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ABSTRACT

Early Child Development and Maternal Labor Force Participation: Using Handedness as an Instrument*

We estimate the effect of early child development on maternal labor force participation using data from teacher assessments. Mothers might react to having a poorly developing child by dropping out of the formal labor force in order to spend more time with their child, or they could potentially increase their labor supply to be able to provide the funds for better education and health resources. Which action dominates is therefore the empirical question we seek to answer in this paper. Importantly, we control for the potential endogeneity of child development by using an instrumental variables approach, uniquely exploiting exogenous variation in child development associated with child handedness. We find that having a poorly developing young child reduces the probability that a mother will participate in the labor market by about 25 percentage points.

JEL Classification: J22, J13, C31

Keywords: child development, maternal labor force participation, handedness

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1 Introduction

Child development has become an increasingly important issue as the number of children diagnosed with development problems increases worldwide (see, for example, Collishaw, Maughan, Goodman, and Pickles (2004); Fombonne (1998); and Maughan, Iervolino, and Collishaw (2005)). One of the most common forms of developmental problems is Attention Deficit Hyperactivity Disorder (ADHD) with the global prevalence estimated to be around 5% (Polanczyk et al. (2007)). Currie and Stabile (2005) report that 20% of US youngsters have a mental disorder, of which symptoms of ADHD are the most common. Such developmental problems can have considerable economic implications for both children and their parents, including increased health and education costs and worse labor market outcomes later in life. In this respect, Currie and Stabile (2005) identify large negative effects on test scores and schooling attainment in Canada and the US, and suggest that mental health conditions are a more important determinant of average outcomes than physical health conditions.

In this paper we investigate one of the potential effects of poor child development, namely, the effect that poor development has on the maternal labor force participation decision. Mothers of poorly developing children may choose to remain at home in order to care for their children. Alternatively, mothers may decide to enter the labor force in order to pay for additional educational and health resources. This paper aims to provide new insight into which of these potentially conflicting maternal labor market responses empirically dominates.

While we are unaware of any other economic studies that directly estimate the impact of child development on maternal labor market decisions, there are a number of studies that provide evidence on the effect of various child health problems (see Salkever (1982); Wolfe and Hill (1995); Powers (2001); Corman, Noonan, and Reichman (2005)). The results from these studies indicate that poor child health generally has a negative effect on maternal employment and, to a lesser extent, hours worked. For example, Powers (2003) finds that child disability reduces females labor force participation by 6 percentage points and reduces desired work by 3.7 hours per week. However, an important limitation of this literature is that most studies make no attempt to control for the potential endogeneity of child health, given the practical difficulty in identifying exogenous variation to use for identification.[1]

Two main factors can lead to bias in the estimated impact of child development on maternal labor force participation. First, there are likely to be unobservable characteristics relating to the mother and child that are correlated with both child development and maternal labor force participation. Two obvious candidates are genetic links in the ability of mother and child, and the extent with which a mother cares about her career relative to her child. The second source of potential bias arises from the direct effect of maternal employment on child development. If maternal employment has a negative impact on child development, then children of working mothers will be less developed than children of non-working mothers, creating a downward bias on the estimated impact. Conversely, if maternal employment has a positive impact on child development then the estimated impact would be biased upward.

To control for the potential bias introduced by the endogeneity of poor child development, we exploit a natural experiment, namely, the allocation of handedness. Johnston, Shah, and Shields (2007) show that handedness is a strong predictor of early child development. Left-handed and both-handed children have significantly lower test scores and are more likely to be rated by their teachers as 'less competent' or 'much less competent' than other right-handed children. Furthermore, handedness appears to be an exogenous source of variation in child development. It is not significantly correlated with child health, family composition, parental employment, or household income. In addition, parental attitudes related to child health, safety, and discipline do not differ between left and right-handed children, and neither do parental developmental inputs, such as the frequency the child is read to and played with (Johnston, Shah, and Shields, 2007). Therefore, we employ an instrumental variables (IV) approach using handedness as an instrument for child development. We believe that this paper is the first study to use the natural variation of handedness as an instrument in any context.

[1]Some exceptions do exist. For example, Corman, Noonan, and Reichman (2005) attempt to control for the potential endogeneity of child health by using the number of adoption agencies per 10,000 women in the city in which the child was born and the presence of a Level III neonatal intensive care unit in the hospital where the baby was delivered.

Our data source is the Longitudinal Study of Australian Children (LSAC), which collected detailed information from parents and teachers on the development and welfare of children aged 4-5 in 2004. As measures of development, we use teacher assessments of children's relative performance in five developmental areas: (1) Emotional, (2) Learning, (3) Language, (4) Gross Motor and (5) Fine Motor. It is an advantage that we can use objective measures of development rather than measures based on parental reports as such reports may suffer from measurement error. The use of multiple teacher assessed measures spanning various aspects of child development is an additional improvement on most previous work within this general literature.

We find evidence of a strong and robust causal impact of poor early child development on maternal labor force participation, with the results from instrumental variables models suggesting that mothers with a poorly developed child are approximately 25 percentage points less likely to participate in the labor force than other mothers. The considerable difference we find between the magnitude of this estimated effect and single equation estimates from other studies is likely caused by a strong negative impact of maternal participation on child development.

Understanding impediments to labor market participation is critical, especially when designing policies aimed at improving family welfare. Our results are an important contribution to knowledge within this area. In addition, our results have important consequences for the literature that examines the impact of child development on maternal employment. Given the difficulty in finding a variable that is correlated with child development and not maternal employment (i.e. a valid instrument), most studies struggle to identify the causal impact. Our results therefore provide new evidence on the likely direction and size of bias in previous studies' estimates.

2 Theoretical Framework

To help motivate our study of the relationship between child development and maternal labor market participation we highlight a simple model of labor supply in the context of time-constraints and child development. Formally, we have the following utility framework:

$$U = u_1(Y_0 + wl) + \alpha u_2(CD_0 + b(T - l)) - cI_{l>0} \quad \text{where} \quad 0 \leq l \leq T \tag{1}$$

Here, $u_1(Y(l))$ denotes the utility derived from income, where income depends on initial wealth Y_0 and labor income, which consists of labor time l and the wage level w. Utility also depends on child development $CD = CD_0 + b(T - l)$ which hence depends on initial talent CD_0 and on the total amount of time available to the mother minus time spent at work $(= T - l)$. Both $u_1(.)$ and $u_2(.)$ are taken to be increasing at decreasing rates. This reflects the classic argument (Gossen's First Law) that there are decreasing returns to each consumption good, of which child development is one aspect and material consumption another. $I_{l>0}$ is an indicator function of whether labor supply is positive. The variable c denotes a fixed-cost of working in the formal sector and applies whenever $l > 0$. We in principle think of c as varying over individuals. The parameter $\alpha > 0$ denotes the degree to which the mother cares for (or has the responsibility for) the development of the child.

Now, simple maximization in an interior solution begets the solution equation for l :

$$wu_1'(Y_0 + wl) = \alpha b u_2'(CD_0 + b(T - l)) \tag{2}$$

The interesting aspects of this solution are in the comparative statics:

$$\frac{dl}{dCD_0} = \frac{\alpha b u_2''}{w^2 u_1'' + \alpha b^2 u_2''} > 0 \tag{3}$$

$$\frac{dl}{d\alpha} = \frac{b u_2'}{w^2 u_1'' + \alpha b^2 u_2''} < 0 \tag{4}$$

and:

$$\frac{dl}{dY_0} = \frac{-w u_1''}{w^2 u_1'' + \alpha b^2 u_2''} < 0 \tag{5}$$

$$\frac{dl}{dw} = \frac{u_1' + lwwu_1''}{w^2 u_1'' + \alpha b^2 u_2''} >< 0 \qquad (6)$$

The intuition behind these results is simple: (1) A higher innate level of child development makes the female less concerned about her child and thereby increases her supply of labor to the formal economy (equation 3); (2) A greater weight of child development in the utility function increases the concern of the female with that development and decreases labor supply (equation 4); (3) A greater initial wealth reduces the level of concern with income and thereby decreases labor supply (equation 5); (4) The effect of wages on labor supply is a mix of the substitution effect and the income effect with an ambiguous overall effect (equation 6). The main prediction we are interested in testing is that lower initial child development decreases female labor supply, with our attention focused on the extensive labor force participation decision.

When considering the labor supply decision, the question of whether $l > 0$ depends on the sign of the welfare gain W of working:

$$W = u_1(Y_0 + wl^*) + \alpha u_2(CD_0 + b(T - l^*)) - c - u(Y_0) - \alpha u_2(CD_0 + bT)$$

where l^* is the solution to equation (2). If this expression is positive, $l = l^*$ and $l = 0$ otherwise. For this expression we can use the results above to see that there holds $\frac{dW}{dCD_0} > 0$, $\frac{dW}{d\alpha} < 0$, $\frac{dW}{dY_0} < 0$, $\frac{dW}{dw} > 0$ and $\frac{dW}{dc} < 0$. This in turn indicates again that the individual is more likely to supply labor if CD_0 is higher, α is lower, Y_0 is lower w is higher and c is lower.

To see how this participation equation works, consider the outcomes if we take a first-order approximation for u_1 (=$\mu_0(Y_0 + wl)$) and a second-order approximation for u_2 (=$\lambda_0\alpha(CD_0 + bT) - \lambda_1\alpha(CD_0 + bT)^2$) while we interpret c as coming from a distribution. After some manipulations we get $l^* = \max\{\frac{CD_0+T}{b} - \frac{\lambda_0}{2\lambda_1 b} - \frac{\mu_0 w}{2\alpha b^2 \lambda_1 b}, 0\}$ and the participation equation becomes:

$$P\{l > 0\} = P\{c < \mu_0 wl^* - \lambda_0 \alpha bl^* + \lambda_1 \alpha(2b(T - l^*)CD_0)\} \qquad (7)$$

which is the equation we would like to estimate. In empirical estimation, a prime difficulty is the two-way causality that comes in via the effect $b(T - l^*)$ on child development of time spent away from work. This leads to a classic endogeneity problem. This is confounded by the problem of variables that are missing in empirical data: we cannot measure α or even measure Y_0 or CD_0 very well. However, it is unlikely that these key parameters are uncorrelated with each other. There are for instance good reasons to suspect that genetic endowments positively link initial wealth Y_0 and initial child development CD_0, which creates a downward bias in the correlation between child development and female labor supply. It is also quite possible that α and CD_0 are positively correlated in which case there is an upward bias in the correlation between child development and female labor supply, which is a classic endogeneity problem.

What is needed to overcome these endogeneity problems between child development and female labor supply is an instrument that is uncorrelated with α, Y_0, c, and w but that is correlated with CD_0. In an empirical context this translates to the need for an instrument that is uncorrelated with the unobserved aspects of α, Y_0, c, and w which cannot be adequately controlled for by observable characteristics. Assuming that there exists such an instrument z, our statistical model becomes:

$$l^* = \beta_1 x + \gamma_1 CD + u \qquad \text{where} \qquad l = I(l^* > 0) \tag{8}$$

and

$$CD^* = \beta_2 x + \gamma_2 l + \delta z + v \qquad \text{where} \qquad CD = I(CD^* > 0) \tag{9}$$

where

$$\begin{pmatrix} u \\ v \end{pmatrix} \sim N(\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix})$$

l^* represents latent (desired) female labor supply while l denotes actual labor supply, CD represents child development, x is a set of exogenous common regressors, u and v are the error terms, and z is the instrument. Equation 8 can be structurally interpreted as the first-order approximation to equation 7. Equation 9 is a re-writing of the model assumption that $CD = CD_0 + b(T - l)$ which allows us to interpret γ_2 as an estimate of b.

Moving to our empirical specification, the Likelihood of observing particular combinations of child development and labor force participation reads:

$$
\begin{aligned}
L(CD_i &= 1, l_i = 1|\beta, \gamma, \delta, x, z) = \int_{-(\beta_2 x + \gamma_2 l + \delta z)} \int_{-(\beta_1 x + \gamma_1 CD)} \phi(u)\phi(v) du dv \\
&= \Phi(\beta_1 x + \gamma_1)\Phi(\beta_2 x + \gamma_2 + \delta z) \\
L(CD_i &= 1, l_i = 0|\beta, \gamma, \delta, \sigma^2, x, z) = \int_{-(\beta_2 x + \gamma_2 l + \delta z)} \int_{-(\beta_1 x + \gamma_1 CD)} \phi(u)\phi(v) du dv \\
&= \Phi(-(\beta_1 x + \gamma_1))\Phi(\beta_2 x + \delta z) \\
L(CD_i &= 0, l_i = 1|\beta, \gamma, \delta, x, z) = \Phi(\beta_1 x)\Phi(-(\beta_2 x + \gamma_2 + \delta z)) \\
L(CD_i &= 0, l_i = 0|\beta, \gamma, \delta, x, z) = \Phi(-\beta_1 x)\Phi(-(\beta_2 x + \delta z))
\end{aligned}
$$

We can calculate the marginal effects of a variable x^k as the average of the marginal of everyone in the sample:

$$ME(x^k) = \frac{1}{N} \sum_i \frac{\delta P(l_i = 1|x_i, CD_i, \hat{\beta}, \hat{\gamma}, \hat{\delta})}{\delta x_i^k}$$

where x_i is a vector of characteristics with x_i^k the k'th element in that vector. The marginal effect of child development on maternal labor force participation is: $ME(x) = \frac{1}{N} \sum_i \{P(l_i = 1CD_i = 1) - P(l_i = 1CD_i = 0)\}$.

3 Data, Definitions and Sample Characteristics

The data we use is drawn from the 1st wave of the Longitudinal Study of Australian Children (LSAC) collected in 2004.[2] LSAC aims to examine the impact of Australia's unique social and cultural environment on the next generation to further the understanding of early childhood development, inform social policy debate, and identify opportunities for early intervention in policy areas concerning children. The study tracks two cohorts of infants and children

[2]The LSAC website is: www.aifs.gov.au/growingup/home.html.

over seven years: (1) children less than 12 months in 2003-4 who will be followed until they reach 6 to 7 years of age and (2) children aged 4-5 years in 2003-4 who will be followed until they reach 10 or 11 years. In this paper we use information on just under 5000 children from the older cohort, children aged 4-5 (83% are 4). Data on one child from each household is collected using a clustered (by postcode) sample design, and it is intended that the samples be representative of all Australian children in each of the selected age cohorts.[3] However, children in the remotest areas of Australia are less likely to be captured in the data.

The data we use are collected from both parents and the child's pre-school or kindergarten teacher. The interviews with parents are conducted face-to-face by a trained interviewer in the child's home, and the interviewer also undertakes direct observations and assessments of the child. The interview for the older cohort takes an average 2.5 hours, so the interviewer is in a strong position to provide assessments of the child.

Information on the handedness of each child is given by the LSAC interviewer. In particular, the interviewer is asked to determine dominant handedness immediately after the child conducts lengthy tasks that involve the child copying shapes, writing words and writing numbers. The interviewer is asked "Did the child use his/her (1) right hand, (2) left hand, or (3) both hands?" Since we use an interviewer assessed measure of dominant handedness, we do not have to worry about parents who might misreport handedness of their child due to their own preferences for having a right-handed child.[4] Using this measure, approximately 10% of the children are assessed to be left-handed and approximately 4% of the children are assessed to be mixed-handed (see Table A-1).[5] While it has been documented that the majority of children have already developed a clear hand preference at 6 months of age, a small minority of children will show no strong preference until later in life (see Bishop (1990)), and so some mixed-handed children may still develop a preference for one hand over another as they become older.

[3]More details of the sampling design can be found in Gray and Sanson (2005).

[4]For example, historically, there has been a tendency towards cultural censorship of left-handedness in certain Asian countries (e.g. Meng (2007)).

[5]While the incidence of left-handedness obviously varies across cultures and over time, 10% of the world population would be classified (or classify themselves) as left-handed on average (Denny and Sullivan, 2007).

The data from the teachers is collected via mail questionnaires. We use teacher evaluations of children's relative performance in five skill areas as our primary measures of child development. The use of multiple teacher assessed measures spanning various aspects of child development is an improvement on most previous work within this general literature. In addition, we use objective teacher assessed measures of child development rather than more subjective measures based on parental reports. Parental reports are more likely to be biased and suffer from measurement error. It does appear that teachers keep parent's informed and so the teacher measures reflect objective parental assessments (which we don't observe). For example, the survey finds that 80% of parents believe their child's teacher does well at informing them about their child's progress.

We have teacher assessments for around 65% of the children because not all children attend a program with a teacher and some teachers do not complete the postal survey. More specifically, 5% of children in the sample did not attend pre-school or kindergarten, 2% of the parents did not give permission for the survey organizers to contact the child's teacher, and 28% of the children had teachers who did not return a completed survey.[6]

Teachers were asked to think about the skills and competencies of the study child (as described in the next statements), and then to rate each child compared to other children of a similar age over the past few months. The five statements were:

1. Social/emotional development (e.g. adaptability, cooperation, responsibility, self-control)
2. Approaches to learning (e.g. attention, observation, organization, problem-solving)
3. Gross motor skills (e.g. running, catching and throwing balls, strength and balance)
4. Fine motor skills (e.g. manual dexterity, using writing and drawing tools)
5. Receptive language skills (e.g. understanding, interpreting and listening)

[6]We examined the possibility of sample selection by regressing the teacher's decision to complete and return the survey on a wide-range of child, parental and household characteristics, and found no evidence that these characteristics are significantly associated with the teacher's decision to provide the assessment. Furthermore, we tested whether a child's handedness significantly influences the probability of having a completed teacher survey, and found that it does not.

Pre-school and/or kindergarten teachers were asked to give one of four possible responses: much less competent than others, less competent than others, as competent as others, and more competent than others.[7] From these responses, we create a set of binary measures that equal one if the child is assessed as 'less competent' or 'much less competent' than other children.

Table 1 presents simple correlation coefficients and the percentage of children that are assessed by their teacher to be poorly developed for each pair of measures. More specifically, it shows the proportion of children identified by each poor development measure and the extent to which these measures are identifying the same children. For example, the correlation coefficient between the measures gross-motor skills and fine-motor skills is 0.38, and 6.2 percentage of children are poorly developed in both of these skills. Two important results are gained from Table 1. First, there are large differences by measure in the proportion of children being identified as poorly developed. For example, teachers rated 22.3 percent of children as having poor social/emotional skills[8], but only rated 10.6 percent of children as having poor gross-motor skills. Second, the development measures are, on the whole, identifying different groups of children. The largest correlation coefficient equals 0.63 (language and learning) and the smallest correlation coefficient is 0.27 (language and gross motor).

In Table 2 we present raw data on the percent of mothers who participate in the labor force, both for children who are poorly developed and for all other children. These estimates show that mothers of poorly developed children are much less likely to participate relative to other mothers - the smallest difference is 8.9 percentage points and the largest difference is 14.4 percentage points. The aim of this paper is to determine whether these large raw differences in maternal participation remain, once we have controlled for the effects of observable and unobservable characteristics.[9]

[7] Teachers were also asked to evaluate children on their expressive language skills. In our sample, handedness is not strongly related to expressive language development and so we do not present estimates of the impact that these measures have on maternal labor force participation. See Johnston, Shah, and Shields (2007) for more details.

[8] This is very close to the percentage of US children found by Currie and Stabile (2005) to have a mental disorder.

[9] Table A-1 presents summary statistics for all other variables that we use in our empirical models.

4 Using Handedness as an Instrumental Variable

To overcome the potential endogeneity problems between child development and maternal labor force participation, we require a valid instrument. This instrument must be (i) strongly correlated with the child development measures; and (ii) uncorrelated with maternal labor force participation, except through child development.

The relationship between child handedness and the probability of being assessed as less or much less competent than other children is shown in Figure 1. The figure indicates that both left-handed and mixed-handed children perform much worse in all skill areas. Furthermore, these significant development differences are not diminished when we control for family characteristics (see results in Johnston, Shah, and Shields (2007)). Thus, handedness is a strong and significant predictor of child development.

The psychology literature proposes two main theories for why left-handed children may have lower cognitive ability. The first is that left-handedness is caused by pre-natal stress (Bakan, Dibb, and Reed (1973)). For example, an elevated incidence of left-handedness has been reported in children who have suffered bacterial meningitis (Ramadhani, Koomen, Grobbee, van Donselaar, van Furth, and Uiterwaal (2006)). This is in principle a 'valid' source of variation as long as we manage to control for other potential impacts of pre-natal stress. Therefore, we include variables in all models that are correlated with the incidence of pre-natal stress, namely, child's birth weight, whether child required intensive care after birth, whether child born premature, whether child a twin or triplet; and whether at age 4 child requires medication. We also include a measure of whether the mother has poor health in order to control for any potential correlation between pre-natal stress and mother's health in subsequent years.

The second explanation is that left-handedness is caused by the inheritance of a recessive gene that negatively affects cognitive ability (Annett and Manning (1989)). The implication of this explanation for our assumption of IV exogeneity is that it is possible that mothers of left-handed children are more likely to be left-handed. If for example, left-handed mothers have worse labor market outcomes than right-handed mothers, our results might be biased.

While current evidence suggests that there is a labor market premium for left-handed men compared to right-handed men, the evidence for women is very weak and inconclusive (Denny and Sullivan (2007); Ruebeck, Harrington, and Moffitt (2007)). In fact, there does not exist any female handedness differential in the United States (Ruebeck, Harrington, and Moffitt (2007)), and only weak support of this proposition in Great Britain (Denny and Sullivan (2007)). Furthermore, the bias this link would generate would be in the 'opposite direction', i.e. the link would create a positive correlation between our observed child development and initial wealth, which would mean that the true labor market response of poor child development is even larger than we estimate.

Ideally, we would control for the genetic link by including maternal handedness in our empirical models. Unfortunately however, information on maternal handedness is not collected in LSAC. So, we instead include an indicator of whether the mother worked while pregnant with the study child. This variable acts as a proxy for labor market attachment and given its lagged nature is unaffected by child development. Importantly, even though this variable is a strong predictor of current maternal labor force participation, the estimated IV effects of child development are not sensitive to its inclusion, suggesting that this potential confounding factor is unimportant.

5 Estimation Results

We present estimation results based on the theoretical framework outlined in Section 2. But first, we present regression results from the effect of child development on maternal labor force participation. As previously mentioned, these estimates may be upward or downward biased, depending upon the effect that maternal employment has on child development. We present probit estimates in-spite of the bias, so that we can compare our estimates with other studies in the literature, since none employ IV techniques. The estimates are presented in columns (1) and (2) of Table 4. The results in column (1) are from a basic model which include controls such as gender, age, birth weight, number of older and younger siblings, mother's age and age squared, and dummy variables for mothers highest educational attainment and maternal employment during pregnancy. The results in column (2) include all of the basic model controls as well as an expanded set of potentially endogenous controls such as single mother status, mother and father's health, dummy variables for father's labor force status, father's weekly income and neighborhood socioeconomic status.[10] The summary statistics for the variables used in the regressions are presented in Appendix Table A-1.

The estimates in Table 4 are strikingly consistent in magnitude across development measures and model specifications. They indicate that mothers of poorly developed children are approximately 6 percentage points less likely to participate in the labor force than other mothers. Interestingly, the magnitude of our probit results are similar in size to previous findings. For example, Powers (2003) shows that having a child who is unable to do age-standard activities reduces wives' labor force participation by 6 percentage points and single mothers labor force participation by 11 percentage points. However, while acknowledging the possibility of biased results, the paper does not control for the endogeneity of child development. We now move to the estimation proposed from the theoretical framework, where we use handedness to instrument for child development.

In Table 3, we report on the effect of handedness on our child development measures (corresponding to δ in equation (9)). The estimates show that handedness significantly affects each of the various measures of child development. Overall left and mixed-handed children fare worse than right-handed children, yet there is some variation in the magnitudes. For example, left-handed children are 10 percentage points more likely to have poor fine motor skills than right-handed children, but only 5 percentage points more likely to have poor language skills. Most importantly, the instruments are jointly significant in each instance, indicating that we do not have to worry about a weak instruments problem.

The main results of this paper are presented in columns (3)-(6) of Table 4.[11] They represent the estimates of γ_1 from equation (8), which correspond to the effect of child development on participation, and the estimates of γ_2 from equation (9), which correspond

[10]We do not include household income in the models due to concerns of endogeneity. However, when we do include income in the regressions, we find that household income is a significant positive predictor of child development. It is not significant in the maternal labor force participation equation.

[11]Full results are shown in Tables A-2–A-5.

to the effect of participation on child development. The estimates of γ_1, which are average marginal effects, are reasonably consistent across the two model specifications, ranging between 0.2 and 0.3, and are all significant at the .01 or .05 level. They suggest that mothers with a poorly developed child are approximately 25 percentage points less likely to participate in the labor force than other mothers.[12] Given that the average rate of maternal labor force participation in the sample is 60 percent, it is clear that mothers react very strongly to having a poorly developed child.[13] Our IV estimates of the effect of child development on maternal labor supply are much larger than the probit estimates reported above. The most likely reason for the difference is that unobserved maternal ability and child health are positively correlated biasing the single equation results.

The estimates of γ_2, while less statistically significant, are all correctly signed, with non-participation in the labor force improving child development. Note that this must be true, otherwise we would observe mothers choosing to increase their labor supply in order to improve the development of their child. Importantly, this result helps explain why we obtain estimates of γ_1 that are much more negative than the corresponding probit estimates of 6 percentage points.

6 Conclusion

It is well documented that the proportion of children who have development problems, particularly related to mental health, has increased substantially in developed countries in recent decades. In this paper we provide a contribution to the general literature on child development by estimating the causal effect that poor early child development has on maternal labor force participation. Mothers of poorly developing children may choose to

[12] As a robustness check, we estimate these same models using a linear specification. These estimates also suggest that poor development has a large negative impact on maternal labor force participation. For example, the estimated effect of poor fine motor skills equals -0.38 (z-statistic equals 2.07). Therefore our main findings with respect to the effect of child development on maternal labor force participation are unchanged.

[13] Importantly, these results also hold when we drop mixed-handed children from the sample and use only left versus right-handed children as the instrument. This implies that it is not the case that mixed-handed children are driving the identification because they are in some unobservable way “different” from other children.

remain at home in order to care for their children, or alternatively they may decide to enter the labor force in order to increase the household budget. The aim of this paper has therefore been to establish which one of these two labor market responses empirically dominates, and we have provided a simple theoretical model of labor supply in the context of time-constraints and child development to motivate our empirical modelling. The particular innovation of this paper is to use natural variation in child handedness, which has been shown to be a strong predictor of early childhood development, as an instrument to tackle endogeneity concerns. We believe that this paper is the first to use handedness as an instrument, but that handedness has the potential to be used in other contexts as an aid to empirical identification.

Using data for a large sample of Australia children aged 4 and 5, and utilizing multiple teacher assessments of a child's relative competencies over a variety of aspects including social/emotional development as our measures of child development, we find that having a relatively poorly developing child leads to a large maternal labor market response. In fact we estimate that a mother with a poorly developing child has around a 20 percentage point lower probability of participating in the labor market than a mother with a young child who is doing well in terms of development. One reason our estimates are larger than previous studies might be due to the young age of our sample. We focus on child development of young pre-school children, and labor market responses of mothers might be different (i.e. less responsive) for older children.

We believe that our results also have an important implication for the literature that has investigated the impact of maternal labor supply on child development (i.e. the reverse relationship). Typically, these studies do not use IV methods to control for the potential endogeneity of maternal labor supply, and instead have to assume that their set of covariates is sufficiently large to control for any important unobservable characteristics (see Ruhm (2004); Gregg, Washbrook, Propper, and Burgess (2005)). Our finding that mothers react strongly to their child's development by reducing their labor force participation when their children have developmental problems, indicate that previous estimates may suffer from endogeneity bias. Such bias would make it appear that maternal employment has a more positive (less negative) impact on child development than it in fact does. Our results also mean that policies designed to stimulate mothers of poorly developed children to find formal employment may have adverse consequences for child development.

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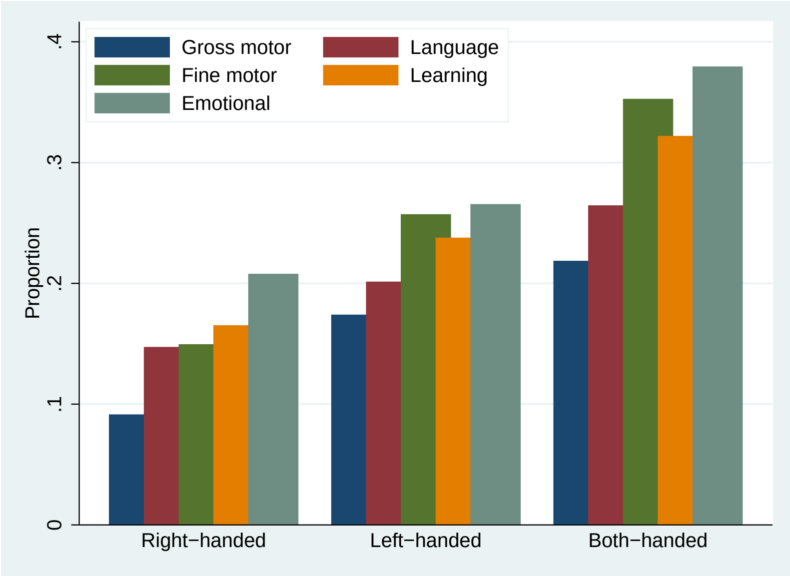

Figure 1: Proportion of Poorly Developed Children by Handedness

Table 1: Correlations and Overlap Across Child Development Measures

	Gross Motor	Fine Motor	Language	Learning	Emotional
Gross Motor	1.00				
	[10.6]				
Fine Motor	0.38	1.00			
	[6.2]	[17.1]			
Language	0.27	0.42	1.00		
	[4.7]	[8.4]	[15.9]		
Learning	0.32	0.55	0.63	1.00	
	[5.6]	[11.1]	[11.8]	[18.1]	
Emotional	0.28	0.38	0.45	0.54	1.00
	[5.9]	[9.8]	[10.3]	[12.6]	[22.3]

The reported results are correlation coefficients. The results in brackets are the proportion of poorly developed children in both skill areas. Sample size equals 3172.

Table 2: Differences in Maternal Labor Force Participation by Child Development

	Poor Development	All Others	Difference
Gross Motor	0.535	0.624	-0.089***
	(0.026)	(0.009)	(0.028)
Fine Motor	0.537	0.631	-0.093***
	(0.021)	(0.009)	(0.023)
Language	0.493	0.637	-0.144***
	(0.021)	(0.009)	(0.023)
Learning	0.521	0.635	-0.114***
	(0.020)	(0.009)	(0.022)
Emotional	0.533	0.638	-0.105***
	(0.018)	(0.010)	(0.021)

Figures in parentheses are standard errors. Sample size equals 3172.
*** denotes sample means differ at 1% level.

Table 3: Effect of Handedness on Child Development

	Basic		Expanded	
	Left	Mixed	Left	Mixed
	(1)	(2)	(3)	(4)
Gross Motor	0.094***	0.129***	0.092***	0.128***
	(0.026)	(0.035)	(0.026)	(0.035)
Fine Motor	0.103***	0.160***	0.101***	0.161***
	(0.026)	(0.036)	(0.026)	(0.036)
Language	0.049**	0.099***	0.046*	0.103***
	(0.025)	(0.035)	(0.025)	(0.035)
Learning	0.068***	0.128***	0.065**	0.134***
	(0.026)	(0.036)	(0.025)	(0.036)
Emotional	0.057**	0.143***	0.053***	0.143***
	(0.027)	(0.037)	(0.026)	(0.037)

The reported marginal effect estimates correspond to estimates of $\widehat{\delta}$ in equation 8 (i.e the effect of handedness on child development). Basic controls include gender, age, birth weight, number of siblings, mother's age and age squared, mothers highest educational attainment and maternal employment during pregnancy. Expanded controls include basic as well as single mother status, mother and father's health, father's labor force status, father's weekly income and neighborhood socioeconomic status. The χ^2 critical value at the 0.1% level equals 13.82. Figures in parentheses are standard errors. Sample size equals 3172. ***indicates significance at 1% level, ** at 5% level, * at 10% level.

Table 4: Estimates of Relationship between Poor Development and Maternal Labor Force Participation

	Probit		IV Model			
	Basic	Expanded	Basic		Expanded	
	γ_1	γ_1	γ_1	γ_2	γ_1	γ_2
	(1)	(2)	(3)	(4)	(5)	(6)
Gross Motor	-0.072***	-0.067***	-0.288***	0.096	-0.264***	0.087
	(0.026)	(0.026)	(0.097)	(0.060)	(0.100)	(0.060)
Fine Motor	-0.053**	-0.046**	-0.203**	0.087	-0.205**	0.092*
	(0.022)	(0.022)	(0.093)	(0.059)	(0.088)	(0.056)
Language	-0.069***	-0.064***	-0.286***	0.121*	-0.270***	0.114*
	(0.022)	(0.022)	(0.092)	(0.062)	(0.089)	(0.059)
Learning	-0.067***	-0.065***	-0.215**	0.092	-0.206**	0.088
	(0.021)	(0.021)	(0.093)	(0.063)	(0.088)	(0.059)
Emotional	-0.064***	-0.059***	-0.294***	0.156**	-0.294***	0.159**
	(0.020)	(0.020)	(0.094)	(0.069)	(0.098)	(0.072)

The reported marginal effects are the average estimated change in probability of participation. Basic controls include gender, age, birth weight, number of siblings, mother's age and age squared, mothers highest educational attainment and maternal employment during pregnancy. Expanded controls include basic as well as single mother status, mother and father's health, father's labor force status, father's weekly income and neighborhood socioeconomic status. Figures in parentheses are standard errors. Sample size equals 3172. ***indicates significance at 1% level, ** at 5% level, * at 10% level.

Table A-1: Sample Descriptive Statistics

	All		Mother Non-Participant		Mother Participates	
Mother Participates	0.615	(0.009)	0.000	(0.000)	1.000	(0.000)
Left-handed	0.100	(0.005)	0.116	(0.009)	0.090**	(0.007)
Mixed-handed	0.054	(0.004)	0.061	(0.006)	0.050	(0.005)
Male	0.509	(0.009)	0.527	(0.014)	0.498	(0.011)
Aged 5 years	0.179	(0.007)	0.173	(0.011)	0.182	(0.009)
Birth weight	3.408	(0.010)	3.387	(0.017)	3.421	(0.013)
Intensive-care birth	0.148	(0.006)	0.152	(0.010)	0.146	(0.008)
Premature birth	0.113	(0.006)	0.122	(0.009)	0.107	(0.007)
Multiple birth	0.028	(0.003)	0.027	(0.005)	0.029	(0.004)
Needs Medication	0.125	(0.006)	0.128	(0.009)	0.123	(0.007)
No. of older siblings	0.899	(0.018)	0.985	(0.028)	0.844***	(0.022)
No. of younger siblings	0.549	(0.011)	0.701	(0.018)	0.453***	(0.014)
Mother's age	34.622	(0.102)	33.825	(0.164)	35.122***	(0.130)
Mother's age squared	12.324	(0.067)	11.893	(0.108)	12.595***	(0.085)
Mother has degree	0.300	(0.008)	0.212	(0.013)	0.355***	(0.010)
Mother has diploma/certificate	0.337	(0.008)	0.313	(0.013)	0.352**	(0.011)
Mother high school graduate	0.156	(0.006)	0.179	(0.010)	0.141***	(0.008)
Mother Australian	0.760	(0.008)	0.710	(0.012)	0.791***	(0.010)
Mother worked while pregnant	0.601	(0.009)	0.408	(0.013)	0.722***	(0.010)
Mother has poor health	0.080	(0.005)	0.099	(0.008)	0.068***	(0.006)
Neighborhood SES	10.080	(0.015)	10.005	(0.023)	10.127***	(0.018)
Single mother	0.122	(0.006)	0.139	(0.009)	0.112**	(0.007)
Father works full-time	0.788	(0.007)	0.745	(0.012)	0.815***	(0.009)
Father works part-time	0.041	(0.004)	0.044	(0.006)	0.039	(0.004)
Father's weekly income	7.954	(0.142)	7.754	(0.228)	8.079	(0.181)
Father has poor health	0.080	(0.005)	0.080	(0.008)	0.080	(0.006)
Sample size	3172		1220		1952	

Figures are sample means. Standard errors are reported in parentheses. *** denotes sample means differ between working and non-working mothers at 1% level, ** at 5% level, and * at 10% level.

Table A-2: Full IV Estimates for Maternal Labor Force Participation Models (Basic)

	Gross Motor		Fine Motor		Language		Learning		Emotional	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Poor development measure	-0.288	(0.097)	-0.203	(0.093)	-0.286	(0.092)	-0.215	(0.093)	-0.294	(0.094)
Male	-0.017	(0.016)	0.019	(0.028)	0.009	(0.020)	0.009	(0.022)	0.027	(0.023)
Age	0.008	(0.021)	0.021	(0.020)	0.025	(0.020)	0.021	(0.020)	0.021	(0.020)
Birth weight	0.016	(0.016)	0.009	(0.016)	0.008	(0.016)	0.007	(0.016)	0.013	(0.015)
Intensive-care birth	0.023	(0.024)	0.015	(0.024)	0.014	(0.024)	0.013	(0.024)	-0.001	(0.024)
Premature birth	0.010	(0.031)	-0.001	(0.030)	-0.006	(0.029)	-0.004	(0.029)	-0.004	(0.029)
Multiple birth	-0.057	(0.053)	-0.062	(0.053)	-0.057	(0.053)	-0.078	(0.053)	-0.049	(0.052)
Needs Medication	0.018	(0.024)	0.007	(0.023)	0.016	(0.024)	0.012	(0.023)	0.016	(0.023)
No. of older siblings	-0.023	(0.009)	-0.019	(0.009)	-0.019	(0.009)	-0.019	(0.009)	-0.022	(0.009)
No. of younger siblings	-0.176	(0.012)	-0.179	(0.012)	-0.175	(0.013)	-0.184	(0.011)	-0.176	(0.013)
Mother's age	0.025	(0.008)	0.024	(0.008)	0.024	(0.008)	0.024	(0.008)	0.020	(0.008)
Mother's age squared	-0.038	(0.012)	-0.037	(0.011)	-0.037	(0.011)	-0.038	(0.011)	-0.031	(0.012)
Mother has degree	0.162	(0.022)	0.155	(0.023)	0.138	(0.027)	0.154	(0.025)	0.146	(0.025)
Mother has diploma/certificate	0.119	(0.020)	0.111	(0.022)	0.110	(0.021)	0.117	(0.021)	0.112	(0.021)
Mother high school graduate	0.038	(0.025)	0.037	(0.026)	0.040	(0.025)	0.037	(0.026)	0.030	(0.026)
Mother Australian	0.068	(0.019)	0.078	(0.018)	0.053	(0.021)	0.071	(0.019)	0.072	(0.018)
Mother worked while pregnant	0.271	(0.019)	0.276	(0.018)	0.257	(0.021)	0.268	(0.020)	0.251	(0.024)

This table reports all marginal effect estimates for the Basic model reported in column (3) of Table 4. Figures in parentheses are standard errors. Sample size equals 3172.

Table A-3: Marginal Effect Estimates for Child Development Equation (Basic)

	Gross Motor		Fine Motor		Language		Learning		Emotional	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Maternal LF participation	0.096	(0.060)	0.087	(0.059)	0.121	(0.062)	0.092	(0.063)	0.156	(0.069)
Male	0.009	(0.013)	0.179	(0.019)	0.094	(0.016)	0.123	(0.017)	0.142	(0.018)
Age	-0.024	(0.015)	0.022	(0.018)	0.030	(0.019)	0.034	(0.019)	0.015	(0.020)
Birth weight	-0.008	(0.012)	-0.045	(0.013)	-0.040	(0.014)	-0.050	(0.014)	-0.021	(0.015)
Intensive-care birth	0.030	(0.020)	0.011	(0.021)	0.021	(0.022)	0.029	(0.023)	-0.026	(0.023)
Premature birth	0.053	(0.027)	0.054	(0.028)	-0.004	(0.025)	0.002	(0.026)	0.026	(0.030)
Multiple birth	0.048	(0.041)	0.011	(0.041)	0.037	(0.045)	0.014	(0.044)	0.044	(0.050)
Needs Medication	0.037	(0.020)	-0.006	(0.020)	0.027	(0.021)	0.033	(0.022)	0.033	(0.023)
No. of older siblings	-0.012	(0.007)	0.006	(0.008)	0.003	(0.008)	0.003	(0.008)	-0.005	(0.009)
No. of younger siblings	0.020	(0.014)	0.016	(0.015)	0.019	(0.015)	-0.006	(0.016)	0.015	(0.018)
Mother's age	-0.006	(0.004)	-0.008	(0.005)	-0.005	(0.005)	-0.005	(0.005)	-0.016	(0.006)
Mother's age squared	0.011	(0.007)	0.012	(0.007)	0.008	(0.007)	0.007	(0.008)	0.026	(0.009)
Mother has degree	-0.046	(0.018)	-0.080	(0.019)	-0.124	(0.018)	-0.107	(0.019)	-0.104	(0.021)
Mother has diploma/certificate	-0.031	(0.016)	-0.069	(0.017)	-0.061	(0.017)	-0.048	(0.018)	-0.055	(0.020)
Mother high school graduate	-0.035	(0.018)	-0.050	(0.019)	-0.041	(0.019)	-0.058	(0.019)	-0.069	(0.022)
Mother Australian	-0.023	(0.015)	-0.002	(0.016)	-0.071	(0.016)	-0.025	(0.017)	-0.022	(0.018)
Mother worked while pregnant	-0.046	(0.019)	-0.049	(0.021)	-0.096	(0.020)	-0.079	(0.021)	-0.106	(0.023)
Left-handed	0.094	(0.026)	0.103	(0.026)	0.049	(0.025)	0.068	(0.026)	0.057	(0.027)
Mixed-handed	0.129	(0.035)	0.160	(0.036)	0.099	(0.035)	0.128	(0.036)	0.143	(0.037)

This table reports all marginal effect estimates for the Basic model reported in column (4) of Table 4. Figures in parentheses are standard errors. Sample size equals 3172.

Table A-4: Full IV Estimates for Maternal Labor Force Participation Models (Expanded)

	Gross Motor		Fine Motor		Language		Learning		Emotional	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Poor development measure	-0.264	(0.100)	-0.205	(0.088)	-0.270	(0.089)	-0.206	(0.088)	-0.294	(0.098)
Male	-0.019	(0.016)	0.018	(0.027)	0.006	(0.020)	0.006	(0.021)	0.026	(0.023)
Age	0.009	(0.021)	0.021	(0.020)	0.023	(0.020)	0.020	(0.020)	0.020	(0.020)
Birth weight	0.016	(0.016)	0.008	(0.016)	0.008	(0.016)	0.007	(0.016)	0.013	(0.015)
Intensive-care birth	0.022	(0.024)	0.016	(0.024)	0.015	(0.024)	0.013	(0.024)	0.000	(0.024)
Premature birth	0.013	(0.031)	0.004	(0.030)	-0.003	(0.029)	0.000	(0.029)	0.000	(0.029)
Multiple birth	-0.061	(0.053)	-0.065	(0.053)	-0.057	(0.053)	-0.079	(0.053)	-0.051	(0.052)
Needs Medication	0.017	(0.024)	0.007	(0.023)	0.015	(0.024)	0.012	(0.023)	0.015	(0.023)
No. of older siblings	-0.026	(0.009)	-0.023	(0.009)	-0.022	(0.009)	-0.022	(0.009)	-0.025	(0.009)
No. of younger siblings	-0.180	(0.012)	-0.181	(0.012)	-0.177	(0.013)	-0.187	(0.011)	-0.178	(0.014)
Mother's age	0.025	(0.008)	0.023	(0.008)	0.024	(0.008)	0.024	(0.008)	0.020	(0.008)
Mother's age squared	-0.038	(0.012)	-0.036	(0.011)	-0.037	(0.011)	-0.037	(0.011)	-0.030	(0.012)
Mother has degree	0.171	(0.022)	0.162	(0.023)	0.150	(0.026)	0.163	(0.024)	0.156	(0.025)
Mother has diploma/certificate	0.118	(0.020)	0.108	(0.022)	0.111	(0.021)	0.116	(0.020)	0.111	(0.021)
Mother high school graduate	0.036	(0.025)	0.034	(0.026)	0.040	(0.025)	0.036	(0.025)	0.029	(0.026)
Mother Australian	0.066	(0.019)	0.074	(0.018)	0.052	(0.021)	0.069	(0.019)	0.068	(0.018)
Mother worked while pregnant	0.270	(0.018)	0.273	(0.017)	0.257	(0.020)	0.267	(0.019)	0.249	(0.024)
Mother has poor health	-0.052	(0.031)	-0.052	(0.031)	-0.060	(0.030)	-0.048	(0.031)	-0.053	(0.030)
Neighborhood SES	-0.011	(0.011)	-0.012	(0.011)	-0.010	(0.010)	-0.011	(0.010)	-0.015	(0.010)
Single mother	0.005	(0.043)	0.012	(0.042)	0.026	(0.041)	0.017	(0.041)	0.004	(0.041)
Father works full-time	0.064	(0.039)	0.067	(0.039)	0.063	(0.038)	0.072	(0.038)	0.048	(0.038)
Father works part-time	0.058	(0.051)	0.069	(0.049)	0.077	(0.048)	0.080	(0.048)	0.050	(0.050)
Father's weekly income	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)
Father has poor health	0.026	(0.028)	0.024	(0.028)	0.013	(0.028)	0.024	(0.028)	0.018	(0.028)

This table reports all marginal effect estimates for the Expanded model reported in column (5) of Table 4. Figures in parentheses are standard errors. Sample size equals 3172.

Table A-5: Marginal Effect Estimates for Child Development Equation (Expanded)

	Gross Motor		Fine Motor		Language		Learning		Emotional	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	ME
Maternal LF participation	0.087	(0.060)	0.092	(0.056)	0.114	(0.059)	0.088	(0.059)	0.159	(0.072)
Male	0.008	(0.012)	0.179	(0.018)	0.094	(0.016)	0.123	(0.017)	0.141	(0.018)
Age	-0.023	(0.015)	0.023	(0.018)	0.028	(0.019)	0.032	(0.019)	0.017	(0.020)
Birth weight	-0.006	(0.012)	-0.042	(0.013)	-0.036	(0.014)	-0.046	(0.014)	-0.017	(0.015)
Intensive-care birth	0.030	(0.020)	0.013	(0.021)	0.023	(0.022)	0.029	(0.023)	-0.024	(0.023)
Premature birth	0.049	(0.026)	0.049	(0.027)	-0.009	(0.024)	-0.005	(0.025)	0.021	(0.029)
Multiple birth	0.049	(0.041)	0.016	(0.042)	0.052	(0.046)	0.024	(0.045)	0.053	(0.051)
Needs Medication	0.035	(0.020)	-0.009	(0.019)	0.026	(0.021)	0.029	(0.022)	0.030	(0.023)
No. of older siblings	-0.012	(0.007)	0.007	(0.008)	0.004	(0.008)	0.004	(0.008)	-0.005	(0.009)
No. of younger siblings	0.020	(0.014)	0.021	(0.015)	0.024	(0.015)	-0.002	(0.016)	0.021	(0.019)
Mother's age	-0.005	(0.004)	-0.006	(0.005)	-0.004	(0.005)	-0.004	(0.005)	-0.015	(0.006)
Mother's age squared	0.009	(0.007)	0.011	(0.008)	0.007	(0.007)	0.006	(0.008)	0.025	(0.009)
Mother has degree	-0.036	(0.019)	-0.071	(0.019)	-0.110	(0.019)	-0.088	(0.020)	-0.089	(0.023)
Mother has diploma/certificate	-0.026	(0.016)	-0.063	(0.017)	-0.051	(0.017)	-0.038	(0.019)	-0.046	(0.021)
Mother high school graduate	-0.030	(0.018)	-0.041	(0.019)	-0.030	(0.020)	-0.045	(0.020)	-0.059	(0.023)
Mother Australian	-0.022	(0.015)	-0.002	(0.016)	-0.068	(0.016)	-0.020	(0.017)	-0.021	(0.019)
Mother worked while pregnant	-0.039	(0.019)	-0.044	(0.020)	-0.088	(0.020)	-0.071	(0.021)	-0.102	(0.024)
Mother has poor health	0.037	(0.025)	0.076	(0.028)	0.031	(0.026)	0.081	(0.029)	0.049	(0.030)
Neighborhood SES	-0.006	(0.008)	-0.007	(0.009)	-0.003	(0.009)	-0.007	(0.009)	-0.012	(0.010)
Single mother	-0.042	(0.023)	-0.023	(0.031)	0.022	(0.035)	-0.006	(0.034)	-0.026	(0.036)
Father works full-time	-0.066	(0.025)	-0.087	(0.028)	-0.049	(0.029)	-0.047	(0.030)	-0.088	(0.033)
Father works part-time	-0.063	(0.025)	-0.064	(0.034)	-0.005	(0.041)	-0.012	(0.042)	-0.072	(0.041)
Father's weekly income	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)	0.000	(0.001)
Father has poor health	0.021	(0.023)	0.027	(0.026)	-0.011	(0.024)	0.032	(0.026)	0.000	(0.028)
Left-handed	0.092	(0.026)	0.101	(0.026)	0.046	(0.025)	0.065	(0.025)	0.053	(0.026)
Mixed-handed	0.128	(0.035)	0.161	(0.036)	0.103	(0.035)	0.134	(0.036)	0.143	(0.037)

This table reports all marginal effect estimates for the Expanded model reported in column (6) of Table 4. Figures in parentheses are standard errors. Sample size equals 3172.