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Abstract

This paper studies the effect of maternal depression on early childhood cognition in Peru. The identification strategy exploits variation in exposure to exogenous shocks during early life to instrument for maternal depression. The results suggest that maternal depression is detrimental to the child's vocabulary at age five. Although the effects fade out by age eight, early vocabulary gaps can undermine other development outcomes. The effects do not vary by maternal education, but they are significant only for children living in disadvantaged households. The presence of a partner worsens the effect of maternal depression on vocabulary development, and this effect is driven by households with partners who drink heavily.

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Does Maternal Depression Undermine Childhood Cognitive Development? Evidence from the Young Lives Survey in Peru[1]

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1. Introduction

Maternal depression is a major public health challenge due to its high prevalence and direct and indirect consequences.[4] Globally, depression is experienced by about 10 percent of pregnant women and by 13 percent of women who have just given birth. In developing countries, the prevalence of depression is almost 50 percent higher than in developed contexts: around 15.6 percent of women experience it during pregnancy and 19.8 percent after childbirth (WHO, 2020). Given the limited availability of data on maternal depression in developing countries (Parsons et al 2012) underscores the likelihood that it remains under-diagnosed and undertreated, these figures likely represent a lower bound of the scale of the problem.

Existing studies on maternal mental health warrant concern about the economic and human costs of maternal depression, not only to the women suffering from it, but also to the children in their care (Aizer et al 2016, Wachs et al 2005). Maternal depression may interfere with the consistent, attentive, and responsive caregiving associated with effective parenting (Paulson, Dauber, & Leiferman 2006). Because mother-child interactions during early life shape foundational neural circuits (Shonkoff and Phillips 2000; Knudsen et al. 2006; OECD 2007), neglect or maltreatment associated with maternal depression can undermine children's brain development and lead to worse health (physical and mental), cognitive, and behavioral outcomes (Stratakis 2006; Gunnar and Quevedo 2007; Center for the Developing Child 2010). Given that it often 'goes hand in hand with poverty' (Shonkoff and Phillips 2000), a major concern about maternal depression is that it may increase poverty and contribute to its intergenerational transmission. In particular, maternal depression can intensify the negative effects of material deprivation and exposure to exogenous shocks associated with poverty, and confine children to substandard developmental trajectories and hence worse outcomes later in life. However, despite the potentially far-reaching harmful effects of maternal depression on the welfare of mothers and their children, there is still a limited amount of rigorous evidence that quantifies its consequences on child development, the channels through which it acts, and how to mitigate its impact on children, particularly in developing countries.

[4] Maternal depression is characterized by sadness, negative affect, loss of interest in daily activities, fatigue, difficulty thinking clearly, and bouts of withdrawal and intrusiveness. We focus our analysis on depression affecting mothers because, in the context under analysis, they traditionally play a more prominent role in childrearing, especially while children are younger.

The present paper aims to provide causal evidence of the effects of maternal mental health on children's human capital accumulation in developing countries. We study the under-explored relationship between maternal depression and child cognition, a dimension of child development that has been extensively documented as a crucial determinant of life outcomes (Becker 1964; Currie and Thomas 1999; Feinstein 2003; Cunha et al 2005). We focus our analysis in the context of Peru, a developing country with a high prevalence of maternal depression.

To shed light on the issue, we conduct our analysis using information from the Young Lives (YL) survey in Peru, a rich longitudinal household survey that follows households with at least one child born between 2001 and 2002 (index child). For our analysis, we use YL's first three rounds: a baseline round in 2002, when the index child was 6-20 months old, the first follow-up when the child was 4 - 6 years old, and the last round in 2009-2010, when the index child was 7 - 8 years of age. The YL also has the novelty that includes questions related to maternal mental health and child vocabulary, along with a wealth of information on child, family and community characteristics.

Inspired by the literature that links the exposure to shocks during pregnancy, maternal mental health and children's outcomes, we employ an instrumental variables (IV) approach as estimation strategy. This approach helps us to address potential simultaneity bias in the estimation of the effect of maternal depression on child's vocabulary. We exploit the richness and longitudinal nature of the data to better capture the dynamic nature of maternal mental health on child cognitive development at 5 and 8 years of age. In particular, we instrument maternal depression with experience of a shock (loss of crop or livestock) at baseline (when the child was in utero or recently born). Given the richness of the YL data, there are several potential exogenous shocks that can serve as instruments for maternal depression or additional controls that can be included in our model. Since the IV estimator is biased when the number of instruments is large, we use IV-LASSO to select the instruments that we include in our model. This method helps to also avoid overfitting the model or omitted variables bias by selecting the vector of control variables that fits better to the data. We also strengthen the robustness of the analysis by considering variations of the indicator used for maternal depression, exploring heterogeneous effects of household characteristics, such as mother's education, household wealth, and the presence of a male partner and some of his characteristics.

We find three main results. First, maternal depression is detrimental to the child's vocabulary at age 5, but the effects fade out by age 8. Our estimations indicate that 1 standard deviation of maternal depression during pregnancy and postpartum reduces the vocabulary of 5-year-old children –measured through PPTV scores— by 0.54 standard deviation. This impact is no longer statistically significant at the age of 8, even considering different measures of maternal depression. The magnitude of these effects is large and consistent with the upper bound found in the existing literature.

Second, heterogeneity analysis by household wealth shows that these effects are driven by children living in disadvantaged households. When the impact of maternal depression is analyzed separately by household wealth, there is evidence of worse effects for less wealthy households, providing suggestive evidence that maternal mental illness may contribute to the intergenerational transmission of poverty given the high rates of depression among low-income mothers cited in the literature.

Finally, we explore whether the presence of household members that support mothers can dampen the effect of shocks that would otherwise affect maternal mental health. We focus on the presence of a partner in the household when the woman was pregnant or during the first year after childbirth. Our estimations indicate that mental health issues of women living with a partner when they experienced a shock affect their child's vocabulary more than those without a partner. Upon further exploration, we find that women living with heavy-drinking partners are the ones driving the negative impacts on child cognitive development. In this sense, this set of results indicates that it is not the presence of a partner itself that matters, but the quality of such partners.

This paper makes several contributions to the literature that studies how parents influence children's developmental outcomes. First, it uniquely identifies the impact of maternal depression on child cognition in a developing country, which, to our knowledge, has not been done before. Findings from previous research of the effect of maternal depression on cognitive development are mixed and mostly use data from developed countries. In a study in England, Cogill et al (1986) found that children of mothers who were depressed in the first year had reliably lower cognitive skills, as measured by a test score at age 4, than children whose mothers had not been ill. Petterson and Albers (2001) also report lower cognitive outcomes for children exposed to depression in the United States. Also, Kurstjens and Wolke (2001) conclude that long-term effects on child cognitive development are more likely to occur when maternal depression is

chronic or the family suffers other social risks. Our study, which focuses on Peru, provides much needed empirical evidence of the deleterious impact of maternal depression on child cognition in a region where the causal nexus between maternal depression and child cognition has not been studied before despite maternal depression prevalence rates that range between 35% and 50% (Wolf et al 2002).[5]

Second, the paper focuses on an important marker of early cognition, the accumulation of vocabulary, which has been extensively shown to predict reading comprehension throughout school and into early adulthood (Powell and Diamond 2012). To capture vocabulary competence, we use performance in the Peabody Picture Vocabulary Test (PPVT), a test of receptive vocabulary, which has been widely used and translated to Spanish and Quechua, the two most widely spoken languages in Peru.[6]

Finally, this paper contributes to the literature on the protective effect that other household members can have on the development of children exposed to maternal depression. Our results suggest that, in and of itself, the presence of other household members does not attenuate the effect of maternal depression on child vocabulary development. In fact, the presence of heavy-drinking partners appears to worsen the effect of maternal depression. This latter result may be explained by the increased risk of Intimate Partner Violence (IPV) associated high alcohol consumption. Evidence from Psychology suggests IPV constitutes a major predictor of post-traumatic stress disorder in abused women (Pico-Alfonso, 2005) and can lead to negative interactions between mothers and children (Taylor et al, 2009), directly affecting child development (Bedoya et al, 2020). Using YL data, Bedoya et al (2020) find that IPV is one of the

[5] In Peru, official statistics show a challenging scenario in terms of mental health in general. Data indicate that Mental, Neurological and Substance Abuse Disorders (MNS) are the leading cause of disease burden in the country, accounting for 17.5 percent of the total disease burden and for an average of 33.5 Disability-Adjusted Life Years for every 1,000 inhabitants (MINSA, 2018). Moreover, the severity of these effects tends to be worse among economically impoverished groups. Specifically, the annual prevalence of mental disorders among poor people is estimated to be up to 41.8 percent, twice as high as that of non-poor individuals (15.8 percent). The cost of inaction due to MNS is estimated at 1.45 percent of GDP in Peru (Bloom et al, 2011). Costs are higher when mid- to long-term effects of MNS are considered.

[6] Using the National Longitudinal Survey of Youth in the United States, Frank and Meara (2009) do not find evidence that maternal symptoms of depression affect contemporaneous cognitive scores in school-aged children, as measured by the Peabody Individual Achievement Test in Math and Reading Comprehension, either. Along the lines of Surkan et al.'s (2012) argument for nutritional studies, it is possible that the heterogeneity of results across studies is the result of differences in measurements of both cognitive development and maternal depression, length of follow-up, sample characteristics, and sample sizes across studies, as well as varying level of social resources, caregiving norms, and both level of cognition, as well as prevalence of maternal depression in the populations under study.

main forms of violence against women in Peru. The authors also find that early-life exposure to alcohol-induced IPV is indeed associated with lower test scores in vocabulary. Our results suggest that maternal depression is a mechanism through which alcohol induced IPV leads to worse child vocabulary outcomes.

The remainder of the paper is organized as follows. In the next section, we describe our research design, including details on the data we are using for our analysis and some descriptive statistics. In Section 3, we describe and motivate the use of instrumental variables as an empirical strategy. In Section 4, we present the main results, including some robustness checks. Finally, in Section 5 we discuss to the policy implications and conclude.

2. Research design

In this section, we briefly describe the data we use to assess the impact of maternal depression on early child vocabulary in Peru. Then, we present some descriptive statistics of the different rounds of data use in our analysis. Since we restrict our study to the sample that has information across all rounds, we also briefly describe the results from the sample attrition analysis.

2.1 Data

A. Description

To measure the effects of MMH on child development, we use the first three rounds of the Young Lives Peru Survey (YL), conducted by the University of Oxford with core-funding from the UK Department for International Development.[7] This is a rich longitudinal survey that includes a complete set of individual, parental, household and community characteristics, including early developmental, economic and demographic indicators, as well as information about social assistance programs in every community. The baseline sample of YL is cluster stratified, with 20 districts randomly selected across the country.[8] Within each of the selected districts, 100 households with at least one child born between 2001 and 2002 (index child) were chosen randomly to participate in the project. The baseline round was conducted in 2002, when the index

[7] The YL survey is also being conducted in Vietnam, Ethiopia, and India (Andra Pradesh region). As of now, 5 rounds of data have been collected.

[8] Because the YL project is particularly interested in children living in poorer households (Wilson et al 2006), the sampling frame excluded the top 5 percent of districts as measured by a district poverty ranking. Despite excluding the least poor, it has been documented that the data reflect the Peruvian population in a broad range of indicators (Young Lives-GRADE 2008).

children[9] were aged 6-20 months, the first follow-up conducted in 2006/7, when they were between 4 and 6 years old, and the last round in 2009/10, when they were between 7 and 8 years of age. The attrition rate between the three rounds of data collection is approximately 4 percent, which is low by international standards (Outes-Leon et al 2011).[10]

Of the 2,000 index children in the baseline round, we focus our analysis on the sample of 1,095 of them who were present in the first three waves for whom data on maternal mental health and PPVT scores are available. We present below tests for differences in some characteristics between the included and excluded samples.

B. Measures of a dimension of Child Development

We use PPVT scores (Dunn et al. 1986) as the measure of early vocabulary skills, a strong predictor of later cognitive ability, including writing and reading skills, schooling and labor market outcomes later in life (e.g., Cunha and Heckman 2007; Case and Paxson 2008; Schady 2011; Powell and Diamond 2012). The PPVT measures receptive vocabulary; children are shown slides, each of which has four pictures, and are asked to identify the picture that corresponds to objects or actions named by the test administrator.[11] The test continues until the child has made six mistakes in the last eight slides. The number and the level of difficulty of questions differ according to children's age (see Cueto et al. 2009). We therefore construct age-specific z-scores by subtracting the month-of-age-specific mean of the raw score and dividing by the month-of-age-specific standard deviation. PPVT scores are available in the second and third rounds of the YL survey, i.e., when children were 4-6 and 7-8 years.

C. Measures of maternal mental health

The explanatory variable is constructed using information on maternal common mental disorders from the Self Reporting Questionnaire 20 items (SRQ20), a screening (case-finding) tool included in the YL survey. This tool is recommended by the World Health Organization and has acceptable levels of reliability and validity in developing countries. The SRQ20 consists of 20 yes/no questions with a reference period of the previous 30 days. It is not diagnostic and cannot separate out anxiety from depression, but to the extent that these conditions are closely related and both

[9] Within each household, YL surveyed an index child who was born in 2000-2001 and is followed from infancy until they reach their mid-teens. More details of this survey are presented in Bendini and Dinarte (2020).
[10] A detailed analysis of the attrition bias between rounds 1 and 2 of the Young Lives sample strongly indicates that attrition is highly unlikely to bias research inferences. (Outes-Leon and Dercon, 2008)
[11] Children do not need to name the objects or actions or be able to read or write them. It is just an object identification or association process.

of them can undermine the quality of care mothers provide to their children, the information gathered from the questionnaire is unusual and quite useful. Henceforth, we will use the term *mental* health to refer to both cases of depression and/or anxiety.

Using the responses to the questionnaire, we estimated three mental health indexes: the simple average of all items and two standardized items using factor analysis and principal components analysis. As we explain below, we use information on maternal mental health from the first round of the YL survey.

D. External shocks

We exploit the availability of data on exposure to external shocks in the first round of the Peruvian YL. Caregivers were asked about events or changes that negatively affected the household welfare and that occurred since the mother of the index child was pregnant until the day of the interview. Survey respondents described the event and the enumerator classified it among the 14 categories. We group these categories into 6 groups of shocks, including natural disaster, crop or livestock loss, decrease in food availability, job or income loss, death or severe illness, and birth/new household member.[12]

2.2 Descriptive statistics

Table 1 reports summary statistics of the variables used in this paper for the sample under analysis. We separate the variables in four panels by mother, child, household and community characteristics. Columns 1-3 present mean, standard deviation, and number of observations for the sample in the 2006/7 round. Similarly, columns 4-6 show same statistics for the third YL round (2009/10).

As presented in Panel A, mothers are 31-35 years old on average between the two rounds. Around 16% of them are of indigenous origin, and although 79% are literate, 57% has not completed primary school. Finally, 94% of mothers attended antenatal care while they were pregnant with the index child. In terms of children's characteristics (Panel B), half of index children are boys and 16% of them are the eldest. Cognitive outcomes, as measured by PPVT Z-scores are practically unchanged between the two rounds, even if, as expected, the mean score increases as the children age, reflecting a larger vocabulary. The average child in the sample

[12] We also created a group called "Others" for all shocks that were not classified by enumerators into the 14 categories. We do not use them in our analysis because this group includes a diverse and potentially unrelated set of events.

scored 0.06 standard deviation above the mean PPVT score of a reference child in both 2006/7 and 2009/10. Children's height-for-age Z-scores on the other hand show an improving trend.

To summarize information at the household level, we created some indexes that capture information on wealth, housing quality, and consumption of durable goods (see Panel C). The wealth and housing quality indexes of the average household from our sample remain similar between the two rounds. Only the consumption of durable goods index increases between 2006-2009. Moreover, 58% of households under analysis live in urban areas and have 5.5 members on average, 1.3 of them are school-aged children in 2006/7. Three years after, 18% households are more likely to live in urban areas.

Table A.1 compares the sample of 1,095 children under analysis with the observations excluded from the study. There are only two differences in maternal characteristics between these two sub-samples, and the difference remains statistically significant at the 10%: mothers in the sample of 1,095 observations are less likely to have completed primary school and are less likely to live in urban areas.

3. Empirical strategy

What are the ways in which maternal depression can undermine children's cognitive outcomes? We frame our analysis following Frank and Meara's (2010) model (FMM) of maternal depression effects on the formation of children's skill, which was inspired on Cunha and Heckman's inter-generational model of human capability formation (Cunha, Heckman et al 2005; Cunha and Heckman 2007). FMM assumes that a skill S is constituted in period *t,* through a production function *f* and several determinants that occurred in the previous period (*t-1)*. In sum, the model can be represented as follows:

$$S_t = f(\, S_{t-1}, I_{t-1}, PS; M_{t-1}, \,) \quad (1)$$

where S is the level of skill formation, PS represents parental skill attributes (education, cognitive abilities, etc.), I_{t-1} indicates monetary and non-monetary investments in child capabilities, and M_{t-1} is maternal mental health status at time t-1. Mental health problems that interfere with mother-child interactions or undermine maternal behavior during *t-1* could potentially undercut the effectiveness of parental skills and/or reduce the productivity of investments and result in deficient children's cognitive ability later in life.

To empirically estimate this theoretical model, we exploit information on maternal mental health during the first round and data on cognitive outcomes for our sample of 1,095 children for whom we have PPVT Z-scores from the second and third rounds of data collection. A naïve estimation of the effects of exposure to lagged maternal stress on cognitive development will regress a measure of maternal stress in 2002 on the PPVT Z-scores in 2006/7 and 2009/10, using the following specification:

$$PPVT_{i,t} = \alpha_0 + \alpha_1 MH_{i,t-1} + \alpha_2 C_{i,t} + \alpha_3 M_{i,t} + \alpha_4 H_{i,t} + \epsilon_{it} \qquad (2)$$

where $PPVT_{i,t}$ represents the PPVT Z-scores for child i in period t (i.e., 2006/7 or 2009/10). $MH_{i,t-1}$ captures the value of any of the three maternal mental health indexes we estimated using data from 2002. $C_{i,t}$, $M_{i,t}$, and $H_{i,t}$ are vectors of child, mother, and household/community observable and time-varying characteristics that can lead to differences in cognitive ability across children and influence their parents' investments in them. These vectors include all the variables presented in Table 1, all of which have been documented to affect child cognition (for a review, see Shonkoff and Phillips, 2000). ϵ_{it} represents a random, idiosyncratic error term.

Under the assumption of complete exogeneity of $MH_{i,t-1}$, the parameter of interest, $\hat{\alpha}_1$, measures performance in the PPVT at each period *t* for children whose mothers were depressed in 2002**.** The fact that the specification uses measures of maternal depression and child's vocabulary taken at different points in time addresses to a large extent the possibility of reverse causality. However, the probability that there are unobserved factors –such as pollution, access to services, or changes that have affected households between rounds—that influence maternal mental health and children's outcomes cannot be entirely ruled out. Consequently, we use an instrumental variable (IV) approach to address the possibility of omitted variable bias.

In addition, the IV estimation helps to remedy the problem of measurement error in the main explanatory variable, which could be a relevant factor in the context of this paper. In particular, our main explanatory variable captures symptoms of mental health issues that affected mothers 30 days prior to the survey in 2002. We used those symptoms and estimated indexes of mental health, which constitute proxies of the unobserved, latent variable $MH^*_{i,t-1}$. Thus, estimations of equation (2) that incorporate the proxy for maternal depression can produce inconsistent estimators of α_1 and lead to attenuation bias of these coefficients if $MH_{i,t-1}$ and the error term $\epsilon_{i,t}$ are negatively correlated (Greene 2005; Berger and Spiess 2009).

The IV approach hinges on finding observable covariates that are correlated with maternal mental health, but which do not affect child cognitive status or other possible omitted variables. Considering this, we define our instrument by relying on the existing evidence that identifies the negative effect of exposure to exogenous shocks during pregnancy or during the first months after birth on children cognitive outcomes (Aizer et al, 2016; Almond et al, 2009; Brown, 2020; Carrillo, 2020; Foureaux and Manacorda, 2016; Guantai and Kijima, 2020; Persson and Rossin-Slater, 2018). Some of these papers find that the main mechanism driving this relationship is maternal stress induced by the shock. Therefore, by exploiting the fact that the first round of YL asked caregivers about exposure to shocks, we use them to instrument maternal mental health. We excluded natural disasters and decrease in food availability due to lack of variation (less than 0.18% of households reported any of these shocks) and job or income loss because it can be highly correlated with the fact that the woman just gave birth. Hence, we restrict our analysis to the remaining three shocks –loss of crop or livestock, death or severe illness, or changes in their household composition—as potential instruments of maternal mental health. In this sense, equation (2) corresponds to our second stage estimation, and our first stage will be given by the following:

$$MH_{i,t-1} = \beta_0 + \beta_1 S^j_{i,t-1} + X_i + \epsilon_i \qquad (3)$$

where $S^j_{i,t-1}$ indicates if the mother of child i was affected by shock j and X_i represent the vectors of child, mother, and household characteristics described in equation (2).

The validity of the instrument has to meet two conditions. First, it has to be relevant. In other words, the correlation between the shock and maternal mental health has to be high and statistically different from zero. To test this condition, we present statistics of the shocks and measures of maternal mental health in Table II, panels A and B. Panel C summarizes the correlations between each measure of maternal mental health and the three shocks under analysis. All correlations are statistically significant. In particular, the correlation between the loss of crop or livestock and the different indexes of maternal mental health ranges between 0.34 – 0.70.

The second condition for the instrument to be valid is exogeneity. In other words, suffering a shock during pregnancy or during the first months after birth should not have an impact on children's vocabulary at age of 5 other than through the impact on maternal mental health in the period when the shock occurred. There are three potential concerns that might affect

this assumption, but we aim to address those concerns with our specification. First, there is the concern of the *nutritional effect* of an income shock. A past shock can affect children's nutritional status in *t-1*, which can then translate in worse cognitive development later in life. To address this concern, we control for several children anthropometric measures. A second concern is *the learning resources*: the shock could limit the exposure of the child to enriching opportunities or materials that might help her to improve her vocabulary development during childhood. To control for this potential channel, we include in our specification some measures of household wealth and consumption in *t-1*. Finally, the third concern is that the shock limited *additional stimulation* that might have been provided to her by other members in the household, in addition to the mother and her partner. For example, in extended households, non-working relatives tend to contribute with childcare duties. The shock may force these other household members to find a job, which could in turn limit opportunities for child stimulation and consequent development. Since extended households are larger than the non-extended ones, we control for that characteristic by including the variable household size in our model.

Despite the richness of data has its advantages, having at least three instruments and a large set of potential control variables posit two particular issues in this setting. First, considering that each of the potential instruments is exogenous, the IV estimator can be biased when the number of instruments is large. Second, using too few controls or the wrong ones may lead to omitted variable bias. However, by using too many, our model may be affected by overfitting. To address these issues, we estimate the parameters of interest using IV-LASSO, a routine for estimating coefficients of interest in linear models with many controls and/or instruments. In particular, we used the post-double selection (PDS) methodology (Belloni et al., 2014 and 2015) that is applied in Stata's built-in commands by Ahrens et al (2018). We argue that the approach we are following differs from a specification search process for at least two reasons. First, we are selecting the bunch of potential instruments after evaluating its exogeneity, as we explained above. We are using shocks that are not determined by children's vocabulary, such as loss of crops or death or severe illness. Second, since these shocks have been extensively used to instrument for stress levels previously in the literature, we are not selecting them based on existing evidence.

4. Results

A. Main results

Table III reports the main results of the paper. Columns 1 - 3 present results for OLS with PDS-selected variables and full regressor set. Each column shows the results for a measure of mental health, as defined above. Columns 4-6 show results for the IV with PDS-selected variables and full regressor set as depicted in equation 2.

First-stage estimates for the exposure to an external shock on maternal mental health are presented in Panel B. The preferred instrument under the LASSO regression was "suffering crop or livestock loss" during pregnancy or within the first year of the index child. The outcome variable is a measure of maternal mental health in 2002. The coefficient indicates changes in maternal mental health after experiencing a shock of crop or livestock loss during pregnancy or after giving birth. Across columns, the precision of the estimate does not change, but the size of the coefficients is sensible to the measure of mental health used.

As presented in Panel A, our IV estimations indicate that poor maternal mental health has a negative impact on child cognition. An increase by one standard deviation in maternal mental health problems when children were 1 year old or younger is associated with a reduction of 0.5-0.54 standard deviation in vocabulary Z-scores when children were 5 years old. This effect corresponds to a reduction of 31 percent of the mean PPVT raw score. These large estimated effects are consistent with existing evidence. For example, Aizer et al (2016) finds that exposure to stress hormones in utero negatively affects cognition (verbal IQ at age 7), behavior and motor development. Specifically, the authors find that exposure to cortisol in the top quintile of the distribution is associated with a 43 percent of a standard deviation reduction in verbal IQ.

Results from OLS estimations (columns 1-3) are different in magnitude to our estimations using IV. A potential explanation is measurement error in the variable we use to measure maternal mental health. This can bias the OLS estimates of the treatment effect toward zero, making them smaller than IV estimates. Since the IV estimate is unaffected by the measurement error, they tend to be larger than the OLS estimates. Alternatively, it is possible that the IV estimates are larger than the OLS coefficients because IV is calculating a local average treatment effect, whereas OLS is estimating the average treatment effect over the entire population. Then IV estimates will be larger than OLS estimates because of heterogeneity in the studied population.

The LASSO regression selected the following controls: mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of

children younger than 5 years in the household, and height-for-age Z-score. The effects on child cognition of demographic controls in the table are in the expected direction. Z-scores of children living in urban areas are 0.33 standard deviation higher than those of children living in urban areas. In addition, children's nutritional status also affects performance in the PPVT. The coefficients for wealth are positive, statistically significant, and among the highest, which is in line with research that points to socio-economic status gradients of cognition as measured by vocabulary (Schady 2011; Paxson and Schady 2007; Fernald et al. 2011; Naudeau et al. 2011; Schady et al 2015).

We next explore whether these negative impacts hold three years after the first measure of vocabulary. Using data of child vocabulary at the age of 8, we estimate the model presented in equations (2) and (3). The main results are presented in Table IV. Our estimations show that maternal depression has no effect on child vocabulary at the age of 8. Not only the estimated coefficients are not statistically significant, but also their sizes are very small – that is, the vocabulary of children whose mothers' experienced mental health problems when they were 1 year old caught up with the vocabulary of children whose mothers did not suffer mental health problems. These results suggest that the effect of exposure to maternal depression during early childhood need not undermine language development permanently and exposure to rich vocabulary environments later on during childhood can compensate earlier developmental gaps. For our sample, it is possible that the convergence in vocabulary development is explained by the fact that by the time they reached age 8, all children had had exposure to formal education opportunities (99.9% of children in our sample), which may have a compensatory effect on children's vocabulary development. Still, given that early vocabulary constitutes a foundational skill that facilitates the development of other cognitive skills (and potentially socio-emotional skills as well), based on our results we cannot rule out the possibility that exposure to maternal depression during early life undermines cognitive development and academic achievement.

B. Heterogeneity by household characteristics

We explore heterogeneous effects by a number of maternal characteristics that have been identified in the literature as moderators of the effect of mental health, using our main model and all measures of mental health.

First, we run separated regressions by different levels of household wealth, which, it is generally agreed, influences the extent to which maternal mental health affects children (Aizer et al 2016, Lovejoy 2000; Shonkoff and Phillips 2000). For our analysis, we compared the vocabulary of children living with mothers with different mental health levels within the upper or lower half of the wealth distribution. Using data from the 2002 round, we estimated three indexes: Housing quality,[13] consumer durables,[14] and services indexes.[15] Then, we created a wealth index for each household of our sample that consisted of the average of the three first ones mentioned above. Using the wealth index distribution, we separated our sample by the median of the wealth index distribution. Results are presented in Table V. Our estimations indicate that 1 standard deviation of maternal mental health issues reduces vocabulary by 0.58 to 0.63 standard deviation of children living in less wealthy households (columns 4-6). This is around 0.08 standard deviation more than the impacts in the total sample. The effects of maternal mental health on vocabulary of children living in wealthier households is not statistically significant.

These results are an important contribution to the evidence of intergenerational transmission of poverty. Poor households are less able to protect themselves from external shocks, such as crop or livestock losses, which then increases stress levels for household heads. In poor families where there is a pregnant woman or with a child younger than 1 year old, our results indicate that the negative shock translates into a reduction of the child's cognitive skills in the short term. Given that the development of these skills during early childhood is the foundation of future ones (Case and Paxson 2008; Cunha and Heckman 2007; Schady 2011; Powell and Diamond 2012), this negative effect can have long-lasting impacts in terms of human capital accumulation, which is in line with existing literature indicating that events before five years old can have large long-term impacts on adult outcomes (Almond and Currie 2010).

The existing literature has also found that maternal schooling levels may modulate the impact of depression (Shonkoff and Phillips 2000; Wachs 2005; Patel 2006). A recent paper by Aizer et al (2016) finds that mothers with low levels of human capital are characterized by higher stress levels and that the negative impact of their elevated stress levels on their children is greater.

[13] It included 4 components: Scaled number of rooms per person and type of materials of walls, roof, and floor. The quality index is a number between 0 and 1.
[14] For this index, we add each of the 12 potential assets the household might own and then divide by the total number of assets (12) so the index is a continuous value between 0 and 1. Productive assets are not included here.
[15] For this index we look at whether or not the household has electricity, the source of drinking water, type of toilet facility and the most common type of fuel used for cooking. The services index is a number between 0 and 1.

We explore this heterogeneity using the YL data by separating the sample in two groups: mothers with less than primary education and mothers with at least primary education completed. Our estimations are presented in Table VI. Unlike the existing literature, there are no apparent differences in the effect of maternal mental health for mothers who have completed or not primary education.

However, when we combine the heterogeneity by household wealth and maternal education, we find out that our results are still in line with the existing literature for two reasons. First, the papers finding that lower maternal education exacerbates the negative effect of maternal mental health on early vocabulary argue that this low maternal education can be associated to sub-optimal childcare practices or to restricted access to quality material inputs and opportunities. Access to quality inputs that help to improve children's vocabulary is restricted to less wealthy households as well. Second, there is extensive evidence of a strong correlation between mother's education and socioeconomic status. In this sense, the expected differences in terms of lack of resources that allow to overcome the negative effects of maternal mental health on child language are captured not by maternal education but by household wealth in this particular context.

In addition, we explore whether the effect of exposure to maternal mental health issues during a child's young age varies depending on whether the mother has a partner, given that this factor may modulate the impact of depression. The literature suggests that the presence of other members in the household that provide support to the mother can buffer the effect of depression on children. Our results are presented in Table VII. Our estimates suggest that having a partner actually worsens the negative effects of maternal mental health issues on child vocabulary (Columns 1-3).

To understand these unexpected results, we further explore the characteristics of the partner. First, we separate the sample of women living with a drinking (columns 4-6) and heavily-drinking partner (columns 7-9). Our estimations indicate that Z-scores of children with mothers whose mental health was 1 sd worse at *t-1* and lived with a drinking partner are, on average, 0.52 to 0.56 standard deviation lower than Z-scores of children of mothers who were also living with a drinking partner. These coefficients are statistically significant at the 5 percent level. Moreover, the estimated coefficients for the effects of mentally ill mothers living with heavily-drinking partners indicate that this group is driving the effects described before.

A potential explanation of these results is alcohol induced physical intimate partner violence (AIPIPV). Existing evidence from Psychology shows that Intimate Partner Violence (IPV) is a major predictor of post-traumatic stress disorder in abused women (Pico-Alfonso, 2005) and can drive negative interactions between mother and children (Taylor et al, 2009), directly affecting child development (Bedoya et al, 2020). Using YL data, Bedoya et al (2020) find that IPV is one of the main forms of violence against women in Peru. The authors also find that early-life exposure to AIPIPV is indeed associated with lower test scores in vocabulary.

A second explanation is budget constraints. Allocating household income to consume alcohol reduces the availability of resources in the household for other needs, including inputs that help to support child development. This creates a vicious cycle for mothers with mental health issues, since it can impose additional stressors.[16]

5. Discussion and conclusions

In this paper, we explore the extent to which maternal depression affects child cognition. The identification strategy exploits variation in the exposure to a particular exogenous shock between pregnancy and when the child was 1 year old in Peruvian households. Exposure to the shock can affect maternal mental health and children's vocabulary development. The paper's main results indicate that exposure to a crop or livestock loss in 2002 increases maternal depression in that period. Moreover, a standard deviation decrease in maternal mental health in 2002 negatively affects the child's vocabulary by up to 0.54 standard deviation when children are 5 years old, a result that fades out by time the children are 8 years old. That is, our results suggest the negative effects of maternal depression on child receptive vocabulary do not persist beyond children's early school years. However, given that vocabulary size in kindergarten and earlier predicts reading comprehension throughout school and into early adulthood, facilitating the development of other cognitive skills (Powell and Diamond 2012), and potentially socio-emotional skills as well, we cannot rule out the possibility that exposure to maternal depression during early life undermines other markers of child development in the medium to long run.

[16] Finally, we explore whether child gender plays a role in determining the effect of maternal mental health on child cognition by conducting separate estimations for boys and girls. We present results in Table A3. While, on average, maternal mental health does not appear to affect the accumulation of vocabulary during childhood for boys at age of 5, PPVT Z-scores of girls whose mothers had worse mental health by 1 standard deviation are around 1 standard deviation lower, a result that is statistically significant at the 1 percent level. The difference between point estimates for boys and girls is statistically significant (not shown).

In addition to the main results discussed above, this paper also estimates heterogeneous effects by household wealth, maternal education level, and presence of a partner in the household. When the impact of maternal depression is analyzed separately by household wealth, we find that the effects of maternal mental health issues are worse for children living in less wealthy households during the period when the shock occurred. These results shed light on the negative complementarities between poverty and maternal mental health. Somewhat surprisingly, we find no heterogenous effects by maternal education. Given that our estimations control for a host of important household characteristics that tend to be associated with maternal education (household wealth, consumption, size, number of young children), our results suggest that maternal education may not be the main conduit through which maternal depression undermines children's vocabulary development.

The heterogeneity analysis in terms of whether the mother has a partner are enlightening. We find that having a partner does not attenuate the effect of maternal depression on child vocabulary, a result that is driven mostly by partners that are heavy alcohol drinkers. This result is consistent with the literature on domestic violence, which defines low-quality partners as those reported to consume high quantities of alcohol. This literature argues that having a drinking partner is positively correlated with IPV, maternal stress, and worse child vocabulary outcomes. Our results suggest that maternal depression is a mechanism through which alcohol induced IPV leads to worse child vocabulary outcomes.

Results in this paper underscore children's incredible resilience, while at the same time provide further evidence that maternal depression can undermine children's development. Moreover, the heterogeneous findings by household wealth and quality of partner, combined with extensive evidence in the literature of the disproportionally high prevalence rates of anxiety and depression among households with low socio-economic status cited in this paper's introduction suggest that maternal mental illness may contribute to the intergenerational transmission of poverty and that stress in general, and associated maternal mental illness in particular, constitute yet another pathway from poverty to substandard developmental trajectories and potentially worse outcomes later in life.

What are the implications of these findings for policy makers? To the extent that the maternal depression-child cognitive development relationship is causal, the findings suggest that a two-pronged approach may be necessary for protecting children's cognitive development from

maternal depression. First, given its disease burden and the associated deleterious effects, a strong case can be made for recognizing maternal mental health problems as disorders of public health significance and integrated as such into maternal and infant health policies (Patel 2002). For this to occur, the public health commitment to mental health problems should increase, particularly in developing countries, where the current commitment is minimal (Patel et al 2006).

Cost-effective interventions to effectively treat mental health issues that affect women in poorer households have been successfully implemented in developed and developing countries. Most relevant to this paper, evaluations of interventions that, in addition to addressing maternal depression, also included children reported improved mother-infant interaction and better cognitive development (Rahman et al 2013). Considering cultural differences and local sensitivities, similar initiatives could prove effective and efficient in improving maternal mental health in developing countries such as Peru as well, in so doing improving the livelihoods of children whose early development is hindered by maternal depression.

The heterogeneous results in this paper suggest that the child cognition nexus is a complex one, determined not only by maternal illness, but also maternal and household characteristics that interact in ways that are not yet fully understood. Consequently, the most effective way to protect children's welfare may be to target children themselves and build support systems at the household, community, or institutional level that protect vulnerable children's outcomes. Programs and policies that promote poor children's cognitive development directly, such as by improving access to quality pre-school programs, or indirectly, by promoting cognitive stimulation at home and improving the quality of their home environments may help prevent and compensate for early deficits related to maternal depression. And given the hierarchical and interdependent nature of development, the earlier in life the intervention, the better. In recent years, there have been a number of interventions in Latin America that have successfully boosted the cognitive development of poor young children, including cash transfers to very poor households in Nicaragua (Macours et al. 2012), programs that increase preschool availability in Argentina and Uruguay (Berlinski et al 2008 and Berlinski et al. 2009); and a program of home visits in Colombia (Attanasio et al. 2012).

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Tables

TABLE I. Descriptive Statistics by Survey Round

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Year 2006/07			Year 2009/10		
	Mean	S.D.	N	Mean	S.D.	N
Panel A. Maternal characteristics						
Age of the mother (years)	31.43	6.64	1095	33.71	6.64	1095
Indigenous ethnic group	0.16	0.37	1095	--	--	--
Less than primary school	0.57	0.50	1095	--	--	--
Literate	0.79	0.41	1095	--	--	--
Attended antenatal care in 2002	0.94	0.23	1095	--	--	--
Panel B. Child characteristics						
Child is a boy	0.50	0.50	1095	--	--	--
Weight at birth	3.21	0.51	1095	--	--	--
Long-term health problems	0.09	0.09	1095	--	--	--
Age (in months)	63.5	4.71	1095	94.9	3.58	1095
Child is the eldest	0.16	0.37	1095	0.23	0.42	1095
Height for age Z-score	-1.42	1.08	1095	-1.05	1.02	1095
PPVT score (raw)	29.9	17.4	1095	47.6	12.9	1095
PPVT Z-score	0.06	0.98	1095	0.07	0.95	1095
Panel C. Household characteristics						
Wealth index	0.49	0.22	1095	0.56	0.20	1095
Housing quality index	0.41	0.24	1095	0.44	0.24	1095
Consumption of durable goods index	0.37	0.23	1095	0.45	0.23	1095
Live in urban area	0.58	0.49	1095	0.76	0.43	1095
Household size	5.52	2.13	1095	5.44	1.94	1095
School aged children in the household (n)	1.33	1.25	1095	1.09	1.05	1095
Panel D. Community characteristics						
Violent crime in community	0.33	0.47	1095	0.36	0.48	1095
Social assistance (education) available	0.95	0.22	1095	0.98	0.13	1095

Table I present summary statistics (mean and standard deviation) of the variables used in the analysis. These variables are available in the first three rounds of the Peruvian Young Lives Survey. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. A detailed description of the rest of variables is presented in Appendix section.

TABLE II. Correlations between Shocks and Maternal Mental Health Indexes (MHI) in 2002

	(1)	(2)	(3)
Panel A. Descriptive statistics of Maternal MHI	Mean	S.D.	N
MHI-1	-0.02	0.50	1095
MHI-2	-0.04	0.98	1095
MHI-3	-0.04	0.92	1095
Panel B. Shocks experienced by mothers during pregnancy or within the first year after the child was born (in 2002)	Mean	S.D.	N
Crop or livestock loss	0.03	0.16	1095
Death, severe illness, divorce	0.13	0.34	1095
Birth/new household member	0.06	0.24	1095
Panel C. Correlations between shocks and Maternal MHI in 2002	MHI-1	MHI-2	MHI-3
Crop or livestock loss	0.34***	0.70***	0.65***
Death, severe illness, divorce	0.15***	0.32***	0.29***
Birth/new household member	0.13**	0.27**	0.24**

Table II present summary statistics (mean and standard deviation) of maternal mental health indexes and shocks experienced by mothers of our sample of analysis. These variables are available in the first round of the Peruvian Young Lives Survey (2002). Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. Mental health index 1 is the standardized average of the SRQ-20 items. Panel A presents statistics of mental health indexes. Mental health index 2 and 3 are standardized indexes estimated using principal components and factor analysis, respectively. Panel B presents the % of mothers reporting being exposed to any of the four shocks. Panel C shows correlations between the mental health indexes and shocks. *** and ** indicate statistical significance at 1% and 5%, respectively.

TABLE III. Effect of maternal mental health on children vocabulary at age 5

Dependent variable: Standardized PPVT

Panel A. OLS and IV second-stage estimations	(1)	(2)	(3)	(4)	(5)	(6)
	OLS with PDS-selected variables and full regressor set			IV with PDS-selected variables and full regressor set		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	-0.0314	-0.0157	-0.0173	-1.025*	-0.499*	-0.536**
	(0.0513)	(0.0254)	(0.0275)	(0.527)	(0.255)	(0.274)
Observations	1,095	1,095	1,095	1,095	1,095	1,095
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. First-stage estimation				MHI-1	MHI-2	MHI-3
Shock: Crop or livestock loss				0.573***	0.616***	0.300***
				(0.165)	(0.179)	(0.088)
Observations				1,095	1,095	1,095
Mother controls				Yes	Yes	Yes
Child controls				Yes	Yes	Yes
Household controls				Yes	Yes	Yes
Weak identification F-Stats (Full IV set)				11.53	11.69	11.75

Table III presents the effects of maternal mental health on children vocabulary at the age of 5 years. Dependent variable was measured using the standardized value of the PPVT test. Mental health indexes are standardized values of the SRQ-20 items using three different estimation approaches. Columns (1)-(3) present estimated coefficients using OLS and columns (4)-(6) show coefficients using IV. Both approaches were implemented using the option PDS-selected variables and full regressor available in the LASSO command. Selected instrument was suffering crop or livestock loss during pregnancy or within the first year of index child. Selected controls are mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of children younger than 5 years in the household, and Height for age Z-score. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. * and ** indicate statistical significance at 10% and 5%, respectively. Robust standard errors in parentheses

TABLE IV. Effect of maternal mental health on children vocabulary at age 8

Dependent variable: Standardized PPVT						
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. OLS and IV second-stage estimations	OLS with PDS-selected variables and full regressor set			IV with PDS-selected variables and full regressor set		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	0.006	0.006	0.008	-0.065	-0.032	-0.034
	(0.0471)	-0.0233	(0.0253)	(0.501)	(0.245)	(0.265)
Observations	1,095	1,095	1,095	1095	1095	1095
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. First-stage estimation				MHI-1	MHI-2	MHI-3
Shock: Crop or livestock loss				0.338***	0.689***	0.639***
				(0.091)	(0.184)	(0.172)
Observations				1095	1095	1095
Mother controls				Yes	Yes	Yes
Child controls				Yes	Yes	Yes
Household controls				Yes	Yes	Yes
Weak identification F-Stats (Full IV set)				13.61	13.65	11.75

Table IV presents the effects of maternal mental health on children vocabulary at the age of 8 years. Dependent variable was measured using the standardized value of the PPVT test. Mental health indexes are standardized values of the SRQ-20 items using three different estimation approaches. Columns (1)-(3) present estimated coefficients using OLS and columns (4)-(6) show coefficients using IV. Both approaches were implemented using the option PDS-selected variables and full regressor available in the LASSO command. Selected instrument was suffering crop or livestock loss during pregnancy or within the first year of index child. Selected controls are mother's age, mother is indigenous, mother literacy, wealth index, living in urban area, consumption of durable goods index, and Height for age Z-score. * and ** indicate statistical significance at 10% and 5%, respectively. Robust standard errors in parentheses

TABLE V. Heterogeneous effects of Maternal Mental Health on Children Vocabulary at Age 5 by HH Wealth Level

Dependent variable: Standardized PPVT

	(1)	(2)	(3)	(4)	(5)	(6)
	IV with PDS-selected variables and full regressor set					
	Effects on children from wealthier HH			*Effects on children from less wealthy HH*		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	-2.971	-1.427	-1.509	-1.194*	-0.581*	-0.625*
	(4.212)	(2.009)	(2.111)	(0.661)	(0.319)	(0.342)
Constant	1.098	1.101	1.098	1.147**	1.157**	1.158**
	(0.869)	(0.854)	(0.839)	(0.583)	(0.576)	(0.574)
Observations	514	514	514	581	581	581
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes

Table V presents estimated effects of maternal mental health on child vocabulary at age 5, separated by whether the HH is in the upper or lower wealth half of the distribution. We estimate the model selected from LASSO procedure. Selected control regressor set includes mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of children younger than 5 years in the household, and Height for age Z-score. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. Robust standard errors in parentheses.

TABLE VI. Heterogeneous effects of Maternal Mental Health on Children Vocabulary at Age 5 by educational level of the mother

Dependent variable: Standardized PPVT

	(1)	(2)	(3)	(4)	(5)	(6)
	IV with PDS-selected variables and full regressor set					
	Effects on children from mothers with primary incomplete			*Effects on children from mothers with at least primary education complete*		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	-0.799	-0.389	-0.419	-1.829	-0.889	-0.949
	(0.513)	(0.249)	(0.268)	(1.848)	(0.885)	(0.937)
Constant	1.292***	1.299***	1.300***	0.739	0.736	0.739
	(0.401)	(0.398)	(0.397)	(0.778)	(0.771)	(0.763)
Observations	719	719	719	376	376	376
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes

Table VI presents estimated effects of maternal mental health on child vocabulary at age 5, separated by whether the mother has completed at least primary education or not. We estimate the model selected from LASSO procedure. Selected control regressor set includes mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of children younger than 5 years in the household, and Height for age Z-score. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. Robust standard errors in parentheses.

TABLE VII. Heterogeneous effects of Maternal Mental Health on Children Vocabulary at Age 5 by the Mother's Marital Status and Partner's Drinking Behavior

Dependent variable: Standardized PPVT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	IV with PDS-selected variables and full regressor set								
	Effects on children from mothers with a partner			*Effects on children from mothers with a drinking partner*			*Effects on children from mothers with a heavily-drinking partner*		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	-0.889*	-0.433*	-0.465*	-1.070**	-0.518**	-0.556**	-1.150**	-0.549**	-0.587**
	(0.459)	(0.222)	(0.239)	(0.511)	(0.246)	(0.264)	(0.573)	(0.270)	(0.287)
Constant	1.144***	1.147***	1.148***	1.195***	1.201***	1.200***	1.653***	1.642***	1.633***
	(0.339)	(0.337)	(0.336)	(0.379)	(0.376)	(0.375)	(0.439)	(0.434)	(0.432)
Observations	963	963	963	770	770	770	486	486	486
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table VII presents estimated effects of maternal mental health on child vocabulary at age 5, separated by whether the mother lives with a partner and his drinking likelihood. We estimate the model selected from LASSO procedure. Selected control regressor set includes mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of children younger than 5 years in the household, and Height for age Z-score. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. Robust standard errors in parentheses.

TABLE A1. Tests for differences between included and excluded subsamples

Variables	(1)	(2)	(3)
	Mean and tests for differences in means between included and excluded samples		
	Included	Excluded	*p*-value
Panel A. Maternal characteristics			
Age of the mother (years)	31.43	33.73	0.235
Indigenous ethnic group	0.16	0.16	0.995
Less than primary school	0.57	0.42	0.085
Literate	0.79	0.77	0.567
Attended antenatal care in 2002	0.94	0.92	0.734
Panel B.Child characteristics			
Child is a boy	0.50	0.51	0.847
Weight at birth	3.21	3.20	0.835
Long-term health problems	0.09	0.08	0.123
Age (in months)	63.5	63.42	0.568
Child is the eldest	0.16	0.17	0.723
Height for age Z-score	-1.42	-1.62	0.167
Panel C.Household characteristics			
Wealth index	0.49	0.49	0.934
Housing quality index	0.41	0.42	0.769
Consumption of durable goods index	0.37	0.35	0.582
Live in urban area	0.58	0.62	0.073
Household size	5.52	5.60	0.382
School aged children in the household (n)	1.33	1.32	0.923
Panel D. Community characteristics			
Violent crime in community	0.33	0.35	0.634
Social assistance (education) available	0.95	0.97	0.913

Table A1 presents mean of the variables used in the analysis from the included sample (children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009) and excluded one (the rest of the sample).

TABLE A2. Correlations between Shock in 2002 and Maternal Mental Health Index in 2006/07

	(1)	(2)	(3)
	MHI-1	MHI-2	MHI-3
Experienced shock of crop or livestock loss in 2002	0.176	0.354	0.335
	(0.126)	(0.256)	(0.239)
Observations	1,095	1,095	1,095
Mother controls	Yes	Yes	Yes
Child controls	Yes	Yes	Yes
Household controls	Yes	Yes	Yes
R-squared	0.074	0.075	0.076

Table A2 presents correlations between maternal mental health indexes and the main shock under analysis experienced by mothers of our sample. Sample is restricted to our group of interest. Mental health indexes are the standardized measures described in the data section using the SRQ-20 items.

TABLE A3. Heterogeneous effects of Maternal Mental Health on Children Vocabulary at Age 5 by Gender

Dependent variable: Standardized PPVT

	(1)	(2)	(3)	(4)	(5)	(6)
	IV with PDS-selected variables and full regressor set					
	Effects on girls			*Effects on boys*		
	MHI-1	MHI-2	MHI-3	MHI-1	MHI-2	MHI-3
Maternal Mental Health (-)	-1.783*	-0.889*	-0.981*	-0.501	-0.238	-0.249
	(0.982)	(0.495)	(0.558)	(0.700)	(0.328)	(0.342)
Constant	0.413	0.411	0.400	1.435***	1.436***	1.437***
	(0.669)	(0.676)	(0.692)	(0.399)	(0.396)	(0.395)
Observations	544	544	544	551	551	551
Mother controls	Yes	Yes	Yes	Yes	Yes	Yes
Child controls	Yes	Yes	Yes	Yes	Yes	Yes
Household controls	Yes	Yes	Yes	Yes	Yes	Yes

Table A3 presents estimated effects of maternal mental health on child vocabulary at age 5, separated by child gender. We estimate the model selected from LASSO procedure. Selected control regressor set includes mother's age, wealth index, living in urban area, child's age, consumption of durable goods index, household size, number of children younger than 5 years in the household, and Height for age Z-score. Sample is restricted to children with available information on maternal mental health in 2002 and PPVT scores in 2006 and 2009. * and ** indicate statistical significance at 10% and 5%, respectively. Robust standard errors in parentheses.