Stunting and academic achievement among Vietnamese children: new evidence from the Young Lives Survey

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Abstract

Most of the empirical literature on the relationship between the health condition and skill development of school children are based on a static relationship between health and skill development. This paper contributes to the literature by examining the dynamic relationship between stunting and school achievement using data from the first three waves of the Young Lives Survey in Vietnam. Using both structural equation and hybrid estimators, empirical results show that past school performance is the most significant predictor of the academic performance. Stunting has significant negative effect on school performance, and its effect in the long-run is as twice as much its effect in the short-run. The empirical evidence also shows that age of the child, mothers' literacy, access to electricity and household consumption significantly affect school performance.

Key words: skills formation, dynamic specification, malnutrition, stunt, Vietnam

JEL classifications: D12, I12, I21

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1 Introduction

The development process of cognitive and non-cognitive skills makes important contributions to future labour productivity. Heckman (2008) emphasised that interventions early in the life cycle of disadvantaged children have much higher economic returns than later interventions. Hence it is important to identify factors that affect the development of skills, particularly in developing countries where children are living in notably disadvantaged conditions. Empirical evidence from the fields of public health and health economics have shown that malnutrition in the early years of childhood has severe negative impacts on academic achievement in school and these impacts can persist until the entry to the labour force (see, for example, a review by Currie and Vogl 2013). However, to our best knowledge, most empirical literature use a static modelling framework of a relationship between health and skill development.

As well argued by Cunha and Heckman (2008), lifecycle skill formation is a dynamic process such that cognitive and non-cognitive skills are built on knowledge previously acquired. Failing to account for the dynamic aspect of the relationship between health and skill development as done in most previous studies could expose empirical results to potential biases due to misspecification. To fill this gap in the literature, we propose a dynamic specification to investigate the relationship between stunting and school performance in Vietnam using the first three waves of the Young Lives Survey.

We apply both a structural equation estimator and a ‘hybrid’ estimator to mitigate the effects of unobserved individual and family characteristics. The use of structural equation estimator also allows us to identify short and long effects of stunting on schooling achievement. Our empirical results confirmed that stunting remains to have negative impacts on Peabody Picture Vocabulary Test (PPVT) scores, but the magnitude of the impact is much smaller after the past scores were controlled for. This finding implies that one needs cautions in interpreting empirical results from static models. Our results also show that the effect of stunting in the longer term is twice as much as an effect in the short-term, which favour early interventions.

The remainder of this paper is arranged as follows. Brief literature review is pro-

vided in Section 2. Methodology and data are discussed in Sections 3 and 4. Empirical results and discussion are presented in Section 5. Section 6 concludes the paper.

2 Literature review

The literature on nutrition and child development is vast. Thus, we focus on reviewing those studies which have a focus on Vietnam, analyse the Young Life Survey, or use dynamic specifications. The most relevant empirical studies about the relationship between malnutrition and schooling achievement in Vietnam include Duc (2011), Crookston et al. (2013) and Miller et al. (2015). Duc (2011) utilised a longitudinal Young Lives Survey data set of 1,200 Vietnamese children to analyse the effect of height-for-age at age one on cognitive achievement regarding the Peabody Picture Vocabulary Test (PPVT) scores at age five. An important finding of this study is that the prematurity during pregnancy is the primary driver behind the negative association between height-for-age and cognitive achievement. In other words, given the same loss in height-for-age, the negative impact on cognitive achievement is more significant if the loss in height-for-age was due to prematurity than that of malnutrition for a full-term born child. The empirical results of the IV model using gestational age as a confounding factor allows the authors to imply that for the full-term born children, the impact of a difference in height-for-age made after birth, even in early childhood, on the cognitive achievement is unlikely to be important.

Crookston et al. (2013) also analysed data of 8060 children from the Young Lives Survey in Vietnam, Ethiopia, India and Peru to examine the relationship between malnutrition measured by height-for-age Z-scores (HAZ) at age one and age eight and cognitive achievement at age eight in terms of overall grade (i.e. whether a child was behind in comparison with the appropriate age for the grade given country-specific schooling norms), mathematics test, reading comprehension and PPVT scores. This study reported a statistically significant inverse associations between the HAZ at age one with all proxies of cognitive achievement. We argue that the inclusion of mathematics test and reading comprehension scores may weaken their analysis because these teachers-conducted scores may suffer from an endogeneity problem caused by unob-

served teachers' characteristics. Miller et al. (2015) analysed data of 58,513 children aged 36-59 months in fifteen low- and middle-income countries, including Vietnam, and found that severe stunting was negatively associated with overall development, physical development and learning, in all countries studied. Most empirical literature in other developing countries, ranging from India (Spears 2012), Ghana (Ampaabeng and Tan 2013), to South Africa (Casale et al. 2014), also revealed a significant negative relationship between malnutrition and school performance. Their findings are consistent across different measures of malnutrition, from HAZ (Spears 2012; Casale et al. 2014) to famine (Ampaabeng and Tan 2013); and among choices of variables to represent cognitive skills such as academic tests (Spears 2012) and intelligent quotient (Ampaabeng and Tan 2013).

One of the most popular approaches to mitigate the possible issues of endogeneity in the literature is instrumental variable (IV) estimator which has been used in many of empirical studies with various instruments such as height-for-age of older sibling (Glewwe et al. 2001), exogenous price changes (Alderman et al. 2001; Wisniewski 2010), and civil war and drought (Alderman et al. 2006). IV models are effective tools to produce reliable estimates of the relationship between malnutrition and cognitive development of children. However, reliable IVs are not easy to find and the validity of most IVs can be challenged (Murray 2006). Also, most empirical literature use a static modelling and thus may suffer from misspecification biases and inability to estimate long-run effects of malnutrition.

Recent theories in human development literature propose that skill formation is dynamic in nature. For example, Heckman (2008, p.290) stated that:

Skill begets skill; motivation begets motivation. Motivation cross-fosters skill and skill cross-fosters motivation. If a child is not motivated to learn and engage early on in life, the more likely it is that when the child becomes an adult, it will fail in social and economic life. The longer society waits to intervene in the life cycle of a disadvantaged child, the more costly it is to remediate disadvantage.

In line with this theory, we argue that a dynamic specification is more suitable than static specification in empirical studies on the relationship between health and skill development of children. Therefore, we fill this literature gap by applying a dynamic specification in an empirical study using the Vietnamese Young Lives Survey.

3 Methodology

Based on the theory of dynamic skills formation by Cunha and Heckman (2008), the cognitive achievement of children in the current period is affected by the skills achieved in the previous periods. Thus, the empirical specification to estimate the relationship between academic achievement and nutrition status is presented as:

$$P_{it} = \alpha_P P_{i,t-1} + \alpha_S S_{it} + \alpha_X X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where P represents academic performance; S is the malnutrition status; X is the set of individual and household characteristics; μ_i is a time-invariant unobserved individual characteristic that can affect both nutrition status and academic achievement; and ε_{it} represents random noise.

The stunting status of the child may be affected by the same set of unobserved individual characteristics (μ_i), and observable factors (Z_{it}) some of which can be included in X_{it} :

$$S_{it} = \beta_X Z_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

The presence of μ_i in both equations suggest that their composite error terms could be correlated (i.e., stunting can be an endogenous variable in Equation 1). Thus, we estimate equations 1 and 2 as a system to obtain the correlation coefficient of their error terms, the significance of which can be used as a proxy of an endogenous test for S_{it} . The presence of P_{t-1} , which captures the effects of the past learning, in Equation 1 allows us to estimate the long-run effects (LREs) of parameters by applying a Taylor-series approximation (i.e., $LREs = \frac{\alpha_*}{1-\alpha_P}$) where α_* is the parameters of stunting status or other

covariates, and α_p is the parameter of the lag-dependent variable. The long-term effects represent the accumulation of short-term effects of malnutrition and other determinants over time (i.e., t , $t - 1$, $t - 2$, etc.). It can be expected that the stunt parameter has a negative sign, showing that malnutrition has detrimental effects on academic achievement. Meanwhile, the parameter α_p is expected to have a positive sign, representing the positive effects of prior learning on future skill development.

For sensitivity test, we also apply a ‘hybrid’ estimator by Allison (2009), which developed from the extended random effects estimator by Mundlak (1978). This estimator is based on the assumptions that the individual unobserved component (μ_i) correlates with the individual-specific means of time-varying observable covariates. Also, the original time-varying covariates are replaced by their mean-corrected values. Applying this estimator, Equation (1) can be rewritten as:

$$P_{it} = \gamma_0 + \gamma_1(M_{it} - \bar{M}_{it}) + \gamma_2\bar{M}_{it} + \gamma_3N_i + \mu_i + \varepsilon_{it} \quad (3)$$

where M are vectors of all time-varying observable variables including $P_{i,t-1}$, S_{it} and X_{it} , and N are the set of observable time-invariant covariates (e.g., sex, and ethnicity). Given the assumption that unobserved individual characteristics if correlated with within-individual means of observable covariates, Equation 3 can be estimated using standard random-effects estimators.

4 Data

4.1 Data source and variable selection

We use data from the Young Lives Survey, conducted in four countries including Peru, Ethiopia, Vietnam and the Andhra Pradesh state of India. The survey covers around 3,000 children in Vietnam with two cohorts: 2,000 younger children (aged 6-18 months in 2002) and 1,000 older children (aged 7.5-8.5 years in 2002). We analyse the data collected from Wave 1 (2002), Wave 2 (2006), and Wave 3 (2009). The sample size of Waves 1, 2 and 3 are 3000, 2983 and 2979, respectively. In this study, we focus on the younger cohort as it is more relevant to examine the effects of stunting during the

first three years of life. The sample size for this younger cohort in Wave 1, 2 and 3 are 2000, 1998 and 1987 children respectively, producing a small attrition rate of 3.3%.

In line with the recent literature (Rietveld et al. 2015; Rieger and Wagner 2015; Núñez and Pérez 2015), we select height-associated characteristics to measure malnutrition via a dummy variable for stunting status, which is coded 1 for those having height-for-age Z-score (HAZ) of -2 or lower (i.e., having height-for-age at two standard deviations (SD) below the median HAZ) and 0 otherwise. The main advantage of this approach is that physical stunting occurs at the first three years of life, in which the brain develops rapidly and hence would have long-term effects on cognitive development. Stunting is difficult to reverse and hence children with stunted growth often develop into shorter adults. For robustness test, we also define a wasting dummy variable, coded 1 for those having weight-for-height Z-score (WAZ) at two SDs or lower than the median WAZ and 0 otherwise, to represent child malnutrition. The two indicators also represent malnutrition from different angles: while stunting can occur due to micronutrient deficiency, wasting is more likely due to food shortages (Christian 2010).

We select PPVT scores as a measure of school performance because the test is internationally standardised and has been used in previous studies (See, for example, Woodhead et al., 2013; Fink and Rockers, 2014; Khanam and Nghiem, 2016). The logarithm of PPVT was selected in our empirical model, and hence the coefficient of the dummy variable likes stunted is interpreted as a change in the percentage of PPVT. The richness of the Young Lives Survey allows for characteristics of the child (age, gender, ethnicity and whether the child has any long-term health problem), characteristics of the household (age, gender and education of the household head and the spouse of household head, household size, the proportion of people outside labour force in the households) and health inputs (water sources, access to electricity, and the household wealth index), to be controlled.

4.2 Descriptive statistics

The descriptive statistics show significant differences between stunted (N=1,300) and children of normal weight (N=4,563). For example, boys are over-represented

among children with stunted growth (57%) compared to children of normal weight (50%). In addition, 36% of the stunted children are from an ethnic minority compared to 8% from the reference group of Vietnamese majority. The parent of children with normal growth have higher levels of literacy (88% for the father and 86% for the mother) compared to the parents of children with stunted growth (67% for fathers and 64% for mothers). The average level of consumption is lower among the households of stunted children (VND 315,000 or USD 17.5) than children of normal weight (VND 493,000 or USD 27.4). Families of stunted children also have poorer quality sanitation, water and lower probability of access to electricity. On average, stunted children have PPVT scores of 53 compared to the average score of 70 of normal children. Children with stunted growth also have lower birth weights (2,943 vs 3,137 grammes) and lower Z-scores for BMI-for-age and weight-for-age (see Table 1).

Table 1: Descriptive statistics

Variables	Normal	Stunted	P-value
Child's gender (1=male)	0.50	0.57	0.00
Child's ethnic group (1=Vietnamese)	0.92	0.64	0.00
Long-term health problem (1=yes)	0.09	0.10	0.09
Child's age (months)	57.12	57.38	0.81
Gender of household head (1=male)	0.86	0.87	0.59
Father's age (years)	33.95	32.87	0.00
Father is literate (1=yes)	0.88	0.67	0.00
Mother's age (years)	30.92	30.35	0.00
Mother is literate (1=yes)	0.86	0.64	0.00
Housing quality index	0.64	0.54	0.00
Consumer durables index	0.47	0.34	0.00
Real consumption (thousand VND/person/month, 2006 prices)	493	315	0.00
Access to electricity (1=yes)	0.16	0.05	0.00
Sanitation quality index	0.94	0.84	0.00
Drinking water quality index	0.59	0.39	0.00
Household size (people)	4.67	4.92	0.00
Face advert events (1=yes)	0.30	0.29	0.53
PPVT Scores	70.09	53.07	0.00
Enroll school late (1=yes)	0.17	0.25	0.00
Birthweight (grammes)	3137	2943	0.00
Height-for-age Z-score	-0.75	-2.69	0.00
Weight-for-age Z-score	-0.74	-2.14	0.00
BMI-for-age Z-score	-0.43	-0.55	0.00

To explore the sensitivity of stunting measurement, Figure 1 shows the distribution of PPVT scores for normal, stunting and wasting children. There is a clear indication that stunted children have a higher frequency of low scores (less than 50) and a lower frequency of obtaining high scores (100 or above). The density plot of PPVT scores in Figure 1 for wasting children also shows poorer performance compared with that of normal children but the magnitude of the difference is much smaller. Thus, in the analysis we focus on using the stunt dummy variable to measure the malnutrition status

of children.

Figure 1: Malnutrition and PPVT scores: Stunting vs Wasting

5 Results and discussion

Table 2 presents results of the main estimator where equations 1 and 2 are estimated as a system. The correlation coefficient (ρ) between the two error terms is significant, suggesting that endogeneity is an issue in Equation (1) and hence standard regressions can produce biased estimates. The results show that the past PPVT scores is statistically significant determinant with the largest magnitude. This means that the past academic achievement is the most significant predictor of that in the current period, which is consistent with recent literature which argues convincingly that skill formation is a dynamic process (Heckman 2008). In particular, one standard deviation increase in the PPVT scores in the past period is associated with 0.55 standard deviation improvement of the test scores in the current period. This finding is a new contribution to the empirical literature as the impact of past academic achievement has not been taken into account in previous empirical literature, at least in the context of Vietnam.

Malnutrition has significant and negative effects on school performance. On average, stunted children have lower PPVT scores by 0.178 standard deviation than non-stunted children. The long-term effects of stunting on cognitive development are more than double the short-term effects with the magnitude of 0.4 SD (i.e., $\frac{-0.178}{1-0.554}$).

Table 2: Effects of stunt on PPVT scores (structural equation estimator)

	PPVT equation		Stunt equation	
	coef	se	coef	se
Lag outcome	***0.554	0.017		
Stunted (Y=1)	***-0.178	0.057		
Red River Delta (Y=1)	-0.022	0.016	** -0.209	0.089
Phu Yen (Y=1)	***-0.048	0.017	0.087	0.081
Da Nang (Y=1)	-0.025	0.020	***-0.551	0.107
Mekong River Delta (Y=1)	-0.006	0.018	***-0.273	0.092
Child's sex (Boys=1)	0.00004	0.010	***0.143	0.050
Child age	***2.261	0.024	** -0.320	0.139
Child's ethnic group (Vietnamese=1)	-0.001	0.025	***-0.587	0.099
Sex of household head (male=1)	-0.017	0.017	** -0.198	0.084
Age of household head	0.016	0.022	-0.084	0.109
Father is literate (Y=1)	0.008	0.018	-0.117	0.084
Mother is literate (Y=1)	***0.048	0.018	-0.052	0.083
Access to electricity (Y=1)	*0.052	0.031	***-0.318	0.117
Household expenditure	**0.026	0.011	***-0.316	0.057
Household size	0.005	0.020	0.134	0.103
Dependency ratio	-0.023	0.024	-0.093	0.122
Long-term illness or health problem (Yes=1)	0.006	0.017	**0.169	0.080
Low birthweight (under 2500 grammes=1)			***0.319	0.083
Constant	***-8.042	0.149	***3.729	0.726
ρ	***0.334	0.129	Sample size	3,680

Note that this long term effects are calculated by applying the Taylor-series approximation with respect to the stunting status and the past learning; hence the long-term effects represent the accumulation of short-term effects of stunting and other determinants over time (i.e. number of years between pair of two years of surveys). This finding is consistent with Alderman et al. (2006) who found that malnutrition in pre-school age is associated with reduction of grade attainment by 0.85 year by adolescence.

Other important determinants of school outcome include age, education of mother, access to electricity and household consumption. Children born to literate mother have PPVT test scores higher by 0.05 standard deviation compared to children of illiterate mother. Children in households with access to electricity score higher in the PPVT test by 0.05 standard deviation than those without electricity access. The consumption per capita also significantly affects school outcome but the elasticity is modest at 0.03 (i.e., 1% increase in consumption per capita is associated with 0.03% increase in children's PPVT scores). Compared to the reference region of Northern Upland, children from Phu Yen province have PPVT scores lowered by 0.05 standard deviation while children from other regions perform no significantly better than the reference location. This is a surprise finding because the reference location Northern Upland region is remote and has poorer infrastructure.

As shown in the last column of Table 2, the main determinants of stunting status include resident location, age, sex and ethnicity, access to electricity, household consumption, long-term health problem and having low birthweight. In particular, children in advantageous locations such as Red river delta, Mekong river delta and Da Nang have lower probability of being stunt by 20.9%, 27.3% and 55.1%, respectively, compared to the reference region of Northern uplands.

Boys have higher probability of being stunt than girls by 14.3% while children of Vietnamese ethnic have 58.7% lower chance of being stunted. Children from households headed by male, which are often more advantageous, have lower probability of being stunted by 19.8%. The negative and significant association of access to electricity and household consumption to stunt status are also as expected. Children in households

with electricity access have lower probability of stunting by 31.8% while one percent increase in household expenditure is associated with 0.32% reduction in the probability of being stunted. This finding is in line with Grantham-McGregor et al. (2007) that children from disadvantaged families are more likely to be stunted and achieve poorer outcomes at schools. Based on the concept of health production by Grossman (1972), we control for the initial stock of health, proxied by the dummy for variable of low birthweight (less than 2500 grammes) and the presence of long-term health condition in Equation 2. The results show that children with long-term health condition have higher probability of being stunted by 16.9%. Also, children with birthweight lower than 2500 grammes have higher probability of being stunted higher by a substantial magnitude of 31.9%. These results are consistent with existing literature (e.g., Aryastami et al. 2017; Rahman et al. 2016) that low birthweight is a significant determinant of stunting.

The hybrid estimator shows that our main results relatively robust to choice of methods: past performance is one of the strongest predictor of the current performance with the elasticity of 0.57 and stunting status is associated with 0.024 standard deviation reduction in PPVT scores between individuals. However, stunting has no significant effects when within-individual variation is controlled for. Child age, mother's education, access to electricity and household consumptions are other significant determinants of PPVT scores. Compared with the structural equation estimator, ethnicity in the hybrid model becomes statistically significant: children of Vietnamese ethnic have PPVT scores higher by 0.04 standard deviation compared with those from minority groups.

We further test the robustness of our results by estimating a static specification using a hybrid estimator. The main difference we observe is that the magnitude of stunting effects increase (in absolute value) substantially from -0.024 to -0.07 but the fixed-effects parameters remain insignificant (see Table 3). This finding suggests that ignoring the evolution of knowledge development may lead to over-estimation of the malnutrition effects to cognitive outcomes. We also try to use severely stunting (a dummy for those in the bottom 99 percentile of the HAZ z-scores) and found similar results. We do not present this result here for brevity but can be made available upon request.

Table 3: Effects of stunt on PPVT scores (hybrid estimator)

Independent variables	Dynamic specification		Static specification	
	Coeff.	Std. err	Coeff.	Std. err
PPVT in the previous period	***0.572	0.012		
Gender of household head (male=1)	-0.013	0.016	*-0.038	0.021
Child's gender (male=1)	-0.001	0.009	-0.005	0.012
Child's ethnic group (Vietnamese=1)	**0.043	0.020	***0.184	0.028
Father is literate	0.006	0.016	***0.083	0.022
Mother is literate	***0.045	0.016	**0.056	0.022
Red River Delta	0.010	0.017	0.007	0.023
Phu Yen	** -0.032	0.016	***-0.210	0.022
Da Nang	-0.018	0.019	*0.048	0.026
Mekong River Delta	-0.001	0.018	***-0.156	0.024
W_Stunt	-0.030	0.027	-0.030	0.032
W_Child's age (months)	***2.319	0.094	***2.319	0.113
W_Age of household head	0.390	0.477	0.391	0.574
W_Access to electricity	-0.025	0.043	-0.025	0.052
W_Consumption per capita	-0.021	0.021	-0.022	0.025
W_Household size	-0.033	0.044	-0.033	0.053
W_Dependent ratio	-0.075	0.053	-0.075	0.064
W_Long-term health problem	-0.001	0.022	-0.001	0.027
B_Stunt	*-0.024	0.013	***-0.070	0.017
B_Child's age (months)	***1.326	0.074	***2.039	0.076
B_Age of household head	0.009	0.021	0.006	0.028
B_Access to electricity	***0.122	0.029	***0.315	0.039
B_Consumption per capita	***0.042	0.011	***0.150	0.015
B_Household size	-0.001	0.021	-0.024	0.029
B_Dependent ratio	-0.011	0.025	-0.001	0.033
B_Long-term health problem	-0.001	0.019	-0.017	0.025
Constant	***-4.245	0.331	***-6.226	0.348
Sample size	3,185		3,374	

Note: Prefix W stands for “within” or fixed-effects parameters (i.e., γ_1 in Equation 3); prefix B stands for “between” or random-effects parameters (i.e., γ_2 in Equation 3).

We also estimate a static version of the structural equation and found similar findings. The results of this estimator reveal higher number of statistically significant vari-

ables, including regional dummies (Da Nang and Mekong river delta), child ethnicity, gender of household head and education of father (see the Appendix). Consequently, the magnitude of the stunt dummy (-0.156) is lower in the static specification than in the dynamic specification. However, the significance of the lag dependent variable and higher log likelihood (-665.5 vs -2775.5) suggest that the dynamic specification is preferred.

6 Conclusions

This paper has examined the effects of stunting on the cognitive development of children using data from Young Lives Survey for Vietnam. This is the first time the dynamic relationship between stunting and cognitive achievement was considered, at least for Vietnam, using both structural equation and hybrid estimators. We also compared our dynamic models with the static model which is commonly used in the literature. Our results provide new empirical evidence into the dynamic relationship between stunting and cognitive development.

Both the structural equation and hybrid models show that the past PPVT scores is the main predictor of the PPVT scores in the current period, which is consistent with the theory of dynamic formation of skills in the economics literature. However the structural equation estimator as we believe to be more appropriate shows that the stunt is significantly negative : stunting is associated with about 0.178 standard deviation reduction in the PPVT scores. Also from the structural equation model, the long term effects of stunting are double the short-term effects. This shows our dynamic specification offers a new set of empirical evidence which makes several implications.

First, failure to consider the cumulative effects of school performance may lead to biased results due to misspecification of empirical models; therefore interpretation from past studies of similar static models need caution. Our empirical results show that the long-term effects of stunting are much larger than the short-term effects even after controlling the effects of the past academic achievement. This finding, again, suggests that the effects of stunting have been underestimated in the literature .

In addition, our empirical results show some regional inequality in Vietnam. Chil-

dren in the Mekong and Red River Delta regions performed better in cognitive tests than elsewhere in Vietnam. We do not find empirical evidence of gender inequality as reported in previous studies. However, the role of mothers' literacy, access to electricity and level of consumption remains important. We acknowledge that these results could be specific to the Vietnamese data and suggest further analyses using data obtained from other countries.

Disclosure statement

No potential conflict of interest is reported by the authors.

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Appendix

Table 4: Effects of stunt on PPVT: static estimate for structural equations

	PPVT equation		Stunt equation	
	coef	se	coef	se
Stunted (Y=1)	***-0.156	0.030		
Red River Delta (Y=1)	-0.003	0.020	** -0.209	0.089
Phu Yen (Y=1)	***-0.208	0.020	0.091	0.081
Da Nang (Y=1)	**0.055	0.022	***-0.554	0.108
Mekong River Delta (Y=1)	***-0.162	0.020	***-0.280	0.093
Child's sex (Boys=1)	-0.001	0.012	***0.151	0.049
Child age	***2.255	0.029	** -0.254	0.120
Child's ethnic group (Vietnamese=1)	***0.173	0.026	***-0.589	0.099
Sex of household head (male=1)	** -0.041	0.020	** -0.204	0.084
Age of household head	-0.001	0.027	-0.074	0.109
Father is literate (Y=1)	***0.090	0.021	-0.117	0.084
Mother is literate (Y=1)	***0.071	0.021	-0.050	0.083
Access to electricity (Y=1)	***0.209	0.037	***-0.319	0.116
Household expenditure	***0.114	0.013	***-0.312	0.057
Household size	-0.014	0.023	0.141	0.103
Dependency ratio	-0.021	0.028	-0.105	0.123
Long-term illness or health problem (Yes=1)	-0.005	0.018	**0.182	0.078
Low birthweight (under 2500 grammes=1)			***0.316	0.084
Constant	***-6.831	0.156	***3.377	0.636
ρ	***0.144	0.040	N=	3680