] Regarding the economic preferences, there are no significant differences between the complete sample and the restricted sample. The only (weakly significant) difference between the samples is found in the age of the mothers and fathers, as the children in the restricted sample have on average a younger mother/father because they are only first and second-born children. In the restricted sample 50% are firstborn and 50% are second-born, and 58% of them grew up in families with a single-gender siblings composition.[13] When examining the effect of the gender composition of siblings in the paper, we will consider in the complete sample the gender of all children and in the restricted sample only the gender of the firstborn and second-born child and classify the composition as either single-gender or mixed-gender.[14] We control in all our regressions for a set of control variables.[15] These include (1) the number of siblings, (2) monthly pocket money since it has been shown that adolescents that are used to exerting financial self-constraint due to little pocket money are more patient (Sutter et al., 2013), (3) fluid intelligence (Raven's matrices) as a proxy for cognitive abilities, (4) gender, (5) socio-economic background (FAS), (6) age of mother and father, and additionally for the restricted sample (7) spacing (between first and second-born, in years) to account for potential effects of age differences between siblings.

4.1 Time preferences

Table 3 shows the average choices in the time preferences experiment for the complete and the restricted sample.[16] The numbers in the table indicate the future equivalent, i.e., the amount of money that participants need to get in three weeks in order to give up an immediate payment of €4.00. On average, this future equivalent is €4.90 (and it is €4.89 in the restricted sample). It differs only slightly, and insignificantly, across gender with €4.86 for boys and €4.95 for girls (Wilcoxon ranksum

[12] Further summary statistics are given in Table B.1 in Appendix B, which shows that we have a balanced distribution across gender compositions.

[13] These values are statistically significantly different from our complete sample as our subsample is restricted to first and second-born children and to families with two or three children. This approach increases the probability of being classified as a single gender family.

[14] Since we also include families with three children in our restricted sample, our approach here ignores the gender of the third child, but we want to especially shed light on the difference between first and second-born children. All results are robust to other specifications.

[15] Our control variables are in line with the proposed control variables for birth order studies by Damian and Roberts (2015). All main results hold true when running the regression analyses without control variables.

[16] We restrict our analysis to the first choice list (payoff today or in three weeks) since we do not find a general pattern of present bias in our data. This is in line with other studies which reject the general presence of a present bias, in particular for field studies and immediate payoffs (Imai et al., 2021). Since the order of the time preference tasks was not randomized we analyze the first set of choices.

Table 3 Time preferences (Future equivalent, in €)

Sample		All	Boys		Girls	
			Single-gender	Mixed-gender	Single-gender	Mixed-gender
Complete sample	1st born	4.82	4.70	4.85	4.87	4.90
		(0.58)	(0.44)	(0.64)	(0.56)	(0.69)
	2nd born	4.94	4.88	4.97	4.94	4.98
		(0.65)	(0.66)	(0.59)	(0.59)	(0.75)
	All (mixed/single)		4.75	4.92	4.91	4.96
			(0.56)	(0.64)	(0.58)	(0.68)
	All	4.90	4.86		4.95	
		(0.62)	(0.6)		(0.64)	
Restricted sample	1st born	4.82	4.74	4.83	4.89	4.89
		(0.57)	(0.51)	(0.55)	(0.57)	(0.69)
	2nd born	4.96	4.93	5.04	4.98	4.91
		(0.65)	(0.66)	(0.57)	(0.62)	(0.77)
	All (mixed/single)		4.82	4.96	4.93	4.9
			(0.59)	(0.57)	(0.59)	(0.73)
		4.89	4.86		4.92	
	All	(0.61)	(0.58)		(0.64)	

Notes: Average future equivalents, i.e., the amount of money that participants need to get in three weeks in order to give up an immediate payment of €4.00, are based on the first choice list and on the complete or restricted sample, respectively. Higher values indicate more impatience. Standard deviations are given in brackets.

test: z = 1.276, Prob > |z| = 0.202). The average future equivalent for firstborn children is €4.82 and for second-born children €4.94. This difference is significant at the 10%-level (z = -1.723, Prob > |z| = 0.084).

Figure 2 presents our regression coefficients based on a Tobit regression (see Table B.2 in Appendix B), taking the standardized future equivalent (in Euros) as the dependent variable.[17] The circles and triangles indicate the complete sample. The diamonds and the squares refer to the restricted sample. The results confirm that there is no gender difference in patience. We find, however, a strong and substantial birth order effect, such that second-born children are significantly more impatient than firstborn children, particularly in the restricted sample. Being second-born increases the future equivalent by 0.282 standard deviations. In comparison, a one standard deviation change of the socio-economic background decreases the future equivalent by 0.224 standard deviations.

As we do not have a gender effect in our data, the question remains if we find differences between mixed- and single-gender siblings. In Fig. 2, we use triangles to refer to regressions with the complete sample that includes interaction terms

[17] We use Tobit regressions in our main analysis as our dependent variables are truncated on both sides and show higher densities on both ends. In Appendix D, we show that our results are robust to the use of other regression models, bootstrapping of standard errors, a triple interaction model and multiple hypothesis testing.

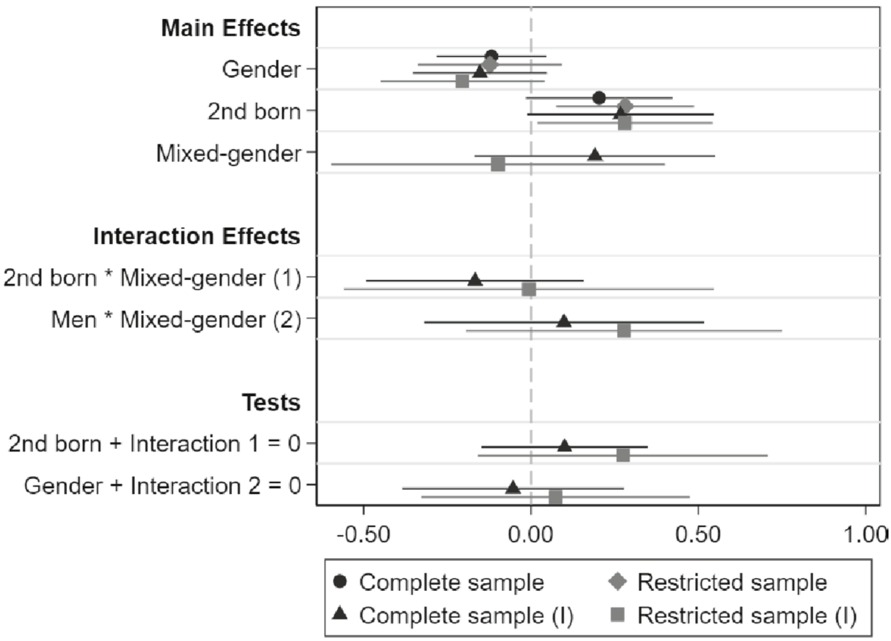

Fig. 2 Time preferences, birth order and sibling composition. *Notes*: Dependent variable is the future equivalent in Euros (std.). The circles and triangles indicate the complete sample. The diamonds and the squares indicate the restricted sample. The labels with "(I)" indicate models with interaction effects. Control variables are risk preferences (std.), spacing (between first and second-born in years (std.), number of siblings (std.), monthly pocket money (std.), cognitive reflection (raven) (std.), socio-economic background (FAS) (std.), age of mother (std.) And age of father (std.). The whiskers indicate the 95% confidence intervals. See Table B.2 in Appendix B for the full regressions

(labeled as "Complete sample (I)" in the figure), and squares for the analogous regressions with the restricted sample (labeled as "Restricted sample (I)"). There we control for interaction effects of mixed-gender composition with birth order ("2nd born*Mixed-gender") and the effect of mixed-gender composition with gender ("Male*Mixed-gender"). As we see, both interaction terms are insignificant and do not alter our birth order effect sizes. Therefore, this model shows that there is no difference between mixed- and single-gender siblings' compositions.

Besides our main interest in birth order and siblings' gender composition effects, we note from Table 2 two further independent variables that are significant for time preferences. Children from a higher socio-economic background (with a higher score in the family affluence scale FAS) are more patient (consistent with recent findings by Falk et al., 2021), children with higher pocket money are more patient, and children from families with three children are (weakly significantly) less patient than children from families with two children.[18]

[18] We also performed the main regressions restricted to biological siblings or restricted to parents who are still together in Appendix D and find qualitatively very similar and in most cases even stronger results (with respect to coefficient sizes).

Table 4 Risk preferences (average lottery number)

Sample		All	Boys		Girls	
			Single-gender	Mixed-gender	Single-gender	Mixed-gender
Complete sample	1st born	2.54	2.57	3.13	2.23	2.29
		(1.68)	(1.59)	(1.95)	(1.53)	(1.58)
	2nd born	2.81	3.13	3.6	2.45	2.08
		(1.76)	(1.77)	(1.83)	(1.64)	(1.41)
	All (mixed/single)		2.79	3.29	2.36	2.14
			(1.67)	(1.85)	(1.6)	(1.47)
	All	2.60	2.98		2.21	
		(1.69)	(1.76)		(1.52)	
Restricted sample	1st born	2.57	2.58	3.7	2.12	2.56
		(1.67)	(1.57)	(2.05)	(1.42)	(1.72)
	2nd born	2.84	3.19	3.79	2.45	1.97
		(1.77)	(1.84)	(1.76)	(1.65)	(1.27)
	All (mixed/single)		2.86	3.76	2.28	2.25
			(1.72)	(1.87)	(1.54)	(1.52)
		2.71	3.12		2.27	
	All	(1.73)	(1.8)		(1.53)	

Notes: The numbers indicate the average lottery number chosen from Fig. 1. Higher numbers imply more risk-taking. The calculations are based on the complete and restricted sample, respectively. Standard deviations are given in brackets.

4.2 Risk preferences

Table 4 presents the descriptive statistics for our risk preference experiment for the complete and the restricted sample. We show the average of the lottery number chosen from Fig. 1, where Lottery 1 yielded a sure payment of €4, while Lottery 6 had a 50:50 chance for €9 or €1. Higher lottery numbers indicate a larger willingness to take risks. Overall, we find an average of 2.6 (respectively 2.71 in the restricted sample). The average lottery number for firstborn children is 2.54, compared to 2.81 for the second-born. This difference is not significant ($z=-1.563$, $Prob>|z|=0.118$). There is a strong gender difference between boys (2.98) and girls (2.21; Wilcoxon ranksum test: $z=-5.343$, $Prob>|z|=0.000$).

The results from a Tobit regression analysis in Table B.3 in Appendix B are shown in Fig. 3. It confirms the significant differences between boys and girls in our samples (both in the complete and restricted sample)[19] and indicates only a marginally significant birth order effect for boys and girls (in the complete sample). Adding interaction effects (see the models with "(I)") shows that the sibling's

[19] Our results are robust to using alternatively an ordered Probit regression (since the lottery number as the dependent variable is an ordinal variable). In Appendix C we show that ordered Probit yields qualitatively identical results. This invariance to the regression technique also applies to the discussion of trust preferences later in this section. Furthermore, in Appendix C, we show that our results are robust to bootstrapping of standard errors, a triple interaction model and multiple hypothesis testing.

gender composition matters for risk preferences. Controlling for interaction effects of mixed-gender composition with birth order and the interaction effects of gender and gender composition (both in complete sample (I) and restricted sample (I)), we find that second-born children are significantly less risk-averse than firstborn children in single-gender compositions, while the opposite is true in mixed-gender compositions.[20] We also note that the gender effect in mixed-gender compositions[21] is significantly larger than in single-gender compositions. Thus, our results show that birth order effects in risk-taking depend on the siblings' gender composition and are particularly pronounced in the case of single-gender siblings. The effect size is comparable in size to the gender difference in risk-taking.

We also note from Table 3 that children who answer more Raven matrices correctly, and those who come from a higher socio-economic background (FAS) are in general more willing to take risks. Moreover, the spacing between first and second-born (i.e., the difference in age of the two firstborn children in years) has a decreasing effect on risk-taking.

4.3 Trust and trustworthiness

The data about trust are given in Table 5 The average amount sent is €1.31 (respectively €1.30 in the restricted sample). It differs largely between boys (€1.43) and girls (€1.2; Wilcoxon ranksum test: z = -4.770, Prob > |z| = 0.000). Comparing firstborn children (€1.23) and second-born children (€1.34) also reveals a significant difference (z = -2.694, Prob > |z| = 0.007). The Tobit regression analysis is given in Table B.4 in Appendix B, and Fig. 4 presents the coefficients. The latter supports both findings: Boys send more than girls, and second-born children send more than firstborn children in both samples (complete and restricted sample).[22]

Next, we look again at how the siblings' gender composition interacts with gender and with birth order. We note that second-born children are more trusting (i.e., send more money in the trust game) in both types of gender composition and that there is no significant difference in this birth order effect between single-gender and mixed-gender compositions. The gender effect seems to originate from the mixed-gender compositions, as the joint effect of "Male" plus "Male*Mixed-gender" is significantly different from zero. In single-gender compositions, there is only a partially significant and much smaller gender difference in trust.

Two background variables are significant in the regression in Table B.4 in Appendix B. Children who answer more Raven's matrices correctly are more trusting (which is reminiscent of findings for adults in Dohmen et al., 2010), and trust is

[20] The coefficient (–0.237) results from the addition of the coefficients of the variables "2nd born" and "2nd born*Mixed-gender".

[21] The value of the gender effect in mixed- gender compositions (1.261 and 1.531, respectively) results from the addition of the coefficients of the variables "Male" and "Male*Mixed-gender". It is significantly larger than in single-gender compositions (with 0.367 and 0.613, respectively).

[22] In Appendix D, we show that our results are robust to the use of other regression models, bootstrapping of standard errors, a triple interaction model and multiple hypothesis testing.

Table 5 Trust (amount sent as sender, in Euros)

Sample		All	Boys		Girls	
			Single-gender	Mixed-gender	Single-gender	Mixed-gender
Complete sample	1st born	1.23	1.19	1.50	1.14	1.13
		(0.61)	(0.65)	(0.57)	(0.58)	(0.55)
	2nd born	1.40	1.42	1.59	1.30	1.29
		(0.57)	(0.61)	(0.57)	(0.54)	(0.52)
	All (mixed/single)		1.32	1.57	1.21	1.18
			(0.64)	(0.57)	(0.56)	(0.56)
	All	1.31	1.43		1.20	
		(0.59)	(0.61)		(0.56)	
Restricted sample	1st born	1.21	1.24	1.4	1.19	1.02
		(0.6)	(0.64)	(0.62)	(0.57)	(0.55)
	2nd born	1.39	1.43	1.62	1.28	1.28
		(0.58)	(0.6)	(0.62)	(0.54)	(0.52)
	All (mixed/single)		1.33	1.53	1.23	1.16
			(0.62)	(0.62)	(0.55)	(0.54)
		1.3	1.39		1.21	
	All	(0.6)	(0.63)		(0.55)	

Notes: The numbers indicate the average amount sent as a sender in the trust experiment. The calculations are based on the complete sample and the restricted sample, respectively. Standard deviations are given in brackets.

reduced if the spacing (in years) between first and second-born children increases. Furthermore, it is important to note that we control for risk preferences in all four models in Table 4 since trust decisions involve a willingness to bear risk.[23] From the coefficients, one can observe that subjects who are more risk-taking tend to trust more, but it is only significant at the 10% level for Models (1) and (2).

The data about trustworthiness, here the share returned, is illustrated in Table 6 for the complete sample and the restricted sample. The average share returned is 70 percent (respectively 67.8 percent in the restricted sample).[24] We find no significant differences between boys (71 percent) and girls (69 percent; Wilcoxon ranksum test: z = -0.041, Prob > |z| = 0.967). Comparing firstborn children (6.9 percent) and second-born children (68.8 percent) also reveals no significant difference (z = 0.531, Prob > |z| = 0.595). The Tobit regression analysis in Table B.5 in Appendix B yields the same findings, and this is illustrated in Fig. 5.[25]

23 Recall that the decision on the transfer of the sender in our trust game is obviously risky since the amount sent back by the receiver to the sender is uncertain ex-ante.

24 Recall that the receiver had gotten the same endowment as the sender. Hence, if receivers return an amount that equalizes payoffs between sender and receiver (in case the initial transfer is larger than zero), then the share returned is 66.6 percent.

25 In Appendix D, we show that our results are robust to the use of other regression models, bootstrapping of standard errors, a triple interaction model and multiple hypothesis testing.

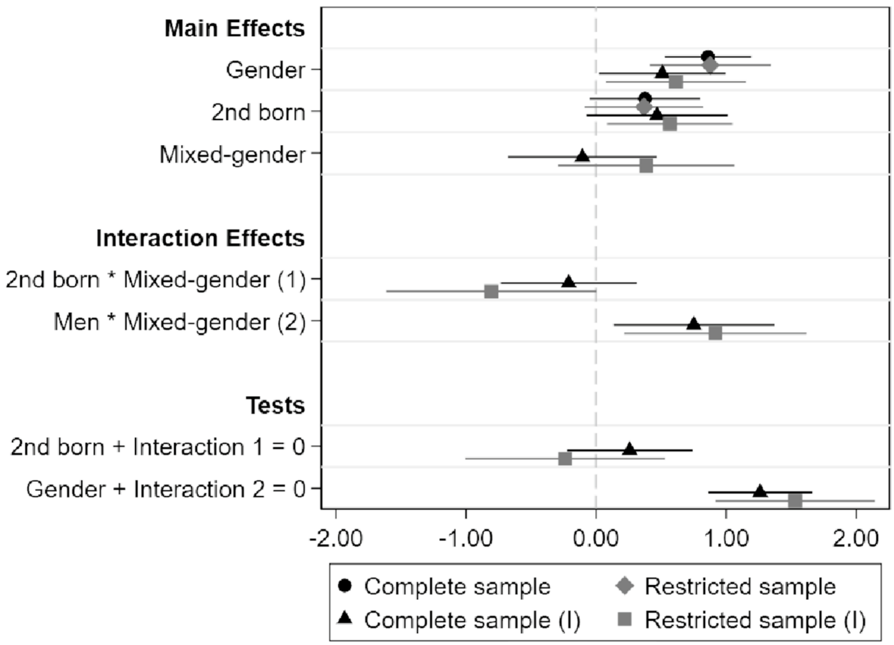

Fig. 3 Risk preferences, birth order and sibling composition. *Notes*: Dependent variable is risk preference (std.). The circles and triangles indicate the complete sample. The diamonds and the squares indicate the restricted sample. The labels with "(I)" indicate models with interaction effects. Control variables are spacing (between first and second-born, in years) (std.), number of siblings (std.), monthly pocket money (std.), cognitive reflection (raven) (std.), socio-economic background (FAS) (std.), age of mother (std.) and age of father (std.). The whiskers indicate the 95% confidence intervals. See Table B.3 in Appendix B for the full regressions

In the next step, we check again whether the siblings' gender composition interacts with gender and birth order. Figure 5, which is based on Table B.5 in Appendix B, reveals that there are differences between the cases of mixed-gender and same-gender siblings. Generally, we find that children with siblings from the opposite gender return less money (-0.318 and -0.417, respectively). We also find a significant gender effect for mixed-gender cases in our restricted sample, with girls returning less money and boys returning more money in these cases. One background variable is significant in Table B.5: Children who answer more Raven's matrices correctly are more trustworthy.

4.4 Effects of spacing between siblings

De-identification and social learning are, as argued in our conceptual framework, the drivers for the birth order effects found for time, risk, and trust preferences. To shed more light on whether these considerations are meaningful we further investigate whether spacing plays a role in our observed effects. The impact of parents on first-born children should generally increase with the spacing of children, as parents spend more time with their firstborn child if spacing increases (Price, 2008). In the case of de-identification, differences between first and second-born children should hence be

Table 6 Trustworthiness (share returned to sender)

Sample		All	Boys		Girls	
			Single-gender	Mixed-gender	Single-gender	Mixed-gender
Complete sample	1st born	0.69	0.73	0.67	0.69	0.66
		(0.37)	(0.4)	(0.4)	(0.35)	(0.33)
	2nd born	0.68	0.68	0.74	0.66	0.64
		(0.38)	(0.39)	(0.45)	(0.38)	(0.32)
	All (mixed/single)		0.71	0.73	0.71	0.67
			(0.4)	(0.42)	(0.37)	(0.33)
	All	0.7	0.71		0.69	
		(0.38)	(0.4)		(0.36)	
Restricted sample	1st born	0.68	0.7	0.62	0.72	0.59
		(0.37)	(0.4)	(0.36)	(0.36)	(0.31)
	2nd born	0.69	0.68	0.79	0.67	0.63
		(0.38)	(0.4)	(0.46)	(0.38)	(0.25)
	All (mixed/single)		0.69	0.72	0.69	0.61
			(0.4)	(0.43)	(0.37)	(0.28)
		0.68	0.7		0.66	
	All	(0.38)	(0.41)		(0.34)	

Notes: The numbers indicate the average share returned by the receiver in the trust experiment. The calculations are based on the complete sample and the restricted sample, repectively. Standard deviations are given in brackets.

specifically pronounced with larger spacing. Social learning in the case of trust preferences should also be particularly pronounced if children differ sufficiently in age. Minnett et al. (1983) have shown that there is more positive behavior of children to a widely spaced sibling, so also their birth order effects should be more pronounced if the spacing is larger. For the impact of spacing on gender composition effects, we assume that parents treat children differently as soon as a sibling with another gender arrives. So, if the spacing is larger, children exhibit less gender stereotyping, and therefore gender composition effects should be larger for smaller spacing.

Tables B.6 and B.7 in Appendix B depict our results for time, risk, and trust preferences differentiating between the spacing of fewer than three years and of three years and more for our restricted sample. We use the complete sample, restricted to first and second-born children, as we concentrate on the effect of differences in spacing between the first and second-born children, and the restricted sample. The results highlight that our birth order results are particularly pronounced and significant for spacing of three and more years for risk, time, and trust preferences. Additionally, the results reveal that gender effects are significantly larger in mixed-gender families for risk, time, and trust preferences if the spacing is smaller.[26]

[26] The results are stable when looking at each spacing separately.

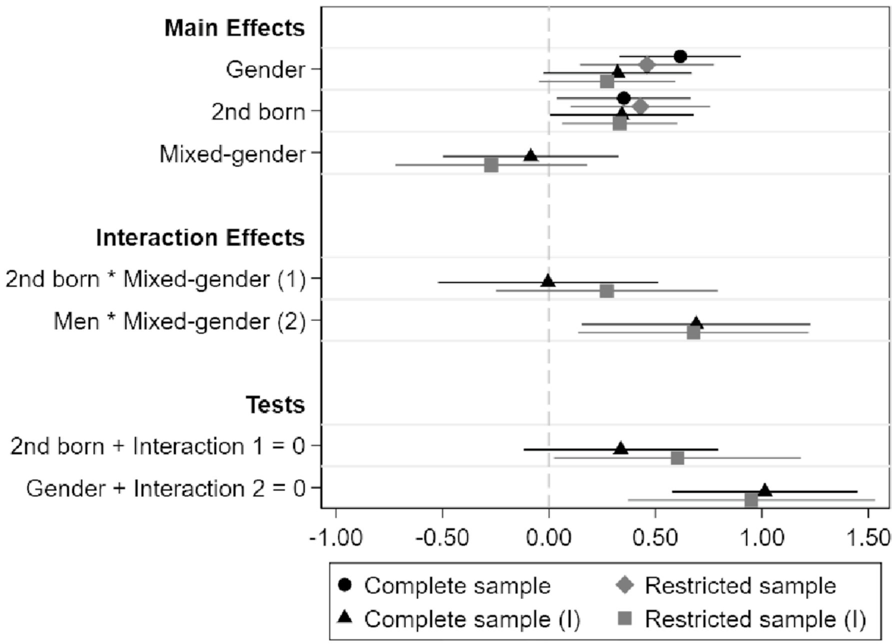

Fig. 4 Trust, birth order, and sibling composition. *Notes*: Dependent variable is the amount sent in Euros (std.). The circles and triangles indicate the complete sample. The diamonds and the squares indicate the restricted sample. The labels with "(I)" indicate models with interaction effects. Control variables are risk preferences (std.), spacing (between first and second-born, in years) (std.), number of siblings (std.), monthly pocket money (std.), cognitive reflection (raven) (std.), socio-economic background (FAS) (std.), age of mother (std.) and age of father (std.). The whiskers indicate the 95% confidence intervals. Table B.4 in Appendix B shows the full regressions

5 Discussion

Our general results for time, risk, and trust preferences match the typical patterns observed in other studies. On average, our students are risk averse and impatient—like, e.g., in studies with children and teenagers of Bettinger and Slonim (2007), Castillo et al. (2011) or Sutter et al. (2013)—and send more than half of their endowment in the trust game—like the adolescents in the study of Sutter and Kocher (2007). Our findings on gender also resemble earlier results. We find boys to be more risk-taking than girls, which is a common finding in the literature (see, e.g., Croson & Gneezy, 2009; Cárdenas et al., 2012; Sutter et al., 2019; Falk et al., 2021). In the trust game, boys are more trusting than girls and show differences with regard to trustworthiness, results that are in line with data from Sutter and Kocher (2007). With respect to time preferences, we do not observe gender differences in our sample. In this preference domain, results vary a lot, however. For instance, Dohmen et al. (2010) and Falk et al. (2021) report boys are more patient than girls, while Bettinger and Slonim (2007) and Castillo et al. (2011) present the opposite result. So, it seems that there is not yet

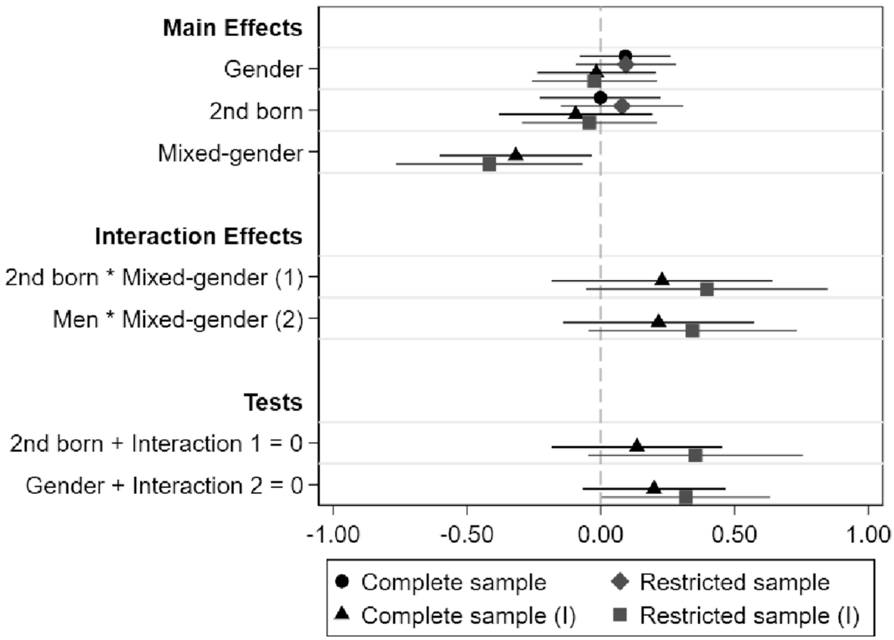

Fig. 5 Trustworthiness, birth order and sibling composition. *Notes*: Dependent variable is the trustworthiness (=amount returned/max amount possible to return) (std.). The circles and triangles indicate the complete sample. The diamonds and the squares indicate the restricted sample. The labels with "(I)" indicate models with interaction effects. Control variables are risk preferences (std.), spacing (between first and second-born, in years) (std.), number of siblings (std.), monthly pocket money (std.), cognitive reflection (raven) (std.), socio-economic background (FAS) (std.), age of mother (std.) and age of father (std.). The whiskers indicate the 95% confidence intervals. Table B.5 in Appendix B shows the full regressions

any consensus on whether gender differences in time preferences exist, and if so, in which direction. However, the effects of gender *per se* have not been at the core of our project.

Rather, the main focus of this paper is to examine the effects of birth order position and of siblings' gender composition on economic preferences. Previous studies have mainly focused on birth order only (Courtiol et al., 2009; Dohmen et al., 2012; Lampi & Nordblom, 2011; Sulloway & Zweigenhaft, 2010; Yiannakis, 1976) or on the sibling's gender (Dudek et al., 2022) and disregarded the interplay between birth order and the siblings' gender composition. According to evidence from developmental psychology—as discussed in Section 2—both birth order and siblings' gender composition can have a major influence on the development of preferences and the impact might be different for each. We, therefore, add to the existing literature by jointly analyzing the effect of birth order and siblings' gender composition as well as extending the analysis to adolescents and we improve internal validity by using incentivized experiments.[27]

Regarding *time preferences*, we find that second-born children are substantially less patient than firstborn children. This corroborates the finding that parents influence their first and later-born children differently (Dohmen et al., 2012) and lends support to the de-identification theory, which claims that siblings tend to develop different behaviors in order to be distinguishable for their parents to get more attention and resources from them. Our finding mirrors one particular result by Lampi and Nordblom (2011) who found in their survey study with adults that middle-born children—in their study typically the second-born children—are the least patient ones. In line with our assumptions, birth order effects do not depend on the siblings' gender composition and remain significant when controlling for the latter. This result is in line with the findings by Dudek et al. (2022) who find no impact of the sibling's gender on time preference.

Regarding *risk preferences*, we find only a marginally significant birth order effect between first and second-born children. At first sight, our result seems to stand in contrast to other studies that have reported a birth order effect on risk-taking (Lampi & Nordblom, 2011; Sulloway & Zweigenhaft, 2010) and seem to support findings by Lejarraga et al. (2019) and Rohrer et al. (2017). Yet, when we add the siblings' gender composition to our analysis, we see that the effect of birth order is considerably more differentiated than postulated in previous studies. Our results show that birth order effects are only significantly visible when siblings have the same gender. In such a single-gender environment, we confirm that second-born children are less risk-averse than firstborn children. In families with both girls and boys, children seem to distinguish themselves from their siblings rather via their gender than via their birth order position. Here the results point in the direction that de-identification is happening through gender, and not through birth order. Boys with sisters are more risk-taking than boys with brothers, regardless of their birth order. Our study, therefore, substantiates the finding that children are more likely to follow gender-specific stereotypes in mixed-gender environments than in single-gender ones (Lawson et al., 2015). Both effects, birth order for a single-gender environment and gender for a mixed-gender environment, fit these studies and are compatible with the theory of de-identification among siblings (Lawson et al., 2015; Lehmann et al., 2018). The results stand in contrast to the findings by Dudek et al. (2022) who find no effect of

[27] While, in general, it seems accepted in the experimental economics community that incentivized choices (as an indication of revealed preferences) are given priority over hypothetical choices (as stated preferences), there is a recent discussion about what incentivized risk preferences actually measure (see Holzmeister & Stefan, 2021, for example). The link of incentivized risk measures to field behavior has been found to be very shacky, and not robust across different ways of elicitation. Survey measures, like the ones used in Falk et al. (2023), for example, seem to have a more robust relation to field behavior. However, Schneider and Sutter (2022) have shown that the latter finding is due to hypothetical risk measures capturing not only risk aversion, but also higher-order risk preferences, like prudence and temperance. Given this debate, the benefits of incentivization in the risk preference task might be limited, but we believe this is much less of a problem with time preferences and trust (see, for example, Angerer et al., 2015, for different methods to elicit time preferences of children, with both methods yielding very similar results).

the sibling's gender on risk tolerance. The differences between their study and ours might be due to the different age structure of the samples, adults compared to adolescents, or the incentivization.

Regarding *trust preferences*, we find that second-born children send more money in the trust game than firstborn children, but return equal shares. This is in line with findings for trust by Courtiol et al. (2009) who studied students around the age of 20 and stands in contrast to the findings of Conzo and Zotti (2020), who used self-reported measures of trust in an adult sample. We additionally show that the results are also significant when risk preferences are included as a control variable and when the siblings' gender composition is considered. As discussed above, we find gender differences in trust, with boys trusting more than girls. When we add the siblings' gender composition to our analysis, we find that gender differences in trust levels are larger (and significant) in mixed-gender environments than in single-gender environments. Boys and girls with same-gender siblings send the same amount on average while boys with sisters send more than girls with brothers. This again stands in contrast to the findings of Dudek et al. (2022), who find no effect of the sibling's gender on trust. With regard to trustworthiness, we do not find a general birth order effect. Yet, including the sibling's gender composition reveals the same pattern as for trust, with boys (girls) returning more (less) money if siblings have mixed genders instead of having the same gender. This means that the development of trust and trustworthiness depends on the environment, in our case the birth order position *and* the siblings' gender composition. This finding lends support to social learning theory in the domain of trust and trustworthiness, with the underlying mechanism that boys with sisters learn that they can trust (their sisters), while girls with brothers learn the opposite.

6 Conclusion

In our paper, we focused on two aspects within the family context that may help to explain differences in economic preferences between children: birth order and siblings' gender composition. We ran incentivized experiments with several hundreds of 16-year-old tenth graders. To the best of our knowledge, our study is the first looking at birth order *and* siblings' gender composition together in a large set of economic preferences (of risk, time, and trust preferences) and investigating humans in a particularly interesting period of development, i.e., in adolescence.

We find that both aspects, birth order and siblings' gender composition, matter. Yet, the patterns we observe depend on the preference. Starting with time preferences, we find strong birth order effects, such that second-born children are less patient than firstborn children. This effect is independent of the gender composition of siblings, so it does not matter whether siblings have the same gender or not. For risk and trust preferences, however, the siblings' gender composition does make a difference, and for these two types of economic preferences, it would be misleading to only look at birth order while disregarding gender composition, or vice versa. Regarding risk preferences, children identify with the gender stereotype in mixed-gender environments where boys are much more willing to take risks than girls, irrespective of birth order. In a single-gender environment, this is not the case, and birth order generates de-identification of (same-gender) siblings. Concerning trust preferences, we find that second-born children send more money in the trust game than firstborn children in both types of siblings' gender composition, but that the gender differences in trust and trustworthiness are larger in mixed-gender than in single-gender environments.

Our results are important in three different ways. First, we show that time preferences vary substantially with regard to birth order, with firstborn children being more patient. Since studies show that time preferences are a good predictor for important lifetime outcomes (Castillo et al., 2011, 2018; Chabris et al., 2008; Falk et al., 2018; Khwaja et al., 2006; Sutter et al., 2013) and patience can increase income as adults (Golsteyn et al., 2014), these large differences may be one explanation why birth order effects have been found in field behavior related to education (Black et al., 2005; Booth & Kee, 2009; Härkönen, 2014), earnings (Behrman & Taubman, 1986; Björklund & Jäntti, 2012), or health (Black et al., 2016).

Second, we contribute to the discussion about de-identification within a family. In the case of time preferences where no gender differences are visible, de-identification by birth order is important. We show, however, that in the case of risk preferences where we find strong gender differences, de-identification by birth order is only visible in single-gender environments. When siblings have different genders, de-identification by gender seems to be more important. So far, de-identification by birth order has been discussed exclusively for risk preferences, but gender composition has not been taken into account (e.g., Sulloway & Zweigenhaft, 2010). Our results highlight that in case of the availability of gender-specific stereotypes (e.g., Eckel & Grossman, 2002, 2008; Siegrist et al., 2002) siblings' gender composition might have a larger impact than the birth order position. This result is important as Lampi and Nordblom (2011) have shown that risk preferences can explain parts of the earnings differences between siblings. Additionally, our results also relate to studies by Cools and Patacchini (2017), Peter et al. (2018), and Brenøe (2022) who report that women with brothers have more traditional gender norms and earn less than women with sisters.

Third, we show that in the case of trust social learning is important. Sutter and Kocher (2007) have shown that trust increases with children's age and is relatively stable during adulthood. Our results show that the family context works as one important environment to form the trust behavior of children and it highlights that it matters with whom children interact in their families for how much they trust in others and how trustworthy they are.

Of course, our paper has also limitations. Firstly, our study is based on a between-family design. We controlled for all important factors discussed, e.g., by Damian and Roberts (2015), but we cannot fully control for the family environment when comparing first and second-born children. Secondly, our relatively smaller sample size compared to other studies, e.g., Dudek et al. (2022), may limit the statistical power and generalizability of the findings. Thirdly, the absence of an experimental design precludes any valid causal interpretations of the observed association. Lastly, the external validity of the findings may be limited to specific samples and contexts. In particular, we can only relate to studies in the Western hemisphere, since family dynamics and social norms may differ substantially across countries or culture. These limitations emphasize the need for caution when interpreting the results and suggest opportunities for future research to address these constraints.

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