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STRATEGIC PARENTING, BIRTH ORDER AND SCHOOL PERFORMANCE

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ABSTRACT

Fueled by new evidence, there has been renewed interest about the effects of birth order on human capital accumulation. The underlying causal mechanisms for such effects remain unsettled. We consider a model in which parents impose more stringent disciplinary environments in response to their earlier-born children's poor performance in school in order to deter such outcomes for their later-born offspring. We provide robust empirical evidence that school performance of children in the NLSY-C declines with birth order as does the stringency of their parents' disciplinary restrictions. And, when asked how they will respond if a child brought home bad grades, parents state that they would be less likely to punish their later-born children. Taken together, these patterns are consistent with a reputation model of strategic parenting.

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1 Introduction

Interest on the effects of birth order on human capital accumulation has been re-invigorated by several recent studies (Black, Devereux & Salvanes, 2005; Conley & Glauber, 2006; Gary-Bobo, Prieto & Picard, 2006) which present new empirical evidence of birth order effects. For example, Black, Devereux & Salvanes (2005) (BDS, hereafter) find large and robust effects of birth order on educational attainment with Scandinavian data. However, despite the convincing results, the underlying causal mechanisms generating such findings remain unsettled. As BDS acknowledge:

> "One important issue remains unresolved: what is causing the birth order effects we observe in the data? Our findings are consistent with optimal stopping being a small part of the explanation. Also, the large birth order effects found for highly educated mothers, allied with the weak evidence for family size effects, suggest that financial constraints may not be that important. Although a number of other theories (including time constraints, endowment effects, and parental preferences) have been proposed in the literature, we are quite limited in our ability to distinguish between these models" p. 698.

In thinking about children's behavior, it is important to remember that parents can resort to a variety of mechanisms to influence it. In particular, they can limit or grant access to important sources of utility for children. This paper advances an hypothesis that has not been previously considered in the generating process for birth order effects in educational outcomes: we consider differential parental disciplining schemes arising from the dynamics of a parental reputation mechanism. One channel that can generate birth order effects is characterized in Hao, Hotz & Jin (2008) (HHJ, hereafter). A key insight of their paper is that birth order effects arise endogenously as the result of viewing parent-child interactions as a reputation game in which parents "play tough" when their older children engage in bad behavior – tougher than caring, or altruistic, parents would prefer – in an attempt to establish a reputation of toughness to deter bad behavior amongst their younger children. Thus, we hypothesize that one mechanism that gives rise to birth order effects is this form of strategic parenting and responses by their children implied by game-theoretic models of reputation in repeated games. In the context of this paper, parents invest in developing a reputation of severe parenting with those born earlier in the hope of inducing their (paternalistic) preferred school effort levels on those born later.

The paper is organized as follows. Section 2 reviews the relevant literature and alternative theories of the effects of birth order on various behaviors, including educational outcomes. Section 3 describes the data we use in our analysis, namely that on the children of female respondents in the National Longitudinal Survey of Youth, 1979. In section 4, we present estimates of the effects of birth order on measures of children's performance in school and examine several potential threats to the validity of our estimates. We find very robust evidence of birth order effects in some measures of school performance that is entirely consistent with children responding to the strategic use of parental monitoring and discipline. In Section 5, we explicitly examine differences in parental monitoring and discipline of their children by birth order. While our ability to link these parenting practices to the specific instances of school performance is limited in our data, we can do so for a measure of parents' intentions, namely, what parents say they would do in response to their children getting bad grades in school. Based on this measure, we find parents engaging in strategic parenting practices by birth order. In Section 6, we offer some concluding observations of the findings in this paper.

2 Review of the Birth Order Literature

In this section we briefly review the literature on birth order effects and on the links between the effort of students in school and their academic performance and achievement.

There is a substantial literature on birth order effects in education. Zajonc (1976), Olneck & Bills (1979), Blake (1981), Hauser & Sewell (1985), Behrman & Taubman (1986), Kessler (1991), among others, found mixed results that provide support for a variety of birth order theories ranging from the "no-one-to-teach" hypothesis to the theory of differential genetic endowments. However, with the strong birth order effects found in Behrman & Taubman (1986) and, more recently, in Black, Devereux & Salvanes (2005) and Booth & Kee (2009), the literature seems to be settling in favor of the existence of such effects and moving towards consideration and sophisticated testing of alternative mechanisms to account for such effects. For example, Price (2008) provides empirical support in time use data for a modern version of the "dilution hypothesis," namely, that, for at least a limited time, the first born does not have to share the available stock of parental quality time input with other siblings, whereas those born later usually enjoy more limited parental input as parents are not able to match the increased demand for their "quality time."[1]

In another strand of research, mostly in Psychology, the issue of birth order effects in IQ has been examined. In particular, Rodgers et al. (2000, 2001) have consistently sided against the existence of such a relationship and they have criticized studies for confounding "within-family" and "between-family" processes and by attributing to the former, patterns that are actually shaped by the latter. More recently, Black, Devereux & Salvanes (2007) and Bjerkedal, et al. (2007) find strong and significant effects of birth order on IQ within families in a large dataset from Norway but Whichman, Rodgers & McCallum (2006) insist, using a multilevel approach, that the effects only arise between families and they disappear within the family. The debate remains open as Zajonc & Sulloway (2007) criticize Whichman, Rodgers & McCallum (2006) on several grounds and reach the opposite conclusion. Finally, Whichman, Rodgers & McCallum (2007) address the issues raised by Zajonc & Sulloway (2007) and confirm their previous findings.

There is also a sizeable literature on the links between students' effort in school and their

[1]See Lindert (1977) for a related approach exploiting time use data.

academic performance (see, for example, Natriello and McDill (1986); Wolters (1999);Covington (2000); Stinebrickner & Stinebrickner (2006)). There appears to be a fairly clear consensus in this literature that greater student effort improves academic performance. For example, Stinebrickner & Stinebrickner (2006) show the importance of actual school effort on school performance. But our understanding of the factors that lead to greater student effort and how such effort interacts with other features of a student's home and school environments is less clear. Relevant to this paper, there is a literature on the relationship between parenting and parental involvement and student effort and, ultimately, performance (see Trautwein & Koller, 2003; Fan & Chen, 2001; Hoover-Dempsey, et al., 2001). Most of this literature does not model or account for the endogenous nature of how the amount of school effort exerted by children is affected by parental incentives and policy instruments.

An exception to this shortcoming of the literature is a recent paper by De Fraja, D'Oliveira & Zanchi (2005). These authors develop an equilibrium model in which parents, schools and students interact to influence the effort of students and their performance and test this model using data from the British National Child Development Study. At the same time, De Fraja, D'Oliveira & Zanchi (2005) do not characterize the potential informational problems that parents have in monitoring their children's input and the potential role of strategic behavior on the part of parents in attempting to influence the children's effort. Our paper attempts to fill this deficit in the literature.

2.1 Alternative Theories of Birth Order Effects

There are several alternative causal hypotheses in the literature trying to explain the relationship between birth order and schooling. First, there could be parental time dilution, noted above. Under this hypothesis, the earlier born siblings enjoy more parental time than later-born siblings. This may explain why earlier-borns do better in school. Second, there could be differences in the genetic endowment of children by birth order. Indeed, later-born siblings are born to older mothers so they are more likely to receive a lower quality genetic endowment. Third, first-borns and parents' experience with them, may have undue influence on parents' subsequent fertility decisions. According to this theory, a "bad draw," e.g., a difficult-to-raise, problematic child, may cause parents to curtail their subsequent fertility whereas an easy-to-rear first-born would not. More generally, this phenomenon implies selection in the quality of parents' last-born child, with it being of lower quality than the average. Fourth, closely related to the "confluence model" of Zajonc, the "no one to teach" hypothesis postulates that the last born will not benefit from teaching a younger sibling. Without this pedagogic experience, the last born will not develop strong learning skills. Fifth, it may well be possible that the later-born siblings are more affected by changes in family structure, e.g., divorce, since later born children are more likely to spend more of their lives exposed to such family disruptions.[2] Last, but not least, first-borns may enjoy

[2]See Ginther & Pollak (2004) for an analysis of the relation between family structure and education outcomes. To examine this hypothesis, BDS (2005) re-estimate their model in a sample of families that experience no family disruptions. They still find sizeable and statistically significant birth order effects.

higher parental investment for insurance purposes or simply because parents are more likely to enjoy utility from observing their eventual success in life.

While all the above theories predict that earlier born siblings will do better, it is worth noting that it is possible that the effect can go in the other direction. For example, parents might learn to teach better. In this case, parents commit mistakes with those born earlier but they are more proficient, experienced parents when the later born siblings need to be raised. It also can be the case that, if there are financial constraints, the later-born siblings might be raised at time in which parental resources are more abundant.

Without taking away the merits of the previous literature, below we advance a novel, complementary mechanism that can induce birth order effects in school performance. It highlights the role of incentives faced by children to perform well in school as well as the reputation concerns of lenient parents.

2.2 Parental Reputation and Child School Performance

As noted in Section 1, we draw on the game-theoretic literature on reputation models. Such models were initially developed in the industrial organization literature in response to the chain store paradox of Selten (1978). In particular, Kreps & Wilson (1982) and Milgrom & Roberts (1982) developed models in which the introduction of a small amount of incomplete information gives rise to a different, more intuitive type of equilibrium. HHJ pioneered the use of this type of models in a family context to analyze teenage risk-taking behavior.

Consider a finite-horizon game between parents and children being played in families with more than one child. In particular, the typical family has a total of N children. Consider a long-lived player (the parent or parents) facing a new short-lived player (the child) at each round of the game. In any round t, $t = 1, ..., N$, the parents and the child of that round observe the entire history of play between the parent and the older children. In particular, the younger siblings observe the choices made by their $N - t$ older siblings and the punishment decisions of their parents when older siblings performed poorly in school. Parents can be of one of two types. They may be "tough parents," i.e., the commitment type that will always punish a child's poor performance in school, or parents are "lenient," i.e., is the type of parents that dislike punishing their children and would never do so, regardless of their performances in school. In the first round of the game, played with the oldest child, the parents' type is not known by that child or her younger siblings. Let $\widehat{\mu}^1$ denote the children's belief, or probability, that their parents are the tough type and $1 - \widehat{\mu}^1$ that they are lenient. At each round of the game, t, $t > 1$, the younger siblings will update their beliefs in a Bayesian fashion based on the accumulated information of the school performance of older children and how their parents responded to these performances. Denote this updated belief, or probability, that the parent is a tough type as $\widehat{\mu}^t$. Note that if older siblings always do well in school, then the younger siblings will not have had the occasion to observe whether their parents punish or accommodate poor performance in school and, as a result, will have no basis for updating their prior beliefs, i.e., $\widehat{\mu}^t = \widehat{\mu}^1$.

It can be shown that a sequential equilibrium for this finitely repeated game exists (see Kreps & Wilson, 1982, or Milgrom & Roberts, 1982). The critical event in this reputation game is observing parental leniency in response to poor school performance at some round t, i.e., at some birth order t. If parents reveal themselves to be of the lenient type by not punishing the poor school performance of one of their children, $\widehat{\mu}^t$ drops to zero and remains there until the end of the game. From then on, the parents' children will fear no punishment from their revealed-to-be-lenient parent whose threats are no longer credible.

The equilibrium of this reputation game between parents and their children is characterized by two phases. In the first phase, played in the early rounds of the game between parents and their earlier born children, uncertainty about parental type and threat of punishment induces these children to exert high levels of effort in school to deliver good school performance and prevent the triggering of potential punishments coded in the parenting rule. In this phase, bad grades will translate into loss of privileges anyway. If a parent is tough, he will punish by principle. If the parent is a lenient type, she will still punish poor preference in order to establish and/or maintain a reputation for toughness so as to prevent later born children from taking advantage of her leniency. As a result, we expect earlier born children playing mostly through this initial phase of the equilibrium to do better in school.[3] As the rounds of the game proceed, the number of remaining children at risk to play the game declines. At some point, the reputation benefits of punishment for a lenient parent is less than the disutility of witnessing their child's suffering, i.e., not doing well in school. Depending on how small $\widehat{\mu}^1$ is and how few rounds in the game remain, i.e., many remaining children a parent has, it will be likely for some of these children to "test the waters" by exerting low school effort and exploring what happens in response. After the first parental accommodating-behavior is observed for a lenient parent, the second phase of the game is triggered in which later born siblings do not put effort in school and go unpunished. (Note that a tough parent type will choose to punish poor performance for each of their children and never accommodate such behavior.)

The model delivers some predictions that can be taken directly to the data. In particular, earlier-born siblings are predicted to put more effort in school and should end up performing better. Moreover, parents are more likely to establish rules of behavior with the earlier-born, engage in a more systematic monitoring of earlier-born's schoolwork and increase supervision in the event of low school performance. Below, we provide evidence on the validity of these predictions for children's performance in school and parental responses to it by birth order.

[3]Here we rely on results from Stinebrickner & Stinebricker (2006) that emphasize the importance of study effort in determining school performance.

3 The Data

We exploit data from the children of female respondents of the National Longitudinal Survey of Youth, 1979 (NLSY79). These data (NLSY-C) contain information on all of the children born to women in the NLSY79 so we potentially observe all of their children as they transition between the ages of 10 and 14, the focus of our analysis.[4] Crucially, many of these women have two or more children so we are able to directly explore birth order effects that arise in these families.

TV watching and, more recently, video gaming and social networking are time intensive activities that usually crowd-out, at least partially, the time that could be used for homework or study. Indeed, there exists a vast literature in psychology documenting the detrimental effects of TV watching on school performance. Therefore these activities are natural places to look for parental discipline schemes. Children value these activities highly and parents may be able to enforce and monitor restrictions on their access.

Useful for our purposes, the NLSY-C includes some detailed information on parenting. Some questions ask the mother and/or the children about different features about the parent-child relationship. We also exploit other parenting rules as reported by the children and/or the mother. Crucially, we are able to observe multiple self-reports from the same mother about all of her kids, and we observe those at two and sometimes three points in time. We restrict the analysis to children between the ages of 10 and 14. However, having repeated observations of parenting rules applied to each child over time allows us to identify changing parenting strategies across birth order, by comparing siblings of different birth order once they transition across a given common age.

On the other hand, the NLSY-C does not have systematic information on grades except for a specific supplemental school survey fielded in 1995-96 about school years 1994-95. However, the NLSY-C includes a self-report about how the mother thinks each of her children is doing in school. The specific question is: "Is your child one of the best students in class, above the middle, in the middle, below the middle, or near the bottom of the class?" Useful for our purposes the same questions are asked of the mother separately for each child and in several waves. Note that even when these self-reports could be validated against school transcripts, it can be argued that it is the parental subjective belief about the child's performance what really matters at the end. We do, however, validate mother's perceptions below, exploiting limited transcript data from the 1995-96 School Supplement.

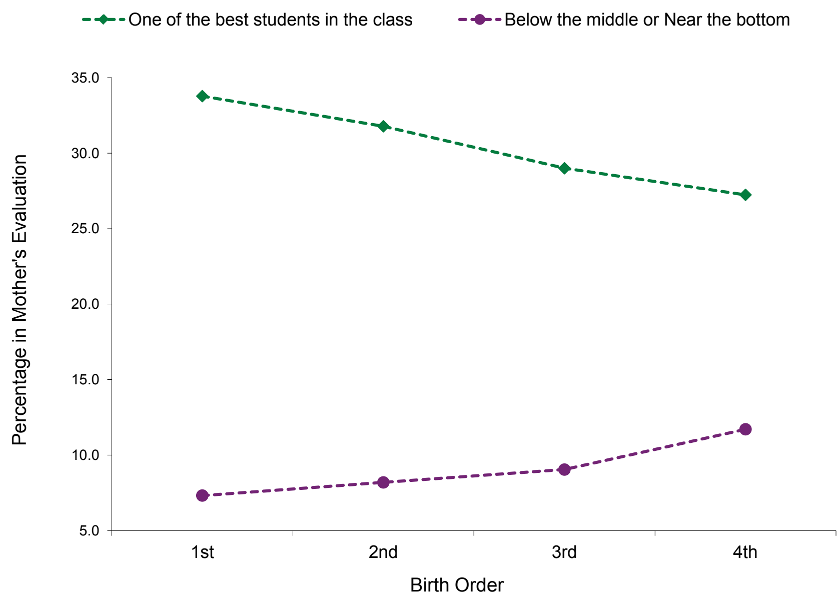
[4]We restrict attention to those ages because some of our key variables are only available for that age range.

Table 1: Mother's Evaluation of Child's Academic Standing by Birth Order

	Birth Order			
	1st	2nd	3rd	4th
One of the best students in the class	33.8%	31.8%	29.0%	27.2%
Above the middle	25.1%	24.3%	23.6%	22.5%
In the middle	33.8%	35.7%	38.3%	38.5%
Below the middle	5.5%	6.2%	7.0%	8.1%
Near the bottom of the class	1.8%	2.0%	2.1%	3.6%

Source: Children of the NLSY. 1990-2008. Maternal reports elicited about each of her children.

Figure 1: Birth Order and Perceptions of School Performance.

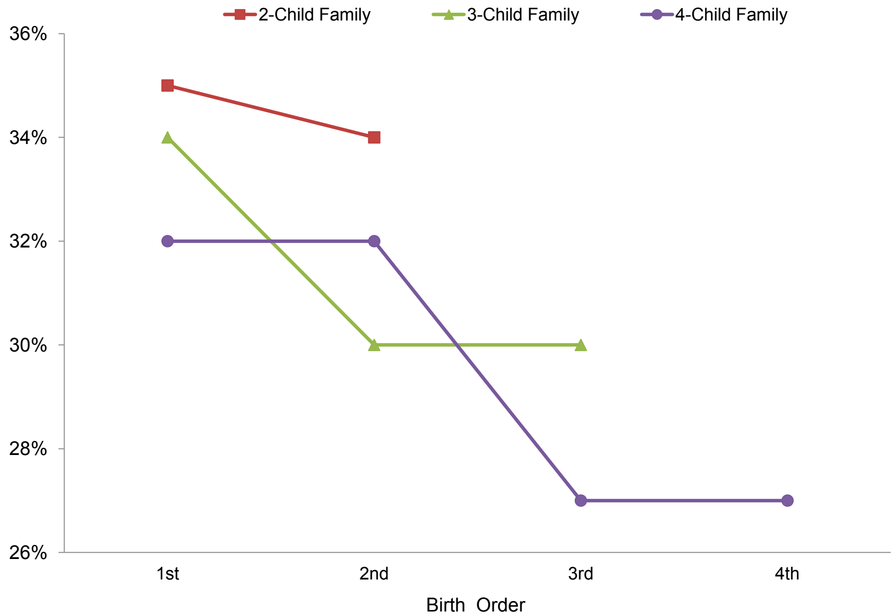


4 Birth Order Effects in School Performance

In this section we provide evidence from our data concerning differences by birth order in the academic performance of the children of the NLSY79 data. Table 1 and Figure 1 show that there exists a clear association between school performance (as perceived by the mother) and birth order. Since the NLSY-C has very few observations coming from families with more than four siblings we focus our analysis on families with 2, 3 or 4 children. The table shows that while 34% of first born children are considered "one of the best in the class" only 27% of those coming fourth in the birth order reach such recognition. On the other hand, only 7.3% of first-borns are considered "below the middle or at the bottom of the class," while 11.7% of 4th-borns are classified in such manner by their mothers.

One possible concern with the results in Table 1 is that they may confound birth order

Figure 2: Birth Order, Family Size & Percent of Children Perceived to be at Top of their Class.



and family size effects, an issue that has been recognized very early in the development of the birth order literature. Figure 2 explores birth order effects within families of specific sizes. Higher birth orders, by construction, belong in families of bigger size. As pointed out by Berhman & Taubman (1986), such families locate themselves at a different locus of the quantity-quality trade-off. Therefore we risk attributing to birth order what really comes from family size. As can be seen in the figure, birth order effects appear to persist in all these families, regardless of size.

A second concern with the results in Table 1 is that they show clear evidence of inflation in perceived school performance (i.e. her assessments appear to show a mother's Lake Wobegon effect about their own children) However, this need not be a problem, per se, as long as the sign and magnitude of these misperceptions do not vary with birth order. In Table 2, we validate maternal perceptions. Higher GPAs of children obtained in the School Supplement are associated with significantly lower chances of being perceived to be at the bottom of the class and significantly higher chances to be classified as one of the best students in the class. Re-estimating the same models including birth order measures show that misperceptions (the differences between perceived and actual performance) are not correlated with birth order. Therefore, to the extent that mothers are too optimistic about their own children performance but they are so for all of their own children, we account for this mother specific bias when we include family fixed effects in our models of perceived school performance.

More formally, we follow BDS (2005) and explore birth order effects in academic performance by estimating the following two linear models for the probability that the child i in family h is being considered by his/her mother to be one of the best students in the class in

Table 2: Validating Mother's Perception of Child's School Performance

	Ordered Probit		Probit		LPM	
	Linear	Non-Parametric	Linear	Non-Parametric	Linear	Non-Parametric
GPA	-0.499***		0.188***		0.168***	
GPA=2		-0.902***		0.357**		0.191**
GPA=3		-0.976***		0.423***		0.266***
GPA=4		-1.870***		0.678***		0.557***
Birth Order	0.063	0.074	-0.062	-0.065	-0.043	-0.051
Observations	180	180	180	180	180	180

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.
Ordered Probit uses 1=Top, 2=Above Middle, 3=Middle, 4=Below Middle, 5=Bottom. The Probit and linear probability models (LPM) use 1=Best, 0=otherwise. (The LPM is estimated using ordinary least squares.) Controls include Age and Gender. In non-parametric specifications GPA=1 is the omitted category.

year t. The first specification we consider imposes linearity across birth orders

$$BestStudent_{iht} = NYS_{iht} + X_{iht}'\beta + \lambda_h + \lambda_t + \varepsilon_{iht} \tag{1}$$

where $BestStudent_{iht}$ is equal to 1 if child i in family h who in year t was rated by their parents as one of the best students in their class, X_{iht} includes controls for child's age and gender (and family size when pooling all families). NYS_i is the number of younger siblings, a measure of birth order that imposes linearity. The λ_ts denote survey year effects and the λ_hs denote family fixed effects.

Our second specification is more non-parametric in the sense that it allows different effects for different birth orders.

$$BestStudent_{iht} = \sum_{k=2}^{4} \alpha_k BirthOrder_{kih} + X_{iht}'\beta + \lambda_h + \lambda_t + \varepsilon_{iht} \tag{2}$$

where $BirthOrder_{kih}$ is a dummy variable which equals one when child i is the k^{th} child born in family h, and equals zero otherwise.

Table 3 presents estimates of specifications (1) and (2) for all families and for families with 2, 3 or 4 children, respectively. The results in Panel A are based on specifications that do not include a family fixed effect, while those in Panel B do. In column 1, the specification imposes linearity of birth order and uses the number of younger siblings as a measure of birth order. In columns 2 to 5, all birth order coefficients are relative to the first born, which is the omitted category. As can be seen in Panel A of Table 3, there exist strong birth order effects in all families. The OLS estimates imply that in families of four children, the last child to be born is 15 percentage points less likely to be among the best students in his class. Moreover, when we estimate (1) and (2) controlling for family fixed effects, the birth order

Table 3: Effect of Birth Order on School Performance

	All Families	All Families	2-Child Family	3-Child Family	4-Child Family
Panel A: OLS					
Number of Younger Siblings	0.0517***				
2nd Child		-0.0532***	-0.0511***	-0.0618***	-0.0423
3rd Child		-0.1040***		-0.0869***	-0.1320***
4th Child		-0.1530***			-0.1730***
Female	0.1040***	0.1040***	0.0888***	0.1180***	0.1130***
Panel B: Family Fixed Effects					
Number of Younger Siblings	0.0529***				
2nd Child		-0.0539***	-0.0855***	-0.0496**	-0.0380
3rd Child		-0.1080***		-0.0632*	-0.1140***
4th Child		-0.1540***			-0.1510***
Female	0.1110***	0.1110***	0.0937***	0.1240***	0.1200***
Observations	13,194	13,194	5,607	5,007	2,580

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

The Family Fixed Effects specifications include a set of year effects and age effects as well as family fixed effects. Dependent variable equals one if child is perceived to be one of the best students in his/her class, equals zero otherwise.

results remain significant and very similiar in size and magnitude. See Panel B of Table 3.

4.1 Birth Order Effects in Initial Conditions

It is likely that parents would be less likely to punish less capable children for bad grades. If there is a genetic component to performance whereby later children are less capable we would also see the patterns of school performance that we identify in the data across birth orders. We start observing our children at age 10. Even if there are no genetic differences by birth order, other processes might establish differential levels of cognitive ability by age 10 across birth order within a family. The NLSY79 Child surveys contain a wide range of detailed assessment information about the children of female respondents. Since 1986, a battery of child cognitive, assessments has been administered biennially for age appropriate children. We use the three PIAT assessments (Math, Reading Recognition and Reading Comprehension) and the PPVT assessment.

The Peabody Individual Achievement Test (PIAT) is a wide-range measure of academic achievement for children aged five and over. It is among the most widely used brief assessment of academic achievement having demonstrably high test-retest reliability and concurrent validity. The Math subscale measures a child's attainment in mathematics as taught in mainstream education using a battery of multiple-choice questions of increasing difficulty. The

Table 4: Effect of Birth Order on Children's Initial Ability

	PIAT Math		PIAT Reading Recognition		PIAT Reading Comprehension		PPVT	
	OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
No. of Younger Siblings	2.351***	0.402	2.857***	2.159***	2.794***	2.465***	4.061***	1.603**
3-Children Family	-2.910***		-3.212***		-2.913***		-5.265***	
4-Children Family	-6.478***		-6.650***		-6.167***		-11.79***	
Female	-0.216	-0.910	2.299***	2.248***	2.054***	1.950***	-0.276	0.494
Constant	96.66***	102.2***	90.60***	99.39***	69.04***	85.71***	82.25***	96.83***
Observations	3,558	3,558	3,597	3,597	3,700	3,700	4,022	4,022

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors. Specifications include a set of year effects and age effects as well as controls for family size or family fixed effects. Dependent variables are the standardized scores for each of the assessment. We use the 2nd assessment. Most children were assessed for a 2nd time around age 10. This is the age at which we begin our analysis of school performance so we refer to this as the "initial ability."

Reading Recognition subtest measures word recognition and pronunciation ability whereas the Reading Comprehension subtest measures a child's ability to derive meaning from sentences that are read silently. Finally the Peabody Picture Vocabulary Test (PPVT) measures an individual's receptive (hearing) vocabulary for Standard American English and provides, at the same time, an estimate of verbal ability or scholastic aptitude.

In Table 4 we present estimates for the same model used to produce the results in the previous tables but use the four assessments (3 PIATs and a PPVT) as dependent variables. As can be seen in this Table, an early birth order is significantly associated with higher PPVT and two of the PIAT scores. These scores are from the 2nd assessment for these children taken around age 10 and therefore reflect some sort of initial condition in ability for our subsequent analysis. This pattern of birth order effects in ability by age 10 could reflect the early operation of reputation dynamics or some of the other mechanisms discussed above.

Having documented the existence of birth order effects in cognitive ability at the beginning of our observation window, we now show that our birth order effects in school performance results between the ages of 10 and 14 hold when we control for individual differences in the initial ability of children of different birth order within families. Table 5 presents the results. As expected, the assessment scores that proxy for initial ability are all positive and almost always highly significant. Still, birth order has a significant and sizable effect on performance that goes beyond what can be explained through (within-family) birth order effects in ability established by age 10 potentially due to some of the theoretical mechanisms discussed earlier.

4.2 Family Structure

While family fixed effects account for time invariant characteristics of the family, they do not account for those characteristics that change over time within families, are correlated

Table 5: Effect of Birth Order on School Performance, Controlling for Child Ability

	All Families	All Families	2-Child Family	3-Child Family	4-Child Family
No. of Younger Siblings	0.0356***				
2nd Child		-0.0341**	-0.0774***	-0.0152	-0.0260
3rd Child		-0.0713***		-0.0157	-0.0912*
4th Child		-0.1080***			-0.1000
PIAT Math	0.0046***	0.0046***	0.0054***	0.0053***	0.0027**
PIAT Reading Recognition	0.0028***	0.0028***	0.0038**	0.0014	0.0039***
PIAT Reading Comprehension	0.0028***	0.0028***	0.0023	0.0035**	0.0021
PPVT	0.0024***	0.0024***	0.0032***	0.0023***	0.0014
Female	0.0997***	0.0997***	0.0972***	0.1070***	0.0975***
Observations	11,355	11,355	4,833	4,338	2,184

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

Specifications include a set of year effects and age effects as well as family fixed effects. Dependent variable equals one if child is perceived to be one of the best students in his/her class, equals zero otherwise.

with birth order and that may directly affect children's school performance. For example, later born siblings are more likely to be affected by changes in family structure, such as divorce, which can affect the economic and social status of families and the upbringing of children in these households. There is a sizable literature in both sociology and economics that examines the effects of family structure on child outcomes.[5] The NLSY sample provides ample opportunities to control for family structure as a potential determinant of birth order effects. We construct a subsample of "intact" families in which children have not been exposed to any kind of family disruption. This subsample is substantially smaller. We re-estimate our family fixed effects models for this subsample controlling for child ability. Table 6 presents the results. Despite the substantially loss of power with this sample, birth order still has a significant effect on school performance among intact families. To be clear, we are not claiming that differences in family structure do not affect child outcomes, including a child's performance in school. Rather, our evidence indicates that the birth order effects that we found in school performance cannot be solely explained by differential exposure to changes in family structure across birth orders.

5 Birth Order Effects in Parental Rules

In this section, we explore whether birth order effects in performance may arise because of differential parental treatment. We ask whether the data shows any sign of differential parenting by birth order. We provide additional evidence consistent with some of the predictions delivered by the reputation hypothesis and discussed in Section 2. In Table 7 we

[5]See, for example, McLanahan & Sandefur (1994); Ermisch & Francesconi (2001), Ginther & Pollak (2004); Tartari (2008) and Finlay & Neumark (2010).

Table 6: Effect of Birth Order on School Performance in Intact Families

	All Families	All Families	2-Child Family	3-Child Family	4-Child Family
No. of Younger Siblings	0.1280*				
2nd Child		-0.1510*	-0.2480**	0.0222	-0.2280
3rd Child		-0.2450		0.1660	-0.5960*
4th Child		-0.3550			-0.8550
PIAT Math	0.0073**	0.0077***	0.0084**	0.0082	0.0075
PIAT Reading Recognition	0.0022	0.0020	-0.0027	0.0016	0.0161**
PIAT Reading Comprehension	0.0037	0.0040	0.0054	0.0056	-0.0010
PPVT	0.0034	0.0033	0.0092***	-0.0013	-0.0113***
Female	0.0729	0.0698	0.1480**	-0.0962	0.1340
Observations	1,173	1,173	665	368	140

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

Specifications include a set of year effects and age effects as well as family fixed effects. Dependent variable equals one if child is perceived to be one of the best students in his/her class, equals zero otherwise.

present evidence of the effects of birth order on the existence of parental rules about TV watching. We find strong birth order effects on these rules and the results are robust to the introduction of family fixed effects. Earlier-born siblings seem to grow up in a more regulated environment regarding TV relative to their later-born counterparts.

While earlier born siblings face a more regulated home environment it is worthwhile to explore whether they actually experience a lack of autonomy to freely choose their preferred time allocation. To address this we exploit information on reported levels of parental monitoring pressure. In Table 8 we provide evidence of birth order effects in how intensely parents monitor a child's homework. Consistent with the reputation model, earlier born siblings face more intense, systematic parental scrutiny regarding homework. Parents are more likely to seek information on how much effort is being exerted by their children on homework. Table 8 shows OLS and Family Fixed Effects estimates based upon a binary version of the dependent variable which equals one when the monitoring is most intense (daily checks on homework).[6] Indeed, once we control for the measures of ability, the OLS estimate in column 2 of Table 8 shows that having one each additional younger sibling is associated with an increase of more than two percentage points in the probability of being monitored every day. The effect is 50% larger once we control for family fixed effects. An early birth order is clearly associated with a loss of autonomy for the child. A first born child of four-children family is on average approximately 10 percentage points more likely to face daily homework monitoring relative to the last child born in that family.

While the results in Table 8 are suggestive of reputation dynamics, a sharper implication

[6] The actual question is *"How often do your parents check on whether you have done your homework?"* Allowed answers include: Never, Less than once a month, 1-2 times a month, 1-2 times a week, Almost every day, Every day.

Table 7: Effect of Birth Order on Existence of Parental Rules about TV Watching

	OLS	OLS	Family FE	Family FE
No. of Younger Siblings	0.0533***	0.0491***	0.0237*	0.0253*
PIAT Math		-0.0009		-0.0011
PIAT Reading Recognition		-0.0013*		-0.0016*
PIAT Reading Comprehension		0.0004		0.0001
PPVT		0.0006		-0.0009*
Female	-0.0352***	-0.0326***	-0.0260**	-0.0206
Observations	10,982	9,895	10,982	9,895

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

Specifications include a set of year effects and age effects. Specifications in columns 1 and 2 include family size effects. Specifications in columns 3 and 4 include family fixed effects. Dependent variable equals one if child is perceived to be one of the best students in his/her class, equals zero otherwise. Dependent Variable is equal to one if the child reports that there exist rules about watching TV, equals zero otherwise.

Table 8: Effect of Birth Order on Intensity of Parental Monitoring of Homework

	OLS	OLS	Family FE	Family FE
No. of Younger Siblings	0.0120	0.0218**	0.0385**	0.0318*
PIAT Math		-0.0015**		-0.0021**
PIAT Reading Recognition		-0.0017**		0.0008
PIAT Reading Comprehension		0.0006		-0.0015
PPVT		-0.0001		0.0010
Female	-0.0404***	-0.0342***	-0.0283*	-0.0212
Observations	8,127	7,166	8,127	7,166

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

Specifications include a set of year effects and age effects. Specifications in columns 1 and 2 include family size effects. Specifications include a set of year effects and age effects as well as family size effects in columns 1 and 2. Columns 3 and 4 control for family fixed effects. All specifications control for indicators that measure how often the teacher gives homework. Dependent variable equals one if parents check every day on homework, equals zero otherwise.

Table 9: Differential Effect of Birth Order on Monitoring Intensity Among Children with Bad and Good Shool Performance

	OLS	OLS	Family FE	Family FE
B	0.0051	-0.0136	0.0176	0.0050
B × No. of Younger Siblings	0.0107	0.0068	-0.0037	0.0046
No. of Younger Siblings	0.0088	0.0190*	0.0402**	0.0307
PIAT Math		-0.0015**		-0.0021**
PIAT Reading Recognition		-0.0017**		0.0008
PIAT Reading Comprehension		0.0006		-0.0015
PPVT		-0.0001		0.0011
Female	-0.0389***	-0.0350***	-0.0265*	-0.0204
Observations	8,127	7,166	8,127	7,166

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.

Specifications include a set of year effects and age effects as well as family size effects in columns 1 and 2. Columns 3 and 4 control for family fixed effects. All specifications control for indicators that measure how often the teacher gives homework. Dependent variable equals one if child is perceived to be one of the best students in his/her class, equals zero otherwise. Dependent variable equals one if parents check every day on homework, equals zero otherwise.

from parental reputation is that we should expect this loss of autonomy among earlier born siblings to occur only among those who underperform in school. In a sense, we should expect to see a significant and positive interaction between our measure of birth order and a measure of under-performance in school. We then consider the following augmented model that features such an interaction:

$$Monitoring_{iht} = \alpha_0 + \alpha_1 B_{iht} + \alpha_2 NYS_{ih} \times B_{iht} + X'_{iht}\beta + \lambda_h + \lambda_t + \varepsilon_{iht}, \qquad (3)$$

where $B_{ih} = 1$ if the child is perceived to be underperforming in school.[7] Still, the reputation model predicts that this loss of autonomy would be more likely when the child is not performing well in school. That is, reputation implies $\alpha_2 > 0$. The results of estimating the augmented model are shown in Table 9. As can be seen in this Table, the preferred specification that controls for family fixed effects and child ability, the estimated interaction effect α_2 is positive, but not significant. While this seems to provide evidence against the reputation model, it is important to notice that our inclusion of B_{iht} and its interaction with our birth order measure, $NYS_{ih} \times B_{iht}$ brings with it endogeneity issues to our modeling of birth order effects in incentives. Indeed, considering in more detail the behavior of the child helps us to understand why these two variables will be likely endogenous, even after controlling for family fixed effects.

The probability that the child under-performs essentially depends on its ability A_i and effort E_i. But how much effort the child allocates to achieve good school performance also

[7] $B_{iht} = 1$ if the child i of household h is thought to be either below the middle of the class or at the bottom of the class at time t.

depends on the probability of autonomy loss in the event of under-performance. Consider then a linear probability model for under-performance

$$B_{iht} = \theta_0 + \theta_1 A_{iht} + \theta_2 E_{iht} + \lambda_h + \lambda_t + \eta_{iht} \tag{4}$$

where $\theta_1 < 0$ and $\theta_2 < 0$. Now, let effort E_{iht} depend on ability A_i and the probability of autonomy loss upon bad school performance

$$E_{iht} = \phi_0 + \phi_1 A_i + \theta_2 \Pr\left(L_{iht} = 1 | B_{iht} = 1\right) + \lambda_h + \lambda_t + \nu_{iht} \tag{5}$$

where $L_{iht} = 1$ if the child suffers autonomy loss due to intense parental supervision and monitoring. If we add the parenting equation to this system we note that $NYS_{ih} \times B_{iht}$ and B_{iht} are likely to be endogenous.

$$L_{iht} = \alpha_0 + \alpha_1 B_{iht} + \alpha_2 NYS_{ih} \times B_{iht} + X'_{iht}\beta + \lambda_h + \lambda_t + \varepsilon_{iht} \tag{6}$$

For example, suppose that children observe more than us, the econometricians, about ε_{ih}, the child i-specific family h unobservables affecting the parental propensity to monitor and supervise at time t. Say $\varepsilon_{iht} = \varepsilon^1_{iht} + \varepsilon^2_{iht}$ and children can observe ε^1_{iht}. We can interpret this as an observable signal (to the child) of parental supervision propensity for that period. The child of course will use this information when forming his beliefs about the probability of losing autonomy in the event of low school performance. Then, we update the effort function to reflect this.

$$E_{iht} = \phi_0 + \phi_1 A_i + \theta_2 \Pr\left(L_{iht} = 1 | B_{iht} = 1, \varepsilon^1_{iht}\right) + \lambda_h + \lambda_t + \nu_{iht} \tag{7}$$

It is clear then that high ε^1_{iht}'s will lead to high effort E_{iht} by increasing the perceived odds of autonomy loss upon bad grades, $\Pr\left(L_{iht} = 1 | B_{iht} = 1, \varepsilon^1_{iht}\right)$. Higher effort will, in turn, translate into higher grades (i.e., a lower probability of observing $B_{iht} = 1$), given $\theta_2 < 0$. From our perspective then ε_{iht} and B_{iht} will be correlated and will induce bias in our parameter of interest, α_2. Moreover, the estimate will be biased *downwards* and therefore it will prevent us from drawing valid inference regarding the hypothesis that $\alpha_2 > 0$. As this example shows, parent-child strategic interactions create substantial endogeneity problems in estimating equations that intend to capture important aspects of child and parental behavior.

As is customary in the literature, one could attempt to solve this type of endogeneity problem by relying in some sort of instrumental variable or quasi-experiment Z_{iht} that should ideally induce exogenous variation in school performance for child i in household h at time t. While finding convincing instruments is usually a difficult task, this is especially difficult in our context, as many potential instruments that do indeed generate random variation in school performance would nevertheless be invalid, as long as they are known by the parent. This is so because those factors, when known by the parents, will be taken into account when executing the parenting strategy. In summary, good instruments are very difficult to find because not only they have to be somewhat random, but also need to be unknown by the parents. Parental unawareness of those random factors is especially unlikely because, if they can be verified, children would have incentives to reveal their existence, in the hopes of providing attenuating circumstances for bad school performance.

Lacking a good instrument we pursue an alternative novel approach to test the implications of the reputation model. Consider the probability of intense monitoring given bad grades.

$$\Pr\left(L_{iht}=1|B_{iht}=1\right)=\alpha_0+\alpha_1+\alpha_2 NYS_{ih}+X'_{iht}\beta+\lambda_h+\lambda_t+u_{iht} \quad (8)$$

where $u_{iht} = E\left[\varepsilon_{iht}|B_{iht}=1\right]$. Note that this specification removes or conditions out the endogenous under-performance measure but still allow us to test for reputation. In a sense, this is a probabilistic model of the parental strategy that integrates out ε_{iht} . Therefore, if we had access to self-reported probabilities (or likelihood ranges) of monitoring upon bad school performance we could test for reputation by exploring whether those subjective probabilities vary with birth order. In particular, we would expect a parent's reported probabilities of increased supervision to be higher for earlier-born siblings.

Fortunately, our data includes such self-reports. The mother was asked about the likelihood that she would take an action (increase the supervision of her child) in response to a hypothetical situation (her child came home with bad grades). That is we have a measure of the mother's self-reported likelihood of punishing in a hypothetical situation, rather than her report of what she actually did in response to her child's actual behavior, where the later is subject to the above-noted endogeneity. The specific question we exploit in this context is the following:

> *"If (Child) brought home a report card with grades lower than expected, how likely would you (the mother) be to keep a closer eye on [his/her] activities?"*

The following were the allowed responses: Not At All Likely, Somewhat Unlikely, Not Sure How Likely, Somewhat Likely, Very Likely.

We work with a dichotomous version of the dependent variable which equals one if the mother would be very likely to keep a closer eye on the child in the event of low school performance and zero, otherwise. This allows us to easily control for family fixed effects. This new form of data provides an interesting complement to more standard data on observed behavior because it essentially recovers the parental strategy directly, even in cases in which the child does well in school and never triggers the eventual punishment.

Estimates of the specification in (8) are displayed in Table 10. We find that the more younger siblings a child has, i.e., the lower the birth order, the more likely are parents to more closely supervise the child in the event of that child would bring home an unexpectedly low performance on a report card. In particular, after controlling for the child's baseline ability and family fixed effects we find that having an additional younger sibling increase the chances that parents report being very likely to increase supervision upon bad school performance by 2.2 percentage points. This implies that within a family with four children,

Table 10: Effect of Birth Order on Probability that Parent would be Very Likely to Increase Supervision if Child brought on Poor Report Card

	OLS	OLS	Family FE	Family FE
No. of Younger Siblings	0.0144**	0.0088	0.0241***	0.0221**
PIAT Math		-0.0005		0.0007
PIAT Reading Recognition		0.0001		-0.0002
PIAT Reading Comprehension		0.0011**		-0.0001
PPVT		0.0001		-0.0001
Female	0.0070	0.0050	-0.0008	0.0019
Observations	11,982	10,380	11,982	10,380

* significant at 10%; ** significant at 5%; *** significant at 1%. Significance levels determined based on robust standard errors.
All specifications include a set of year and age variables. Columns 1 and 2 include family size variables, while columns 3 and 4 include family fixed effects. Dependent variable equals one if parents report being very likely to supervise the child more closely in the event of low grades, equals zero otherwise.

a first born sibling is 6.6 percentage points more likely to have the parent being very likely to punish upon bad grades relative to the last born, i.e., the fourth child in the family.

6 Conclusions

We contribute to the literature on birth order effects in human capital accumulation by showing that those born earlier perform better in school. While most of our analysis uses perceptions of school performance, as opposed to true measures of school performance, a validation of perceptions using actual transcript data shows that these findings do no reflect Lake Wobegon effects or, more importantly, any differential performance misperception by birth order. Our results are robust to controls for family size and, more generally, to the inclusion of family fixed effects. We also show that the same reputation dynamic or other mechanisms may have established birth order effects in ability at the time children reach age 10 and become part of our analyses of incentives. Still, we find that after controlling for measures of a child's ability taken at earlier ages, birth order effects in school performance persist. Moreover, these findings also hold in a subsample of intact families, thus minimizing the chance that birth order effects mask differential exposure to family structure disruption that could hinder school performance.

We then provide evidence consistent with parental reputation incentives generating birth order effects in school performance. In particular, earlier born siblings are more likely to be subject to rules about TV watching and to face more intense parental monitoring regarding homework. We then propose a new reputation test based on parental self-reported likelihood of increased supervision upon bad grades. We present evidence that mothers are more likely to report that they would increase the supervision of one of their children in the event that child brought home a worse than expected report card when the child in question was one of her earlier-born children. While further research is needed to rule out alternative explanations associated with changing cost and technologies of alternative parenting strategies as sibships grow, we believe that results indicate that parental reputation dynamics may explain part of the observed birth order effects in school performance.

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