The impact of public expenditure on child malnutrition in Peru: Are exclusion mechanisms at work?

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Abstract

Why is the urban-rural gap in child malnutrition increasing in Peru despite government efforts to improve the provision of public services? This paper examines the impact of regional public expenditure in Peru on the nutritional outcomes of young children. To account for policy endogeneity, I instrument for public expenditures using the level of natural resource royalties assigned to each region. I consider separately supply and demand restrictions that diminish the effectiveness of public expenditure. I find that public spending has a positive impact on children's outcomes only in urban areas. This statement is true regardless of the type of expenditure analyzed. However, worse off urban households do not benefit from public good provision. This suggests that the poor face constraints that limit their ability to make use of public goods and services. In rural areas, there is no effect for either the poor or the non-poor. This result is shown to be due to the lower quantity and quality of public services and the crowding out of private expenditure in rural areas.

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I. Introduction

Thirty percent of children less than 5 years old endure chronic malnutrition in Peru, with the resulting negative impact on cognitive development (Glewwe et al. 2001, Walker et al. 2005) and human capital formation (Glewwe et al., 1995, Maluccio et al. 2006). Chronic malnutrition differs drastically between urban (14%) and rural areas (46%)[1]. Furthermore, this difference widened from 26 percentage points in 2000 to 32 percentage points in 2005. Simultaneously, both GNP and public expenditure in regions increased annually on average by 4%, while regional health expenditures grew by almost 7% every year. Peru has been growing relatively steadily and quickly with an expanding public budget. Furthermore, the country has signaled an increased awareness of the importance of early childhood in its policy agenda as featured by the announcement of the National Plan of Action for Childhood and Adolescence (PNAI 2002-2010). Yet health disparities broadened.

This paper provides potential explanations for the increase in the urban-rural malnutrition gap. To do so it analyzes the impact of total regional public expenditure on child nutritional outcomes from their first birthday until age 6. I use a panel of children, this approach contrasts with most previous papers in the literature which perform cross-country analysis (Filmer et al. 1999, Baldacci et al. 2002 and Gupta et al. 2003). Having panel data allows me to control for unobserved household/child heterogeneity.

My study contributes to the literature since it provides exogenous variation to correct for the potential endogeneity of regional public expenditure. The variation comes from the interaction between natural resource endowments in each political region in Peru and the world prices of these resources. This interaction generates variation in the level of natural resource royalties assigned to each political region. The instrument used is superior to health input prices, typically used in the health economic literature (Schultz 2004), because it is not altered by individual regional migration, as proven later in the document. Any omitted factors need to fluctuate within regions over

[1]. Source: 2004-2006 Continual Demographic and Family Health Survey (ENDES Continua 2004-2006)

time in the same non-linear way as world mineral prices and regional mineral production volumes to have a confounding effect on child malnutrition. Two possibilities are that (1) regional incomes increases with increases in natural resource royalties (2) health outcomes worsen with increases in natural resource royalties. I show that both concerns are unsubstantiated. Yet, regional governments could have changed their patterns of expenditure in response to the amount of royalties received, spending more in sectors that directly influence child health. To avoid introducing any bias I follow Altonji and Card (1991) approach and use the expenditure structure present in 1999 to generate the fraction spent in each sector in 2002 and 2006.

In addition, this paper differs from the existing literature because it disentangles supply and demand restrictions that diminish the effectiveness of public expenditure. I show rural areas have lower levels and worst quality of public services. In these areas due to a lower population density and hence a reduced demand, higher quality private services are being crowded out when public services expand. Hence public expenditure ends up being ineffective and some times even detrimental to child well-being. This statement is true regardless of the type of expenditure analyzed. In urban areas, spending in health and sanitation is the most important channel through which public expenditure impacts child health, followed by transportation and education. Surprisingly, programs that finance nutritional interventions do not impact child well-being. In cities, despite the availability of effective public goods and services, demand and efficient use are limited by the lack of complementary private assets. I confirm consumption levels of public goods and services differ depending on child, maternal and household characteristics. The children not being benefited by public spending belong to households with lower incomes, have indigenous mothers and are the ones with the lowest birth weights.

The paper is divided into 8 sections. The next section briefly describes the determinants and consequences of child malnutrition. Section 3 presents the theoretical model, while section 4 describes the data. The next section explains the estimation

procedure and provides validity checks for the instrument chosen. Sections 6 and 7 present the results. Finally, I conclude with a discussion of the findings.

II. Consequences and Determinants of Child Malnutrition

This study focuses on the impact of public investment on the nutritional level of children from birth until around their 6th birthday. This period is a particularly important developmental stage for children. Authors such as Knudsen, Heckman, Cameron and Shonkoff (2006) and Heckman (2007) have emphasized the importance of early experiences as they have a distinctively great influence on the development of diverse skills as well as on biological processes[2]. These skills and processes determine the mental potential of an individual and consequently his ability to achieve strong economic productivity in adulthood. A large literature finds that adult stature, an outcome of child health, is related to socioeconomic status (Case et al. 2002, Currie and Stabile 2003, Case et al. 2005, Case and Paxson 2006, Alderman et al. 2006, Oreopoulos et al. 2008). Moreover, lower human capital in the aggregate may hamper a country's economic development (Thomas and Strauss 1998).

The causes of stunting are multiple and inter-related[3]. A child's nutritional level results from a process that starts even before birth. Children with low birth weights, inadequate levels of nutritional intake and high burdens of disease will become stunted. Furthermore, diseases such as diarrhea and acute respiratory infections can cause a vicious cycle of malnutrition and illness[4] (Ehiri et al. 1999). Malnutrition in Peruvian children is caused by both food deprivation and infectious diseases which in turn are related to poverty, lack of access to markets, deficient transportation, inadequate health

[2] "During the first 2 years the brain develops rapidly through neurogenesis, axonal and dendritic growth, synaptogenesis, cell death, synaptic pruning, myelination, and gliogenesis" (Grantham-McGregor et al. 2007).

[3] A child is stunted if he/she falls two standard deviations below the height-for-age z-score. The z-score is calculated using the World Health Organization/ National Center for Health Statistics/Centers for Disease Control International Growth Reference (NCHS 1977).

[4] These diseases deplete vital nutrients and complicate the child's recovery by decreasing food consumption and absorption. The consequent nutritional deficiencies will weaken the immune system, rendering the child more vulnerable to other diseases.

and sanitary infrastructure and low levels of education (Valdivia 2004, Escobal et al. 2005, Aguiar et al. 2007). Public goods and services could directly affect a child's nutritional status by providing access to health facilities, better sanitary infrastructure or nutritional programs. Investment in health services could affect the growth of children by increasing the likelihood of visiting a health provider due to reductions in waiting times and distance to facilities. Furthermore, health facilities in Peru help organize the delivery of social services run by the Ministry of Health (e.g. vaccination campaigns, food supplementation programs, etc.). Valdivia (2004) explored the direct association between an expansion in health infrastructure during the 1990's and the nutritional level of children in Peru. He found that for urban areas there was a significant impact of this expansion on a child's nutritional level. Yet he found no impact in rural areas. This study expands on this approach by examining the impact of total public expenditure and not just the effect of increases in public health infrastructure. Moreover, in addition to analyzing the impact of investment it also looks at the effect of current spending which amounts to 84% of total expenditure. Similarly, Thomas, Lavy and Strauss (1996) found that healthcare facilities in both urban and rural areas explain a great percentage of the variation in child nutritional status in Côte D'Ivoire. In addition, public health interventions that increase access to both healthcare and nutritional information in Indonesia helped improve children's nutritional level (Frankenberg et al. 2005).

Total government expenditure might have an effect beyond solely health interventions in disadvantaged localities where a limited diet interacts with poor sanitation facilities, proliferation of infectious diseases and inadequate access to health facilities (McGinnis et al. 2002). Building roads lowers transportation costs, thus allowing food to reach previously disconnected areas and potentially diversifying a child's diet or simply enhancing it. Building a dam can improve the agricultural productivity of a region and as a consequence increase the food supply and assure food availability. Furthermore, government investments in research and infrastructure could stimulate growth that could lead to greater income earning opportunities (Fan et al. 2000). Since there are a wide array of public expenditure types that can affect child

health it is important to analyze in addition the effect of total public expenditure on child well being. In addition, it is important to measure the impact of total public expenditure because bundled public services have been shown to affect welfare more strongly than separate interventions (Escobal et. al 2002 and Chong et al. 2003).

Yet, the impact of public spending on child nutrition does not only depend on the amount of money spent. The quality of the goods and services provided is crucial to its effectiveness. Peru is a country characterized by a low income per capita, a lack of economic diversification, an extreme concentration of wealth in its capital (Lima) and inefficient public institutions. These factors combined with deep ethnic and regional disparities have resulted in differentiated access to public good and services. These differences are most evident between urban and rural areas and could be impacting the nutritional level of children there. Van de Poel et al. (2007) found that Peru had the largest urban/rural gap in nutritional levels of 47 developing countries. Moreover, the urban-rural gap in child malnutrition has been increasing in Peru despite increases in government spending. Hence it is of outmost importance to analyze the differentiated impact of government efforts in urban and rural areas separately. Moreover, Wagstaff and Watanabe's (2000) study of 20 developing countries found that Peru had the most unequal distribution of malnutrition of all countries, regardless of geographical location. Thus, the quantity and quality of publicly supplied goods and services are not the only constraining elements when it comes to the effectiveness of public spending. Public expenditures will not be effective if households are not able or willing to access public goods and services. For example, in urban areas, despite the availability of higher quality public services, demand and efficient use could be limited due to language barriers or lack of economic resources. These concerns are also addressed in this study.

III. Modeling and Estimation

1. The Theoretical Model

I consider the nutritional level of the child to be a choice that results from the household's efforts to maximize its utility (Becker 1965, Grossman 1972, Gronau 1977, Wolfe et al. 1982, Strauss et al. 1998, Currie 2000, and Mwabu 2008). Parents' behavior is determined by the interaction of the preferences and capacities of the members of the household and the social and economic environment they currently face and expect to face in the future. Parents are assumed to know all the values of the relevant demographic and economic variables over the course of their life in every different state of nature. The parents are assumed to choose the child's nutrition level N^c, leisure L, and the level of consumption of goods and services C, in order to maximize their utility. The H^{th} household preferences are represented by the following additive utility function:

$$U_t^H(\cdot) = E_0\left[\sum_{t=0}^{T}\beta^t U^H\left(C_t^F, L_t^F, C_t^M, L_t^M, N_t^c\right)\right]$$

N_t^c = Nutritional level of child (z-score)
C^i_t = Personal consumption good for i=father or mother
L^i_t = Amount of leisure for i= father or mother

The production function for the nutritional level of the child

The nutritional level of the child has the following production function:

$$N_t^c = F_N\left(P_t^E, H_{t-1}^c, T_t^{nM}, V_t^n, X_t^c, X_t^M, X_t^H, X_t^C, \mu_t\right)$$

The height-for-age z-score is used to measure the long run nutritional status of the child. Child nutrition is a result of *effective public expenditure* at the regional level (P_t^E), the time the mother invested to produce a better outcome (T_t^{nM} e.g. time used to boil water), the goods purchased to produce a better outcome (V_t^n e.g. nutritious food), child characteristics such as age (X_t^c), health status in the previous period (H_{t-1}^c), parental characteristics (X_t^M) such as mother's height, household characteristics such as wealth level (X_t^H), community characteristics (X_t^C) including access to health and sanitary

facilities and unobserved attributes related to both the mother and the child (μ_t) such as resilience and maternal initiative and determination.

It is very important to specify what I mean by *effective public expenditure*. The ability of a household to take advantage of public goods and services is not only determined by the availability (the actual supply) and the quality of these. It is also related to the capability and motivation of this household to take full advantage of these goods and services. There could be very strong complementarities between public and private assets[5]. Specifically, if these services are provided in a language that differs from the maternal mother tongue it will be less probable that they will be used. In addition, a mother with a different mother tongue may be unable to comprehend fully and carry out instructions given by public providers (e.g. doctors). Parents with boys could see them as a good investment and could be motivated to use public services more often than if their child was a girl. Also parents with more resilient children (as proxied by higher birth weight) could have a differential use of public facilities. Finally, households with extremely high opportunity cost for time will be unable to take their children to a public facility with long waiting times. Hence, *effective public expenditure* (P_t^E) is a function of both actual public expenditure (P_t) and child, maternal and household characteristics. People maximize their utility and the child's nutritional level given the level of actual public expenditure in the region the child resides. Yet child, maternal and household characteristics influence the way this variable enters the nutrition production function.

Financial constraint

Assuming non existent savings (which is a reasonable assumption in Peru) we have:

$$p_t\left(C_t^F + C_t^M\right) + p_t^n V_t^n = \left(T_t^{LF}\right)w_t^F + \left(T_t^{LM}\right)w_t^M + Y_t^H$$

This financial constraint shows that the parental expenditure on consumption goods and health inputs depends on their prices (p_t, p_t^n, respectively) as well as on the

[5] I define assets in a broad way, not only including material belongings but also taking into account personal characteristics that could be beneficial for the individuals.

household earnings. These earnings are determined by the amount of parental time spent working in the labor market (T_t^{LF} and T_t^{LM}), the wage paid to the parents (w_t^F and w_t^M) and the amount of unearned income held by the household (Y_t^H). As well, the parent's are constrained by the amount of time available to them.

Parent's time constraint

$$T_t^F = T_t^{LF} + L_t^F$$
$$T_t^M = T_t^{LM} + T_t^{nM} + L_t^M$$

This time constraint is very important when dealing with the demand of public goods and services. By definition one can consider these to be free. Nevertheless, in order to be able to consume them the household has to give up valuable time that could otherwise be used for other productive activities. This means households with tighter budget constraints will be less prone to dedicate time to child enhancing activities.

Now assume the decision maker maximizes household welfare, subject to the financial constraint, and the parents' time-constraints. Maximizing household welfare subject to these constraints implies that the nutritional level of children depends on the levels of effective public expenditure, the price for the composite consumption good, the price for the nutritional inputs, the wage rates for parents, unearned income, child-specific characteristics, parents-specific characteristics, household-specific characteristics, community-specific characteristics; and a vector summarizing all unobservable characteristics. This is illustrated by equation 1.

$$N_t^c = \Phi\left(P_t^E, p_t, p_t^n, w_t^F, w_t^M, Y_t^H, H_{t-1}^c, X_t^c, X_t^M, X_t^H, X_t^C, \mu_t\right) \quad (1)$$

Just as height-for-age is a long run indicator of nutritional status, wealth is a net cumulative indicator of economic well being. Household wealth was chosen in this study instead of individual income since income data is not available in the Young Lives survey which I use in this paper. Yet the survey has a wealth indicator based on a series of household characteristics (flooring, walls and ceiling materials, ownership of goods, type of cooking fuel, toilet facilities, etc.). I create my own wealth score summarizing

household characteristics using a principal component analysis[6]. Wages and unearned income in the household are assumed to reflect household wealth (W_t^H). The nutritional status of the child is presented in equation 2.

$$N_t^c = \Phi\left(P_t^E, p_t, p_t^n, W_t^H, H_{t-1}^c, X_t^c, X_t^M, X_t^H, X_t^C, \mu_t\right) \qquad (2)$$

I estimate this model by taking a first order Taylor expansion of the previous expression. This yields an empirical equation with a constant plus all the variables included in the function, multiplied by their respective coefficients.

IV. Data

My analysis relies on three main sources of data. I use the Young Lives International Study of Childhood Poverty. This study tracks the lives of 2,052 Peruvian children born in the year 2000/1 for 15 years. The first round of data was collected in 2002 and the second round between late 2006 and early 2007. This survey includes information about the child, the household and the social, economic and environmental context of the community where the children reside. These data allow me to control for different aspects in the child's life that could affect his/her nutritional level, such as health status and age. Secondly, I match these data with statistics at the regional level by using the 2002 and 2006 National Household Surveys (ENAHO). These are yearly surveys conducted in the whole country to measure living conditions, poverty levels and the impact of social programs. Finally, I have collected information about public expenditure from the Ministry of Economics and Finance statistics data base.

1. The Design of the Young Lives Study

The Young Lives study was designed to analyze the changing nature of childhood poverty in four developing countries (Ethiopia, India, Peru and Vietnam) for over 15

[6] This wealth score is created using housing quality characteristics, consumption of durables and access to public services. The index includes de following variables: rooms per person, quality of floor, roof and wall, dummies for the possession of durables by the household and finally dummy variables indicating access to drinking water, electricity, a toilet and fuel.

years. This is a long-term research project that has tracked the same children since 2000. In Peru the survey consists of a stratified (urban and rural) nationwide sample of over 2,000 children, in 20 geographical sites, ages 6 months to 17 months in 2002. An additional older cohort of 860 children aged between 7.5 years old and 8.5 years old, not used in this analysis was also sampled in 2002.

The Young Lives Sampling strategy selected approximately 100 children in 20 different geographical sites. This survey over-sampled individuals in poor areas and by design excluded the wealthiest 5% of the sample in order to focus more on poorer groups and ethnic minorities. Hence it is not a nationally representative sample, although it is representative of the Peruvian population in a broad array of socio-economic indicators (Escobal et. al 2008).

The Young Lives study has a modest attrition rate. The non-response rate was 4.39% for the younger cohort[7]. Tests for selection bias due to this attrition reveal almost no statistically significant differences between the sample that attrited during the second round and the children that continued in the sample as shown in **Table 1**[8]. The only significant differences of means are for mother's height and probability of having an immunization program in their community.

2. Main Variables

The nutritional status of the child is measured using height z-scores. Height has proven to be an informative long run indicator of the nutritional status of children. Z-scores are constructed using the new World Health Organization (WHO) international child grow standards[9]. Specifically, they are defined as the standard for well nourished

[7] The survey team made sure to track migrating children between survey rounds.
[8] This table contains mean difference tests for a wide range of child, household, community and region characteristics.
[9] The WHO Child Growth Standards differ from existing growth charts in many ways. First they compare growth measurements against a standard optimum value, which is in contrasts with previous references that simply described how the average child grew. In addition, it uses a pooled sample from six countries (Brazil, Ghana, India, Norway, Oman, and the United States), allowing the development of a truly international standard. In the past, international references were based on children from a single country.

children. For example, the height-for-age Z-score for a child *i* in age and gender group *c* is constructed as

$$Z_{ic} = \frac{(H_{ic} - MedianH_c)}{\sigma_c}$$

where H_{ic} is the measured height of the child, and $MedianH_c$ and σ_c are the age- and gender-specific median height and the standard deviation of the height, respectively, of well nourished children. A risk indicator is falling two standard deviations below this z-score measure. In round 1, 18% of children in the sample were malnourished, compared to 32% in round 2. In urban areas, stunting increased from 11 to 21% between rounds, whereas in rural areas it increased from 30 to 58%.

The independent variable of interest used in this study is the level of public expenditure in each region. Total public expenditure is defined as the summation of investment and current expenditure. The unit of measurement is 100 million soles (about 33 million dollars)[10]. During the time period analyzed (2002-2006) total per capita government expenditure increased by 34%[11]. The most important spending categories were education (35%), poverty alleviation programs (27%), health and sanitary infrastructure (14%) and transport (9%). Per capita expenditure in each of these areas increased dramatically. Educational expenditures grew by 35%, expenditure in poverty alleviation programs by 16%, health and sanitary infrastructure spending by 38% and transportation expenditures by 40%. As well as analyzing the impact of total expenditure on child nutrition, all of these categories are analyzed separately.

3. Descriptive Statistics

Table 2 illustrates differences between urban and rural areas for both rounds of the survey. The most remarkable divergences are related to the possession of private assets such as maternal education, access to drinking water in the household and wealth. In

[10] I chose the measurement unit because it is very close to the actual annual average growth in average regional expenditure (95 million soles). Hence the results obtained in this paper could be relevant for analyzing the impact of the actual yearly increase of public expenditure on the nutritional level of children.
[11] Statistics from the Ministry of Economics and Finance (www.mef.gob.pe)

addition, community characteristics such as the size of the population and the probability of living in the highlands differ greatly. There is a differential access to health professionals such as general physicians, pediatricians and trained midwives that persists between the two rounds. In contrast, the differential access to health facilities and programs narrows in the second round, with significant increases in rural areas. Finally, children in rural areas have a much worse height z-score and have almost three times the probability of being undernourished in comparison to urban areas. Between the two rounds these differences broaden. There exist differences in the quality and availability of public services in these two areas as found by Valdivia (2004). Delivery of public goods especially in remote rural areas is poorly monitored. This lack of accountability results in high rates of absenteeism and irregular working hours (Devrajan et al. 2004).

Child nutritional outcomes and household characteristics also differ (Smith et al. 2005, van de Poel 2007, Larrea et al. 2005). An explanation for the nutritional gap could be the high altitude at which most of the rural population in Peru lives. As stated in their 2007 study by van Poel, O'Donnell and van Doorslaer child growth retardation could be caused by hypoxia (oxygen shortages) which is common in high altitudes. Similarly, this could be the result of the highlands diet with a low protein and micronutrient intake (Larrea et al. 2005).

V. Empirical approach

Public expenditure at a regional level is determined by factors that could simultaneously be impacting the nutritional level of the child. Maternal characteristics that induce mothers to choose a specific location with a specific level of public expenditure could also affect their ability to care for their child. Moreover, the government could decide to spend more in an area where there is more need for public intervention (Rosenzweig et al. 1986). This incentive creates reverse causality. The

endogeneity problem should be addressed. I do so by using an instrumental variable approach.

1. Identification Strategy

My exogenous variation in public expenditures comes from the natural resources royalties assigned to each region each year. Natural resources royalties are made up of 6 different types of royalties (mining, oil, gas, hydro-energetic, forest and fishing). Yet mining, oil and gas royalties are by far the most important resources. These three resources are referred as mining resources in Peruvian national accounts. Mining royalties are a percentage of the income and rents collected from mining companies by the central government and assigned to regions from the exploitation of mining resources in their jurisdictions[12]. The variation in the level of mining resource royalties assigned to regions comes from the interaction between the endowment of these resources in each region and the world prices of these resources. Peru has one of the world's leading mining sectors[13]. This sector has been growing consistently in the last few years with an annual real average growth of 6.5% in its GNP between 2002 and 2006[14]. On top, the prices of minerals have increased dramatically since the beginning of 2002 reaching historic highs in 2006[15]. For example, the price of copper (the second most important metal in Peru) increased by 331% between those years (See **Graphs 1** and **2**). Hence the amount of royalties assigned to each region has increased dramatically across years. In addition, these royalties varied greatly geographically, providing sufficient variation for identification (see maps in **Appendix 1**).

[12] See: Mining Canon Regulations (Supreme Decree No. 005-2002-EF) and Supplemental methodologies to calculate the royalties in license contracts for the exploration and exploitation of hydrocarbons (Supreme Decree No. 017- 2003-EM).

[13] According to statistic from the Peruvian Ministry of Energy and Mines in 2006 Peru ranked worldwide 1st in the production of silver, 3rd in the production of copper, tin and zinc, 4th in the production of lead and 5th in the production of gold.

[14] Statistics from the Peruvian Ministry of Energy and Mines (MINEM)

[15] Between 2002 and 2006 the price of the leading exported metals (presented here in order of importance) increased enormously: silver by 150%, copper by 331%, tin by 116%, zinc by 321%, lead by 185% and gold by 95%. Source: London Metal Exchange and London Bullion Market Association. Oil and gas prices also soared by 156% and 118% respectively. Source: NGA, annual reports. Oil Patch Research Group.

The amount of royalties assigned to each region does not respond to local circumstances. It only depends on the price of minerals in the international market and in the volume of minerals produced. Royalties are arguably unrelated to children's nutritional outcomes, provided an increase in natural resources royalties is uncorrelated with changes in net per capita income, expenditure categories and migration patterns and that mining does not directly affect child health. Variations in the amount of natural resource royalties do not lead directly to an increase in economic activity in the areas where the resource is located. Mining in Peru is an economically isolated activity. Almost all mining is surface mining. This type of excavation type entails removing soil and rock overlying the mineral deposit for which heavy equipment, such as earthmovers, and dragline excavators or bucket wheel excavators are used[16]. Hence, the type of mining exploitation carried out in Peru requires great levels of capital investment and small amounts of highly specialized labor. The mining sector represented around 6.4% of real GDP between 2002 and 2006[17] (see **Graph 3** for regional distribution), yet it employed less than 1% of the labor force[18]. This means an increase in production will not generate a direct expansion in the local economy.

I verify that increases in mining royalties do not directly expand local economic activity by running a reduced form pooled OLS regression (with data from 2002 and 2006) where the dependant variable is net per capita income and one independent regressor is the level of natural resources royalties assigned to the region (see **Table 3**). As controls, I use a community poverty index, public expenditure at the regional level, year fixed effects and regional fixed effects. For this analysis I cluster my standard errors at the region-year level. Results using present and future values of natural resources royalties are presented. The impact of future levels of royalties is estimated because the amount of royalties generated in a year is distributed with a delay of a year and a half. For example whatever level of royalties was generated during 2007 it will be distributed starting on June 2008 until May 2009. This results in a disassociation between the time

[16] This machinery is not produced in Peru, much less in the localities where this exploitation takes place.
[17] Source: National Institute of Information and Statistics (INEI)
[18] 0.7% in 2003, 0.8% in 2005 and 0.9% in 2006. Source: Peruvian Ministry of Labor

these amounts are generated and when they are spent. In other words, the total royalties spent this year would have affected economic activity a year and a half ago. I therefore present four specifications to account for any lagged effects. The first one shows the impact of the level of present Natural Resources Royalties on income. The second one the impact of next year's royalties, the third one the effect of the average level of royalties assigned between next year and the year after that. Finally the fourth model shows the effect of royalties assigned two years from now. Royalties have no statistically significant impact on net per capita income. Furthermore, the magnitude is minimal. For an increase equal to the average level of royalties, annual per capita income would increase by less than 1.7% of a standard deviation.

Secondly, royalties could be thought to impact health status directly. Increased mining activities could generate enough additional pollution to reduce the general population health level. In order to test this hypothesis a reduced form Probit regression is run. The dependant variable is health status (a dummy that indicates the person was ill in the past 4 weeks) and the independent regressor is the level of natural resources royalties spent in the region. I use the same controls and I also cluster the results by region-year. Estimations are performed using present and future levels of royalties but also lagged and double lagged levels. These additional estimations are performed in order to account for a cumulative health impact of mining extractive activities. Pollution generated in a period can end up affecting a person's health several periods in the future. These results are shown in **Table 4**. Just as before royalties do not have a statistically significant impact on the probability of being ill in the last 4 weeks

Similarly, regional governments with higher levels of royalties could have different patterns of expenditure than other regions. Regional governments receiving more royalties could spend more in sectors that directly influence child health such as health and sanitation. This could bias the results. I initially test this theory by graphing the average percentage amount of government expenditure directed to different sectors in each region ordering the regions by the total amount of royalties assigned to them between 2002 and 2006 (**Graph 4**). No pattern arises. Yet this could mask changes over

time in response to the amount of royalties received. Following Altonji and Card (1991) I avoid introducing any bias due to the effect of the amount of royalties assigned to each government, by using the expenditure structure present in 1999 to generate the fraction spent in each sector in 2002 and 2006. In 1999, most regions (56%) did not receive royalties and the royalties represented only 1.7% of total expenditure. Due to changes in the legislation at the beginning of the decade[19], the percentage of mining income assigned to royalties increased greatly. During 2002 and 2006 royalties represented on average 5.6% of total expenditure, furthermore, 92% of regions received royalties.

Finally, households could be migrating to areas with higher levels of natural resources royalties. Hence royalties could be related to individual preferences. I test this hypothesis by running a reduced form Probit regression. The dependent variable is the probability of moving (a dummy variable that indicates if the child migrated to another region) and the independent regressor is the level of royalties assigned to the region. I use a poverty index and the level of government spending as controls and I cluster the results by region. Estimations are performed using present, future and lagged and double lagged levels of royalties. This is to account for a possible decision making process that takes into account all relevant information available. The results are presented in **Table 5**. Royalties do not have a statistically significant impact on the probability of migrating. Thus I concluded the exogeneity assumption is valid.

The amount used in the estimation is the level of royalties assigned each year, not the actual amount spent in the region during that year. These two quantities differ significantly. Between 2002 and 2006 the average amount of royalties assigned to each region was 30 million soles, while the average spent was 21 million soles (only 70%). More efficient regional governments could be able to spend a higher percentage of the royalties assigned to them. Hence by using the amount of royalties assigned, instead of spent I avoid including a bias in my estimation.

[19] In January 2002 the Mining Canon Regulations (Supreme Decree No 005-2002-EF) were approved. This meant that starting in the year 2002 regional and local governments would be entitled to 50% of the income and rents obtained by the central government from the exploitation of mining activities in their jurisdictions (Mining Royalties). This percentage used to be only 20% in the past.

2. Specification

As mentioned previously, the instrument chosen in this study is the level of natural resources' royalties assigned to each political region in Peru. Furthermore, I include individual fixed effects, regional fixed effects and year fixed effects.

My first stage equation is

$$P_{jt} = \delta_j + \phi_t + \rho_1 X_{jt}^{R} + \rho_2 Z_{jt} + \varepsilon_{jt} \quad (3)$$

Z_{jt} is the level of natural resources' royalties obtained by each region j at time t, P_{jt} is the level of public expenditure in period t and region j, δ_j are region fixed effects and ϕ_t are year fixed effects. Other regional characteristics that vary over time are also controlled for (X^{R}_{jt})[20].

My second stage equation is

$$N_{ijt}^{c} = \theta_i + \delta_j + \phi_t + \alpha P_{jt} + \beta_1 X_{ijt}^{c} + \beta_2 X_{ijt}^{M} + \beta_3 X_{ijt}^{H} + \beta_4 X_{t}^{C} + \beta_5 X_{t}^{R} + \mu_{ijt} \quad (4)$$

where N^{c}_{ijt} is the heath-per-age z-score level and θ_i are individual fixed effects. The child's past health status is included in the child's characteristics and the wealth index is part of the household characteristics. I use a first difference approach and cluster the standard errors at the region-year level to account for any variation within region and year[21].

As previously stated, public expenditures will not be effective if households are not able or willing to access to public goods and services. To shed some light on the complementarities involved in the consumption of private and public goods and services I also estimate the effect of total public expenditure on sub samples defined by child, maternal and household characteristics.

[20] Prices of basic food staples are not included in the estimation due to the high number of missing values.
[21] The clustering level is the region-year. There are dummies for non movers as well as dummies for movers. I.e. there is a dummy for children that lived in Lima in 2002 and stayed in Lima in 2006 and there are different dummies for children that lived in Lima in 2002 but moved to other regions in 2006.

VI. Results

1. Assessing the instrument's strength

Given the disparities between urban and rural areas, I performed separate estimations of the conditional demand functions for the nutritional level of children for these areas as well as for the whole sample. According to the first stage regression parameters (see **Tables 6A** and **6B**) the instrument is relevant for the whole sample as well as for rural and urban areas. This is true not only for total expenditure, but also for expenditure in the most important sectors (health and sanitation, education, poverty alleviation programs and transport). It is significant at a 1% level for all specifications (with the exception of expenditure on transportation in rural areas) and it displays a positive and non immaterial effect on the level of total public expenditure. For example, an increase of 100 million soles in the amount of natural resources royalties assigned to a region during the fiscal year will increase the level of total expenditure in the whole sample by 213 million soles. This amount is 288 million soles in rural areas and 135 million soles in urban ones.

Royalties are destined by law to investment projects and feasibility studies. If a region can afford to prepare feasibility studies this will increase the probability of getting their investment projects approved and as a consequence of getting them financed with public funds. Hence, an additional sol in royalties can have a multiplier effect in the amount of government spending. **Graph 5** shows the strong relationship between the amounts of royalties assigned to a region and the amount of money spent by that region in investment projects during 2006[22].

In addition, I assessed the strength of the instrument using the first-stage F statistic. Estimators can perform poorly when instruments are weak resulting in non-normal sampling distributions of IV statistics and unreliable standard IV point estimates, hypothesis tests, and confidence intervals[23]. The null hypothesis is that the instrument is

[22] This is just a fraction of the total amount invested in that region

[23] A set of instruments is defined as being weak if the concentration parameter is small enough that inferences based on conventional normal approximating distributions are misleading. The concentration

weak. For all the estimations the F statistic (at a 5% significance level) ensured that the maximal bias of the IV estimator relative to OLS was no bigger than 5% (again with the exception of expenditure on transportation in rural areas). This fits the definition of a strong instrument according to Stock, Wright and Yogo (2002).

2. The impact of regional public expenditure on a child's z-score

The results for the second stage are shown in **Table 7**. The first column shows results for simple panel data estimation without instrumenting total public expenditure. The second column shows results for pooled data where total public expenditure has been instrumented using the amount of natural resources royalties assigned to a region in a fiscal year. The third column provides panel estimation where total public expenditure is also instrumented for using the level of royalties. The fourth and fifth columns display panel IV results for the rural and urban samples, respectively. All specifications include regional and time fixed effects. Time variant child characteristics (age, relative health status and incidence of serious illness), maternal characteristics (education), household characteristics (number of children under 5 years of age, availability of drinking water, household size and wealth score), community characteristics (availability of feeding programs as well as preventive and curative health public programs, population size, a dummy for belonging to the highlands, a dummy for being an urban area and a poverty index) and regional variables (debt payments) are controlled for [24]. According to the simple panel data estimation for the whole sample total public spending appears to have a negative but not statistically significant effect on a child's nutritional status (the coefficient is equal to -0.066). This result is consistent with the reverse causality hypothesis that states that the government will spend more in areas where there are pressing social demands. The instrumental variable pool estimation shows a positive, yet not significant coefficient (0.149) which is

parameter is a unit less measure of the strength of the instruments (Stock, Wright and Yogo, 2002). One measure of whether a set of instruments is strong is whether the concentration parameter is sufficiently large.

[24] Individual time invariant variables such as birth weight, ethnicity, gender, maternal height and maternal age at birth where excluded from the estimation, since individual fixed effects are included.

much larger than the one obtained using the IV panel estimation (0.086). This change in the coefficient could indicate the presence of unobserved heterogeneity that if not accounted for could bias the results. Again the estimate is not statistically significant.

The coefficients calculated for urban and rural areas represent the impact of public spending in each area multiplied by the share of spending made in that area. In rural areas the IV estimation also shows no statistically significant impact of public spending. In contrast, in urban areas there is a positive (0.294) and significant impact of public expenditure on a child's nutritional outcome (almost five times the size of a simple OLS estimation for urban areas[25]). For an increase equal to the average annual change in the level of average expenditures in a region, the average urban child z-score would have increased by 23% of a standard deviation. . In addition the coefficient for urban areas is around three and a half times bigger than the one estimated for the whole sample[26]. This magnitude should be understood in the context of a growth curve.

3. The impact of regional public expenditure on the growth curve for urban children

I use growth charts[27] to assess the extent to which increasing public expenditure in urban areas can improve a child's nutritional level. A growth chart consists of a series of percentile curves that shows the distribution of height for age for boys and girls since birth. Using these tables a child's height can be compared to the expected parameters of children of the same age and sex to determine whether the child is growing appropriately.

During the first round, both girls and boys in urban areas were above the 25th percentile (almost at the 30th percentile) for their age. In the second round, both girls and

[25] Simple panel data estimations were performed for urban and rural areas. In rural areas public spending appears to have a statistically significant and negative effect on children's stunting (with a coefficient of -.108). In urban areas there is small and positive but not statistically significant effect (with a coefficient of 0.059).

[26] I performed additional estimations using a dichotomous variable (being malnourished or not) as the dependent variable. Yet no statistically significant results were found in urban areas for any of the specifications. This could indicate that in urban areas public expenditure is not able to raise a child's nutritional level all the way until is crosses the malnutrition threshold. In rural areas increasing public expenditure appears to increase the probability of being malnourished.

[27] Source: World Health Organization

boys were barely below the 15th percentile. In contrast, in rural areas both boys and girls were below the 15th percentile during the first round and during the second round they did not even reached the 3rd percentile.

Using the average age of the children, the average height per age of each group, the impact of public expenditure and the increase in public expenditure between the two rounds, it is possible to calculate how much of the increase in the disparities between urban and rural areas could have been explained by increases in public spending between 2002 and 2006. Over seventy percent of the increase in malnutrition disparities between rural and urban areas can be explained by the increase in total public expenditure during the two rounds (78% for boys and 75% for girls).

4. Impact of regional public expenditure by type of expenditure

The results obtained suggest that there is a threshold (in terms of quality and/or quantity) that public expenditure needs to cross in order to be effective. Apparently, public expenditure is crossing that threshold only in urban areas. This outcome could help us understand how malnutrition disparities could be increasing between these urban and rural areas despite an increase in average public expenditure.

Yet it is possible that the results are driven by the type of expenditure made in each region. In order to test this hypothesis estimations for the most important expenditure groups (education, poverty alleviation programs, health and sanitation and transport) are presented in **Table 8.** According to these results royalties explain variations in the expenditure levels in all sectors. Yet only expenditures in health and sanitation, education and in transportation appear to have an impact on child nutrition. Again, this impact is limited to urban areas. In these areas, there is a positive and statistically significant effect of all these types of expenditure. Health and sanitary spending shows by far the largest effect (3.802) per unit spent. It is followed by transportation expenditures (1.813) and educational spending (0.513). For an increase equal to the average annual change in the level of average spending in health and sanitation in a region, the average urban child z-score would have increased by 31% of a standard

deviation. Spending on education would have represented an increase of 9% of a standard deviation and transport a rise of 11% of a standard deviation

In terms of overcoming the urban-rural gap these results translate into health and sanitary spending being able to explain over 100% of the increase in this gap (104% for boys and 100% for girls). If we only consider educational spending this percentage decreases to 30% and if we look only at the effect of expenditure in transportation it would ascend to 33%. As expected spending in health and sanitation is the most important channel through which public expenditure impacts child health. Unexpectedly, poverty alleviation programs, which finance most nutritional interventions in Peru, do not appear to have an impact on child well-being. Conversely expenditure on education and transportation which are not traditionally associated to child nutritional levels, appear to be influencing this outcome.

5. Impact of regional public expenditure on intermediate outcomes

Public expenditures could be having an impact on a child's nutritional level through several channels. As indicated by the large impact of expenditure in health and sanitation on child nutrition, the availability of health professionals and the access to health facilities and programs could be pathways by which public spending improves child health. In order to asses these channels I run IV panel estimations where the dependent variable was not the child z-score but an intermediate outcome such as the availability of a general physician in the locality. All these estimations include regional and time fixed effects. As controls, I use the household wealth score, community characteristics (population size, a dummy for belonging to the highlands, a dummy for being an urban area and a poverty index) and regional variables (average level of education in the region and debt payments). As before, I cluster my standard errors at the region-year level. The results are presented in **Tables 9A** and **9B**. Public spending increases the probability of accessing public health programs (disease prevention campaigns and child growth controls) only in urban areas. Similarly, an increase in public expenditures increases the access to a health professional in the locality (a general

physician, pediatrician/gynecologist or midwife) only in urban areas. There is even a negative effect of public expenditure on the availability of a pediatrician/gynecologist in rural areas. Yet, an increase in public spending increases the probability of accessing public health centers only in rural areas. Thus, the negative relationship between public expenditure and the availability of a pediatrician/gynecologist may be due to a crowding out effect. In rural areas with small markets for health services, opening a new health center could drive away private practitioners as demand switches to the cheapest public service. This could have a harmful effect on child nutrition if the alternative public health centers are less effective. To investigate these two necessary conditions for the increasing in the urban-rural malnutrition gap I first assess the effectiveness of public expenditure on alternative child health outcomes as well as on child health inputs. Secondly, I directly test for the existence of crowding out of private hospitals due to increases in public health centers. These results are found in **Tables 9C** and **9D.** I ran three IV pool estimations where the dependent variables were (i) the intensity level of the prenatal care received by the mother, (ii) a dummy indicating that the child had been vaccinated against tuberculosis and (iii) a dummy indicating the child had a low birth weight (less than 2,500 grams). I also ran an IV panel estimation with a dummy indicating the child suffered a serious illness as the dependent variable[28]. The results show that increases in public spending generate worse health outcomes in rural areas, while improvement in urban ones. Moreover public expenditure is increasing the level of child health inputs used only in urban areas. Probably poor quality services are not generating interest in the rural population decreasing the potential demand. The results provide evidentiary support to the claim of less effective public services in rural areas. Finally, I measure the existence of crowding out of private services in rural areas by

[28] In all estimations I used as controls maternal education, household characteristics (number of children under 5 years of age, availability of drinking water, household size and wealth score), community characteristics (availability of preventive and curative health public programs, population size, a dummy for belonging to the highlands and a poverty index) and the level of regional debt payments. In addition in estimations (ii) and (iv) I controlled for child's age and relative health status, while in estimation (iii) I also controlled for child gender and maternal native tongue. For estimations (i) (ii) and (iii) I clustered the standard errors at the region level, while for (iv) I did it at the region-year level and I used time and regional fixed effects.

running a panel regression where the dependent variable is the child z-score. All the controls and fixed effects included in the main estimations are included. Three regressors are added: (i) the predicted level of public health centers in the locality, (ii) the level of private hospitals in the locality and (iii) the interaction between the predicted level of public health centers and the level of private hospitals in the locality. The predicted level of public health centers is calculated using the estimates from the IV regression presented in **Table 9B**. The estimates obtained show a positive impact of private facilities in rural areas and a negative impact of public ones. The interaction term is negative, indicating that increasing public facilities decreases the effectiveness of private practices in rural areas. These estimates support the crowding out theory.

VII. Exclusions at work

Disadvantaged groups may end up profiting little from public expenditures if access to and use of services provided by the government are affected by the possession of private assets (Filmer et al. 1999 and 2003, Filmer 2000, Castro-Leal F. et al. 1999, O'Donnell 2007, O'Donnell et al. 2007, Thomas et al. 1991). This will lead to heterogeneous treatment effects. When we do not take into account these differences we end up calculating what Heckman and Vitlacyl (1999) called average treatment effects (ATE) instead of what we should aim to measure which are the effects of the treatment on the treated (TT). Hence the initial results could underestimate the actual impact of increasing public expenditure on those who are able to access the services. I present estimates from urban and rural samples to differentiate the effect of a lower quantity and quality supply of public goods and services from the impact of lacking access to key private assets[29].

[29] The instrumental variable in all of the following estimations was tested and proved to be strong.

1. The impact of public spending according to gender

In some cultures boys are given preferential treatment and could therefore profit more from the availability of public goods and services. I test this theory by estimating separate conditional demand functions for the nutritional level of boys and girls for both urban and rural areas (see **Table 10)**. Total expenditure has a positive and statistically significant impact on both boys and girls living in urban areas. The impact is larger for girls (0.33 compared to 0.26) and the difference is statistically significant. I find no statistically significant impact in rural areas regardless of gender. These results could indicate that at least in urban areas there could be a preferential treatment for girls.

2. The impact of public expenditure according to child resilience

Children with a lower birth weight may be more fragile and less resilient. Parents with more resilient children could either use public facilities less than the average mother (confidence selection[30]) or be more intense users of public services (favorable selection[31]). To evaluate these contrasting hypotheses I divided the children in two groups: those belonging to the lowest birth weight quartile and those belonging to the other quartiles[32].

In urban areas, public expenditure has a statistically significant and positive impact only on the nutritional level of children that are above the 25th birth weight percentile (see **Table 11**). The coefficient estimate for the sub sample in the highest percentiles for birth weight is larger than the one for the whole urban sample (0.348 vs. 0.294). These results would be consistent with the favorable selection hypothesis. On the other hand, in rural areas public expenditure has a negative impact (less statistically significant, but

[30] Mothers with children with higher birth weight and full term pregnancies could consider their children to be at a very low risk of having a poor nutrition outcome. These women may delay care and only take their children to sporadic checkups (Frick and Lantz 1996).
[31] Mothers with more resilient children are mothers that took better care of themselves during their pregnancies. These health-conscious women probably see their resilient children as an investment and are motivated to use public goods and services to take good care of them. Also they might adhere more firmly to health providers' advice and so promote a better outcome in their children (Frick and Lantz 1996).
[32] There were 270 children that did not have information about their birth weight. If this information was not available, children prematurely born were considered to be in the lowest birth weight quartile. Children with missing data for birth weight and born not prematurely were not included in the estimation.

still significant at a 10% level) on children belonging to the higher birth percentiles. There is no statistically significant impact for the non resilient group in either area. To understand the results for rural areas it is necessary to consider the possibility of the crowding out of higher quality private goods and services by lower quality public goods and services. When public expenditure expands in rural areas this could lead to the displacement of more effective private services. Given that rural markets are very small it is quite possible that an enlarged public sector could leave no space for the private sector to make a profit. Consequently, the children of mothers who actively look for services (the ones with the most resilient children according to the favorable selection hypothesis) would be the ones that could be more hurt by this increase in public spending.

3. The impact of public spending according to maternal mother tongue

Another personal characteristic that could influence access and demand levels of public goods and services is maternal mother tongue. Specifically a mother whose mother tongue is not Spanish will face difficulties. The language barrier could decrease the ability to comply with medical advice or simply allow women to comprehend publicly available information related not only to health but also to hygiene and feeding practices. This limitation could increase the risk of acquiring infectious diseases and of fighting them better. In addition, non Spanish speakers when attending a public facility might not be able to communicate adequately with the service providers. This inadequacy could create in these mothers a lack of self confidence and a fear of inferior treatment (Rogers et al. 2002). I define as "indigenous" the group of mothers with a mother tongue different from Spanish and as "not indigenous" the ones with Spanish as their mother tongue.

In rural areas there is no statistically significant effect of public spending regardless of mother tongue (see **Table 12**). In urban areas the impact of public expenditure is only positive and significant for not indigenous mothers. This impact is stronger than for the whole urban sample (0.314 vs. 0.294).

4. The impact of public spending according to household wealth level

Families with more economic resources might be better able to afford the cost of using public services and of consuming public goods. In order to take advantage of public goods and services people need to invest time. In a household with an extremely tight budget, taking one day off to take a child to the hospital might not be a feasible option. I define poor households as those with an initial household wealth score below the regional household wealth median[33]. Households below the regional household wealth median are considered to be "poor" given that the average per capita income during that period for those households was the equivalent to $ 719[34]. This means $ 60 per month. Children in rural areas are apparently not being benefited by public spending (see **Table 13**). Public expenditure is only impacting positively (and statistically significantly) the nutritional level of children belonging to "non poor" households in urban areas.

VIII. Discussion

This paper offers new evidence of the differential impact of public expenditure on child health outcomes in a developing country. In contrast to previous work it uses longitudinal micro data and exploits variation in natural resource royalties. This instrumental variable is shown not to be related to child nutrition except through public spending. In addition, this paper differs from the existing literature because it disentangles supply and demand restrictions that diminish the effectiveness of public expenditure. I provide evidence that indicates public expenditure is ineffective in rural

[33] The regional household wealth median was calculated using the ENAHO surveys.

[34] There is no information about income in the Young Lives Study. To create an income measure I estimated an OLS regression using information from the ENAHO surveys. Specifically I regressed per capita income on age, education level, insurance ownership, type of toilet facility, household size, household wealth score, regional public expenditure level, a time dummy and regional dummies. Using the estimated coefficients I estimate predicted per capita income for the sample in the Young Lives Study. Then I calculated the mean value of this predicted income for household with wealth scores below the regional household wealth median. For households above the median annual predicted per capita income is $1,311.

areas. This statement is true regardless of the type of expenditure analyzed. Lower quantity and quality of services and the existence of crowding out of private expenditure in those areas are the main explaining factors for this result. In urban areas, spending in health and sanitation is the most important channel through which public expenditure impacts child health. Unexpectedly, poverty alleviation programs, which finance most nutritional interventions in Peru, do not appear to have an impact on child well-being. Conversely expenditure on education and transportation which are not traditionally associated to child nutritional levels, influence this outcome. Furthermore, in urban areas consumption of public goods and services differs depending on child, maternal and household characteristics. The children not being benefited by public expenditure are the worst off. These children belong to households with lower incomes, have indigenous mothers and are the ones with the lowest birth weights. The consequence is a regressive distribution of stunting. These findings are consistent with previous studies that indicate an anti poor bias of public spending in developing countries (Castro-Leal, F et. a. 1999, O'Donnell et al. 2007, Wagstaff et al. 2000). Public expenditure is not helping the most destitute children and thus is unable to break the cycle of poverty and malnutrition. This result means disparities in outcomes could deepen in the future. A limitation of this paper is the lack of information for infants as well as for older children. I use data for children between their first birthday and until they turn 6 years old. Nutrition production varies across age groups and there could be periods where public expenditure could be more critical than others. Hence, the findings of this study may not generalize to younger or older children.

Future research should focus on how to raise health services utilization in rural areas. This implies evaluating policies that offer the greatest potential to break down the barriers that constrain access to goods and services that improve the nutritional level of the child e.g.: extending health insurance coverage or providing cash transfers. This could prevent crowding out in sparsely populated areas and help the poor access higher quality private goods and services.

References

Adair, L.S. and Guilkey, D.K. 1997 "Age-Specific Determinants of Stunting in Filipino Children" *Journal of Nutrition* 127:314-320

Aguiar, C., Rosenfeld, J., Stevens, B., Thanasombat, S. and Masud, H. 2007 "An Analysis of Malnutrition Programming and Policies in Peru", paper prepared for the International Economic Development Program, the Gerald R. Ford School of Public Policy and School of Public Health, University of Michigan

Alderman, H., Hoddinott, J. and Kinsey, B. 2006 "Long term consequences of early childhood malnutrition" *Oxford Economic Papers* 58: 450-474

Alderman, H., Hentschel, J. and Sabates, R. 2001 "With the help of one's neighbors - externalities in the production of nutrition in Peru" *The World Bank,* Policy Research Working Paper Series 2627

Altonji, J. and Card, D. (1991) "The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives," in J. Abowd and R. Freeman, eds. Immigration, Trade and the Labor Market, *Chicago: University of Chicago Press*

Baldacci, D. Guin-Siu, M.T. and de Mello, L. 2002 "More on the Effectiveness of Public Spending on Health Care and Education: A covariance Structure Model" *IMF Working Paper* (2)90

Barrera, A. 1990 "The role of maternal schooling and its interaction with public health programs in child health production" *Journal of Development Economics* 32: 69-91

Becker, G. 1965 "A Theory of the Allocation of Time" *Economic Journal* 75: 493-517.

Castro-Leal, F, Dayton, J., Demery, L. and Mehra, K. 1999 "Public social spending in Africa: do the poor benefit?" *World Bank Research Observer* 14(1): 49–72

Cebu Study Team 1992 "A Child Health Production Function Estimated from Longitudinal Data." *Journal of Development Economics* 38:323-351.

Cebu Study Team 1991 "Underlying and Proximate Determinants of Child Health: The Cebu Longitudinal Health and Nutrition Study." *American Journal of Epidemiology* 133(2):185-201.

Chong, A., Hentschel, J and Saavedra, J. 2003 "Bundling and household welfare in the delivery of social services in developing countries using panel data: The case of Peru", *IDB/WB/GRADE*

Currie, J. 2000 "Child Health in Developed Countries" *Handbook of Health Economics* 1(19): 1053-1090

Devarajan, S. and Reinikka, R. 2004 "Making Services Work for Poor People," *Journal of African Economies* 13(1): i142-i166

Ehiri, J. and Prowse, J. 1999 "Child health promotion in developing countries: the case of integration of environmental and social interventions?" *Health Policy and Planning* 14(1): 1-10

ENDES 2001 "Encuesta Demográfica y de Salud Familiar 2000". *INEI*

ENDES 2007 "Encuesta Demográfica y de Salud Familiar Continua 2004-2006". *INEI*

Escobal, J., Saavedra, J., Suárez, P., Huttly, S. Penny, M., Lanata, C. and Villar, E. 2005 "The Interaction of Public Assets, Private Assets and Community Characteristics and its Effect on Early Childhood Height-for-Age in Peru", *Young Lives: An International Study of Childhood Poverty Working Paper* 14

Escobal, S. Ames, P., Cueto, S., Penny, M., Flores, E. 2008 "Young Lives: Peru Round 2 Survey", *Young Lives: An International Study of Childhood Poverty Country Report*

Escobal, J and Torero, M. 2002 "Asset complementarities: The case of rural Peru", paper presented at the 2001 Global Development Network (GDN) Annual Conference, Rio de Janeiro.

Fan, S. Hazell, P. and Thorat, S. 2000 "Government Spending, Growth and Poverty in Rural India" *American Journal of Agricultural Economics*, 82(4): 1038-1051

Filmer D. 2003 "The incidence of public expenditures on health and education Background note for the World Development Report 2004: making services work for the poor" *World Bank*

Filmer, D. and Pritchett, L. 1999 "The impact of public spending on health: does money matter?" *Social Science & Medicine* 49:1309–1323

Filmer D, Hammer J and Pritchett L. 2000 "Weak links in the chain: a diagnosis of health policy in poor countries" *World Bank Research Observer* 15(2):199-224

Frankenberg, E., Suriastini, W. and Thomas, D. 2005 "Can Expanding Access to Basic Health Care Improve Children's Health Status? Lesson's from Indonesia's 'Midwife in the Village' Program" *Population Studies* 59(1): 5-19

Frankenberg E. and Mason W. 1995. "Maternal Education and Health-Related Behaviors: A Preliminary Analysis of the 1993 Indonesian Family Life and Survey." *Journal of Population* 1(1): 21-44

Frick, K. D. and Lantz, P. M. 1996 "Selection Bias in Prenatal Care Utilization: An Interdisciplinary Framework and Review of the Literature." *Medical Care Research and Review* 53(4): 371-396

Glewwe, P., Jacoby HG, and King EM. 2001 "Early childhood nutrition and academic achievement: a longitudinal analysis." *Journal of Public Economics* 81: 345–368

Glewwe, P. 1999 "Why does mother's schooling raise child health in developing countries? Evidence from Morocco" *The Journal of Human Resources* 34(1): 124-59

Glewwe, P. and Jacoby, Hanan G. 1995 "An Economic Analysis of Delayed Primary School Enrollment in a Low Income Country: The Role of Early Childhood Nutrition" *The Review of Economics and Statistics* 77(1): 156-169

Gronau, R. 1977 "Leisure, Home Production and Work – The Theory of the Allocation of Time Revisited" *Journal of Political Economy* 85(6): 1099-1123

Grossman, M. 1972 "On the Concept of Health Capital and the Demand for Health" *Journal of Political Economy* 80(2): 223-255

Gupta S, Verhoeven M, Tiongson ER. 2003 "Public spending on health care and the poor" *Health Economics* 12:685-96

Heckman, J. and Vytlacil, E. 1999 "Local instrumental variables and latent variable models for identifying the bounding treatment effects" *Proceedings of the National Academy of Sciences* 96(8): 4730-4734

INEI http://www.inei.gob.pe/

Larrea, C., Montalvo, P. and Ricaurte. A.M. 2005 "Child Malnutrition, Social Development and Health Services in the Andean Region" *Inter-American Development Bank* Research Network Working paper R-495

Maluccio, John A.; Hoddinott, John; Behrman, Jere R.; Martorell, Reynaldo; Quisumbing, Agnes R. and Stein. Aryeh D. 2006 "The Impact of Nutrition during Early Childhood on Education among Guatemalan Adults" *PSC Working Paper Series* 06(04)

McGinnis, J. M., Williams-Russo, P and Knickman, J. R. 2002 "The Case for More Active Policy Attention to Health Promotion" *Health Affairs* 21(2): 78-93.

McKinnish, T. 2008 "Panel Data Models and Transitory Fluctuations in the Explanatory Variable" *Advances in Econometrics* 21.

Mwabu, G. 2008 "Health Economics for Low-Income Countries," *Handbook of Development Economics* (4)53: 3305-3374

O'Donnell, O. 2007 "Access to health care in developing countries: breaking down demand side barriers" *Cad. Saúde Pública* 23(12):2820-2834

O'Donnell O, van Doorslaer E, Rannan-Eliya RP, Somanathan A, Adhikari SR, Harbianto D, et al. 2007 "The incidence of public spending on healthcare: comparative evidence from Asia" *World Bank Economic Review* 21:93-123

Oreopoulos, P., Stabile, M., Walld, R. and Roos, L. (2008) "Short, Medium, and Long Term Consequences of Poor Infant Health: An Analysis Using Siblings and Twins." *The Journal of Human Resources* 43(1): 88-138.

Pollack, Robert A. 1969 "Conditional Demand Functions and Consumption Theory" *The Quarterly Journal of Economics*. 83(1): 60-78.

Rogers, B., Rajabiun, S., Levinson, J. and Tucker, K. 2002 "Reducing Chronic Malnutrition in Peru: A Proposed National Strategy" *Tufts Nutrition*, Discussion Paper 2

Russett, Bruce; Jackson, Steven; Snidal, Duncan and Sylvan, D. 1981 "Health and Population Patterns as Indicators of Income Inequality" *Economic Development and Cultural Change* 29(4): 759-779

Rosenzweig, M. and Wolpin, K. 1986 "Evaluating the Effects of Optimally Distributed Public Programs: Child Health and Family Planning Interventions" *The American Economic Review* 76(3): 470-482

Schultz, P. 2004 "Health economics and applications in developing countries" *Journal of Health Economics* 23(4): 637-641

Smith, L., Ruel, M. and Ndiaye, A. 2005 "Why Is Child Malnutrition Lower in Urban Than in Rural Areas? Evidence from 36 Developing Countries" *World Development* 33(8): 1285–1305

Stock, J. H. and Yogo, M. 2002 "Testing for Weak Instruments in Linear IV Regression" *NBER Technical Working Paper* 284

Stock, J. H., Wright, J. and Yogo, M. 2002 "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments" *Journal of Business & Economic Statistics* 20(4): 518-529.

Strauss, J. and Thomas, D. 1998 "Health, Nutrition, and Economic Development" *Journal of Economic Literature* 36(2): 766-817

Thomas, D., Strauss, J. and H .Henriques, M. 1991 "How does mother's education affect child height?" *The Journal of Human Resources* 26(2): 183-211

Thomas, D., Lavy, V. and Strauss, J. 1996 "Public policy and anthropometric outcomes in the Côte D'Ivoire" *Journal of Public Economics* 61: 155-92

Valdivia, Martin, 2004 "Poverty, health infrastructure and the nutrition of Peruvian children" *Economics and Human Biology* 2(3): 489-510

Van de Poel, E., O'Donnell, O. and van Doorslaer, E. 2007 "Are Urban Children really healthier? Evidence from 47 developing countries" *Tinbergen Institute* Discussion Paper TI 2007-035/3

Wagstaff A, Watanabe N. 2000 "Socioeconomic inequalities in child malnutrition in the developing world" *World Bank* Policy Research Working Paper 2434

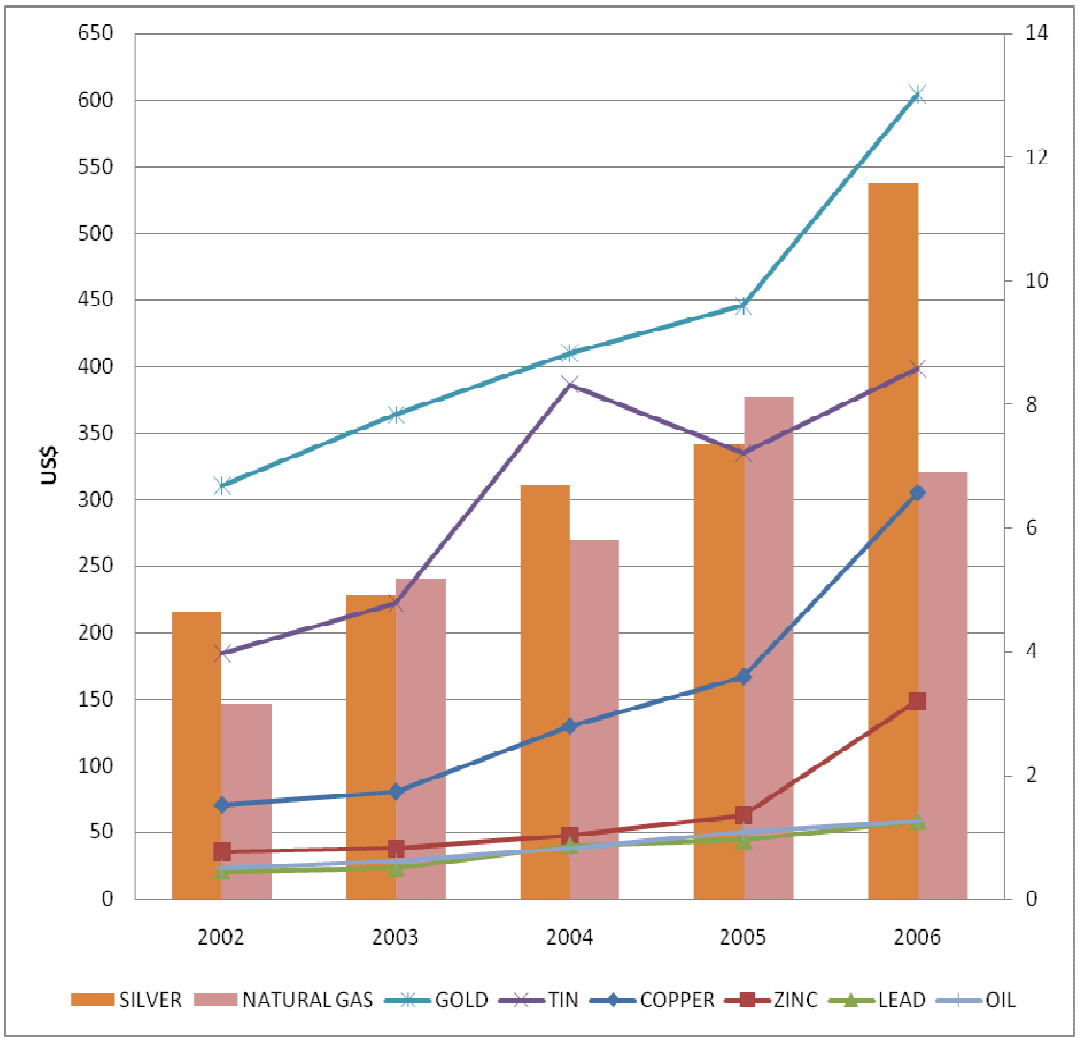
Walker S.P., Chang S.M., Powell C.A., Grantham-McGregor S.M. 2005 "Effects of early childhood psychosocial stimulation and nutritional supplementation on cognition and education in growth-stunted Jamaican children: prospective cohort study." *Lancet* 366: 1804–07

Wolfe, B. and Behrman, J. 1982 "Determinants of child mortality, health and nutrition in a developing country" *Journal of Development Economics* 11(2):163-193

Wooldridge, J. 2002 "Econometric Analysis of Cross Section and Panel Data" *MIT Press*

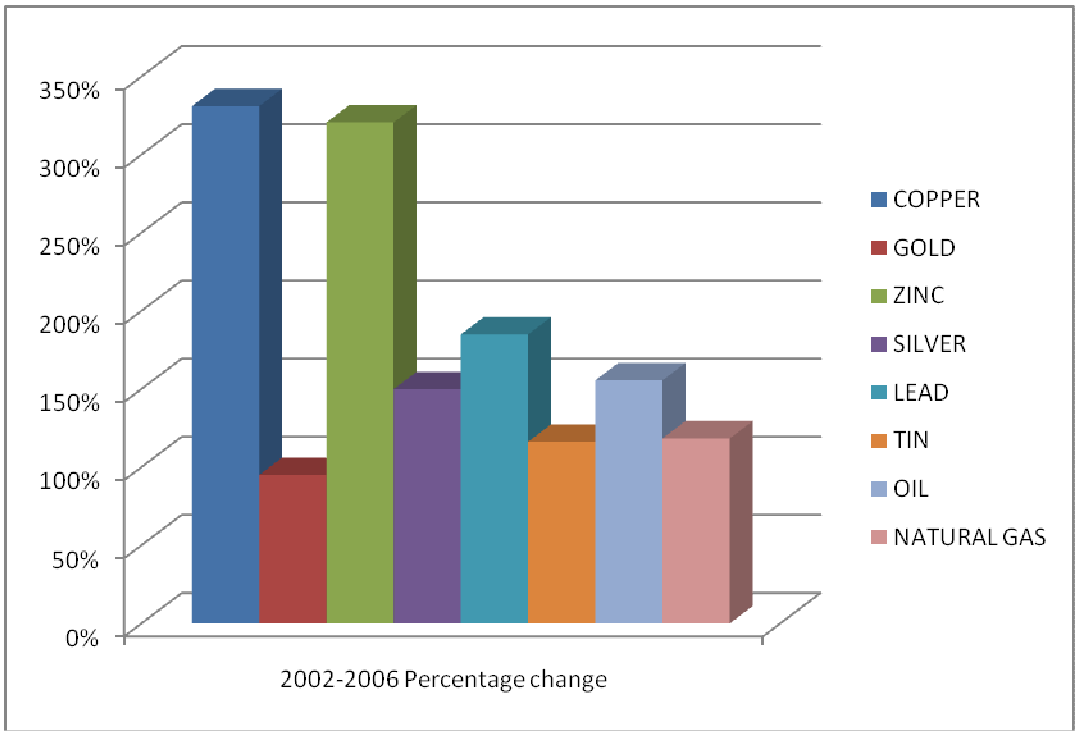
Tables and Graphs

Graph 1
Evolution of World Mineral Prices: 2002-2006



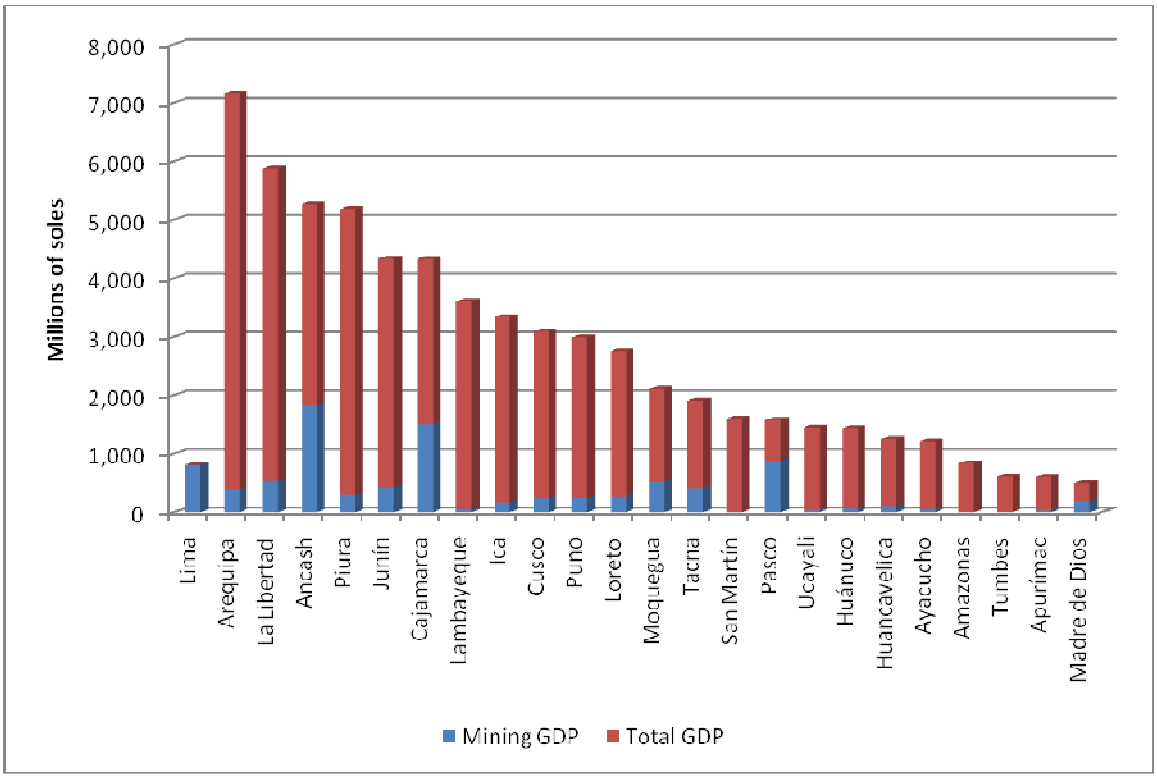
Note: Copper, zinc, lead and tin are measured in US$/lb, gold and silver are measured in US$/Oz.tr. Oil is measured in US$/bbl. and natural gas in US$ per 1000 feet3.
Silver and natural gas are measured on the right vertical axis.
Source: London Metal Exchange and London Bullion Market Association and NGA, annual reports, Oil Patch Research Group

Graph 2
Percentage change in World Mineral Prices between 2002 and 2006



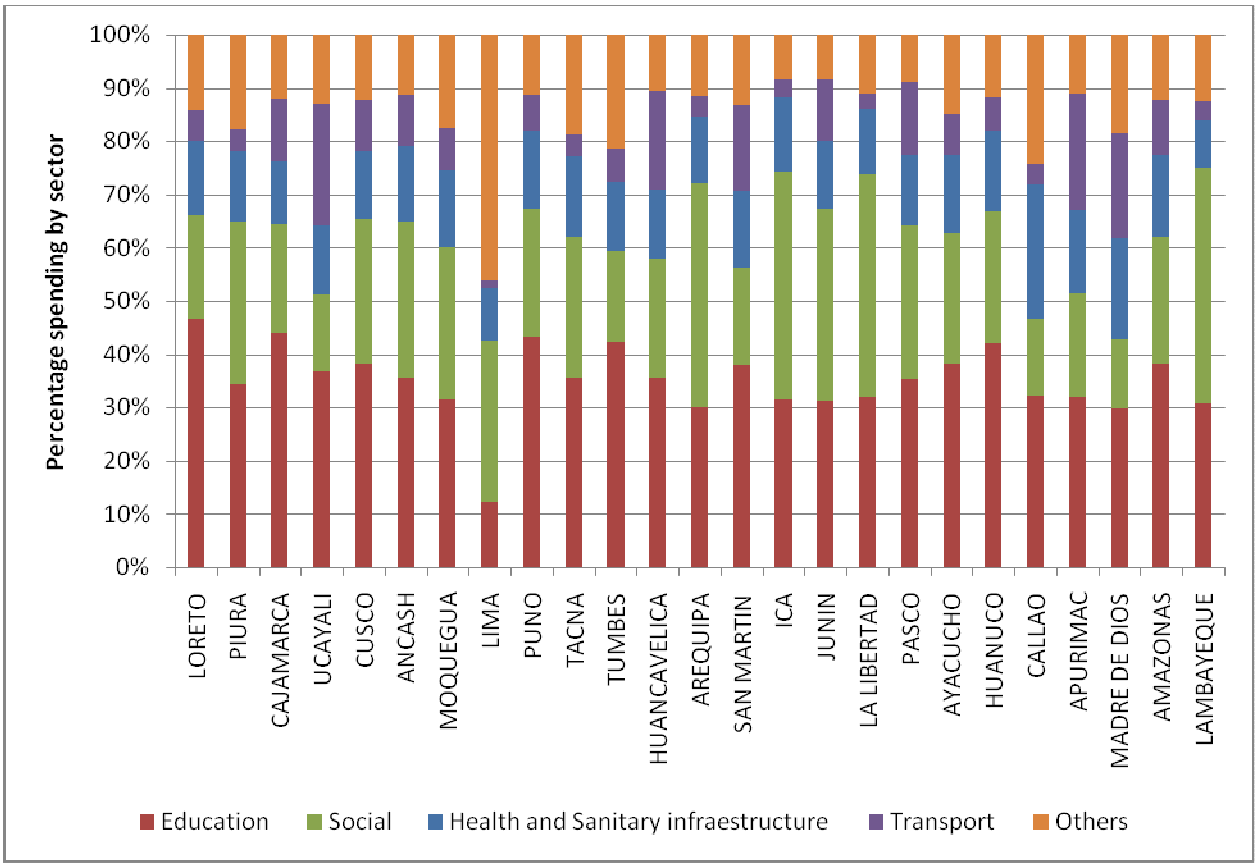
Source: London Metal Exchange and London Bullion Market Association and NGA, annual reports, Oil Patch Research Group

Graph 3
Average total GDP and mining GDP between 2002 and 2006 by region



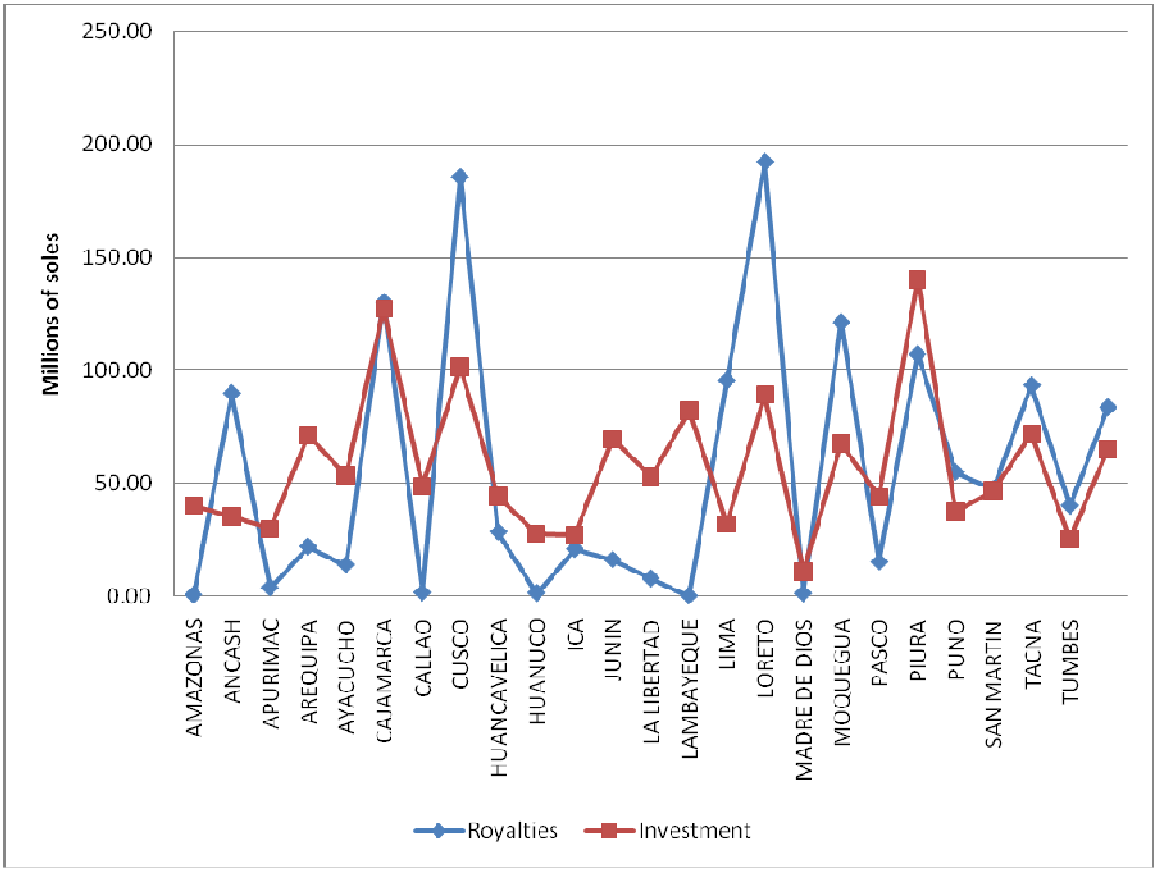
Note: The total average GDP for Lima (64,710 million soles) has been excluded to better show the relationship between mining GDP and total GDP for the rest of the regions.
Source: National Institute of Information and Statistics (INEI)

Graph 4
Percentage of average government expenditure directed to different sectors in each region between 2002 and 2006
Regions ordered by the total amount of royalties assigned to them between 2002 and 2006



Note: In Lima 27% of public spending is directed to defense, 9% to administration and planning and 4% to Justice. This makes up for over 85% of the "Others" category.
Regions are ordered according to the total amount of royalties received between 2002 and 2006. Loreto received the largest amount, while Lambayeque received the smallest.
Source: Ministry of Economics and Finance (2002-2006)

Graph 5
Relationship between the amounts of royalties assigned to a region and the amount of money spent by that region in investment projects during 2006



Source: Ministry of Economics and Finance (2006)

Table 1
Test for mean differences between attrited sample and continuing sample

Variable	Continued		Attrite		T -statistic
	Mean	S.D	Mean	S.D	Ho: diff = 0
Probability of being malnourished	0.17	0.01	0.24	0.05	-1.54
Z-score (height for age)	-0.78	0.03	-0.81	0.17	0.22
Gender	0.50	0.01	0.41	0.05	1.73
Birth weight	3201	12	3188	57	0.23
Age of child in months	11.54	0.08	11.63	0.38	-0.25
Serious illness	0.32	0.01	0.33	0.05	-0.29
Age of mother at birth	27	0.15	26	0.68	1.34
Mother's height	150	0.12	149	0.63	**2.18**
Maternal mother tongue is not Spanish	0.32	0.01	0.42	0.05	-1.94
Maternal education level	7.56	0.03	7.51	0.10	0.10
Number of children in household under 5yrs	0.43	0.01	0.49	0.06	-0.97
Household size	5.71	0.05	5.52	0.24	0.76
Drinking water piped into the household	0.77	0.01	0.72	0.05	1.11
Household Wealth score	0.01	0.06	-0.21	0.25	0.81
Immunization program in community	0.85	0.01	0.76	0.05	**2.57**
Number of people living in the locality	4.81	0.09	4.68	0.41	0.29
Highlands	0.50	0.01	0.59	0.05	-1.64
Poverty Index	0.14	0.00	0.14	0.01	-0.73
Urban	0.65	0.01	0.72	0.05	-1.37
Debt Repayment	11.02	0.60	10.70	2.76	0.11
Total Public Spending	29.34	1.28	28.63	5.93	0.12
Natural Resources Royalties	0.10	0.01	0.06	0.02	1.92

Attrite sample: 90 children. Continuing children: 1962.
Source: Young Lives Study Round 1 and ENAHO 2002, and Ministry of Economic and Finance Budgetary Expenditure for 2002.

Table 2
Descriptive statistics for urban and rural areas for both rounds

	Round 1				Round 2			
Variable	**Urban**		**Rural**		**Urban**		**Rural**	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Probability of living in the area	65%	48%	35%	48%	69%	46%	31%	46%
Probability of being malnourished	11%	31%	30%	46%	21%	40%	58%	49%
Z-score (height for age)	-0.50	1.25	-1.32	1.30	-1.20	1.05	-2.18	0.95
Age of child in months	12	3	12	4	65	4	61	4
Serious illness	0.31	0.46	0.33	0.47	0.19	0.39	0.23	0.42
Maternal education level	2.17	1.19	1.07	0.77	2.39	1.26	1.21	0.88
Number of children in household under 5yrs	0.36	0.58	0.58	0.64	0.59	0.71	1.12	0.85
Household size	5.57	2.32	5.95	2.34	5.25	2.04	6.08	2.05
Drinking water piped into the household	0.84	0.36	0.63	0.48	0.74	0.44	0.34	0.47
Household Wealth score	1.08	2.29	-2.05	1.16	1.07	2.26	-2.42	1.19
General Physician in locality	79%	40%	27%	45%	78%	31%	32%	21%
Pediatrician/Gynecologist in locality	50%	50%	4%	20%	39%	36%	3%	11%
Midwife in locality	88%	33%	50%	50%	79%	26%	52%	20%
Public Health Center in locality	79%	41%	21%	41%	99%	4%	92%	9%
Blood bank in locality	23%	42%	0%	0%	20%	30%	3%	9%
Immunization program in locality	92%	27%	72%	45%	99%	3%	95%	6%
Disease prevention Campaigns in locality	93%	25%	78%	41%	99%	3%	95%	6%
Program to control child growth in locality	93%	25%	78%	41%	99%	3%	95%	6%
Family Planning Program in locality	93%	25%	78%	41%	99%	3%	95%	6%
Highlands	39%	49%	72%	45%	36%	48%	77%	42%
Number of people living in the locality	6058	3918	2416	3364	21246	24190	1769	4382

Source: Young Lives Study Round 1 and 2.

Table 3
Impact of royalties on net income per capita

Dependent Variable: Net income per capita	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Natural Resources Royalties	-2.99			
	(30.417)			
Next Year's Natural Resources Royalties		18.28		
		(14.527)		
Average future Natural Resources Royalties			14.65	
			(10.835)	
Two years from now Nat. Res. Royalties				11.43
				(8.243)
Community poverty line	26.25	26.16	26.17	26.19
	(3.030)***	(3.038)***	(3.035)***	(3.033)***
Dummy for year=2002	-2,382	-2,254	-2,234	-2,230
	(194.14)***	(178.09)***	(185.81)***	(189.22)***
Total Public Spending	5.33	4.93	4.90	4.91
	(0.418)***	(0.414)***	(0.407)***	(0.390)***
R-squared	0.23	0.23	0.23	0.23

Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors are clustered by region and year. Geographical Regions: 25. Observations: 171,903
Note: Royalties are measured in 10 million soles and net per capita income in soles per year.
Source: ENAHO 2002, 2006 and Ministry of Economic and Finance Expenditure Statistics for 2002 - 2008.

Table 4
Impact of royalties on the probability of being ill in the last 4 weeks

Dependent Variable: Health status	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Average future Natural Resources Royalties	0.001				
	(0.001)				
Next Year's Natural Resources Royalties		0.001			
		(0.001)			
Natural Resources Royalties Current Year			0.003		
			(0.002)		
Lagged Natural Resources Royalties				0.004	
				(0.005)	
Double Lagged Nat. Res. Royalties					0.003
					(0.008)
Other Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors are clustered by region and year. Geographical Regions: 25. Observations: 171,903
Marginal effects calculated at the means. Controls: Community poverty line, total public spending, year fixed effects and regional fixed effects.
Note: Royalties are measured in 10 million soles and net per capita income in soles per year.
Source: ENAHO 2002, 2006 and Ministry of Economic and Finance Expenditure Statistics for 2000 - 2008.

Table 5
Impact of royalties on the probability of migrating to another region

Dependent Variable: Probability of migrating	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Average future Natural Resources Royalties	0.001				
	(0.010)				
Next Year's Natural Resources Royalties		0.004			
		(0.012)			
Natural Resources Royalties			0.026		
			(0.021)		
Lagged Natural Resources Royalties				0.041	
				(0.026)	
Double Lagged Nat. Res. Royalties					0.034
					(0.041)
Poverty Index	-0.126	-0.127	-0.140	-0.139	-0.138
	(0.085)	(0.085)	(0.084)*	(0.085)*	(0.085)
Total Public Spending	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors are clustered by region. Geographical Regions: 23. Observations: 1,962
Marginal effects calculated at the means
Note: Public Spending and Royalties are measured in 100 million soles.
Source: Young Lives Study Round 1 and 2, Ministry of Economic and Finance Expenditure Statistics for 2002 and 2006.

Table 6A
First stage estimation
Impact of royalties on public expenditure for the whole sample, rural and urban areas

Dependent Variable: Public Spending	**Pooled IV**	**Panel IV**	**Panel Rural IV**	**Panel Urban IV**
Natural Resources Royalties	2.067	2.125	2.883	1.347
	(0.047)***	(0.069)***	(0.175)***	(0.053)***
Other Controls	YES	YES	YES	YES
Number of observations	3,836	1,877	676	1,201
Partial R-squared of excluded instrument	0.332	0.340	0.298	0.353
F-test for weak identification	1929	946	271	635

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. They include regional fixed effects and time fixed effects.
Controls: child's age and health status, maternal education, number of children under 5 years of age in the household, availability of drinking water, household size, wealth score, availability of public programs in the community, population size, a dummy for belonging to the highlands, a dummy for being an urban area, a poverty index and the level of regional debt payments. Covariates that should be taken care by the fixed effect (sex, maternal age at birth, maternal height, birth weight and ethnicity) were not included. Spending measured in 100 million soles. The independent variable is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 6B
First stage estimation (IV Panel Data)
Impact of royalties on different types of public expenditure for the whole sample, rural and urban areas

Dependent Variable: Public Spending on Health and Sanitation			
	Whole Sample	**Rural Sample**	**Urban Sample**
Natural Resources Royalties	0.205	0.313	0.104
	(0.008)***	(0.019)***	(0.006)***
Partial R-squared of excluded instrument	0.268	0.291	0.214
F-test for weak identification	694	263	317
Dependent Variable: Public Spending on Education			
	Whole Sample	**Rural Sample**	**Urban Sample**
Natural Resources Royalties	0.950	1.108	0.768
	(0.023)***	(0.058)***	(0.020)***
Partial R-squared of excluded instrument	0.467	0.366	0.559
F-test for weak identification	1,668	369	1,477
Dependent Variable: Public Spending on Poverty Alleviation			
	Whole Sample	**Rural Sample**	**Urban Sample**
Natural Resources Royalties	0.442	0.796	0.086
	(0.026)***	(0.056)***	(0.023)***
Partial R-squared of excluded instrument	0.128	0.240	0.012
F-test for weak identification	278	202	14
Dependent Variable: Public Spending on Transportation			
	Whole Sample	**Rural Sample**	**Urban Sample**
Natural Resources Royalties	0.142	0.022	0.218
	(0.014)***	(0.032)	(0.014)***
Partial R-squared of excluded instrument	0.053	0.001	0.171
F-test for weak identification	108	0.5	242
Other Controls	YES	YES	YES
Number of observations	1,877	676	1,201

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. They include regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The independent variable is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 7
Pooled and Panel Data Estimation
Impact of public expenditure on a child's nutritional level for the whole sample, rural and urban areas

Dependent Variable: Z-score (height for age)	Panel OLS	Pooled IV	Panel IV	Panel Rural IV	Panel Urban IV
Total Public Spending	-0.062	0.149	0.086	-0.052	0.294
	(0.048)	(0.110)	(0.098)	(0.051)	(0.093)***
Other Controls	YES	YES	YES	YES	YES
Number of observations	1,877	3,836	1,877	676	1,201
R-squared	0.353	0.328			

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. They include regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for the IV estimation is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 8
IV Panel Data Estimation
Impact of public expenditure by government sector on a child's nutritional level for the whole sample, rural and urban areas

Dependent Variable: Z-score (height for age)	Whole Sample	Rural Sample	Urban Sample
Total Public Spending in Health and Sanitary	0.89	-0.476	3.802
	(1.091)	(0.480)	(1.509)**
Total Public Spending in Education	0.192	-0.134	0.513
	(0.198)	(0.142)	(0.133)***
Total Public Spending in Poverty Alleviation	0.413	-0.187	4.618
	(0.579)	(0.183)	(6.909)
Total Public Spending in Transportation	1.284	-6.879	1.813
	(1.260)	(40.510)	(0.460)***
Other Controls	YES	YES	YES
Number of observations	1,877	676	1,201

Note: each coefficient represents an independent regression. Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. They include regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year. Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 9A
IV Panel Data Estimation
Probability of accessing a health professional in your locality by area

	General Physician		Pediatrician/Gynecologist		Midwife	
Dependent Variable: Availability of a health professional in the locality	**Panel IV-Rural**	**Panel IV-Urban**	**Panel IV-Rural**	**Panel IV-Urban**	**Panel IV-Rural**	**Panel IV-Urban**
Total Public Spending	-0.092	0.438	-0.06	0.325	-0.143	0.205
	(0.063)	(0.082)***	(0.027)**	(0.115)***	(0.120)	(0.096)**
Household Wealth score	-0.009	0.015	-0.001	0.009	0.01	0.012
	(0.016)	(0.006)**	(0.005)	(0.008)	(0.021)	(0.004)***
Number of people living in the locality	0.003	0.01	0.008	0.006	0.019	0.004
	(0.012)	(0.005)*	(0.006)	(0.002)***	(0.015)	(0.004)
Average educational level in the region	0.427	-0.655	0.058	-0.229	-1.028	-2.00
	(1.048)	(0.826)	(0.309)	(1.254)	(1.528)	(0.805)**
Highlands	-0.219	-0.087	0.09	0.065	-0.018	-0.083
	(0.075)***	(0.058)	(0.044)**	(0.047)	(0.086)	(0.053)
Poverty Index	1.291	-0.451	0.673	0.317	1.239	-0.325
	(0.354)***	(0.482)	(0.169)***	(0.599)	(1.065)	(0.394)
Debt	-0.015	-0.804	0.127	-0.588	0.504	-0.376
	(0.320)	(0.148)***	(0.070)*	(0.209)***	(0.342)	(0.175)**
Year=2002	0.294	0.928	0.113	1.111	-0.149	0.082
	(0.404)	(0.476)*	(0.145)	(0.568)*	(0.893)	(0.334)
Number of observations	1285	2636	1285	2636	1285	2636
R-squared	0.260	0.484	0.194	0.630	0.071	0.496

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. It includes regional fixed effects and time fixed effects. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year. Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance (2000 – 2006).

Table 9B
IV Panel Data Estimation
Probability of accessing a health program or facility in your locality by area

	Disease prevention		Child growth controls		Public Health Center	
Dependent Variable: Availability of a health programs in the locality	**Panel IV-Rural**	**Panel IV-Urban**	**Panel IV-Rural**	**Panel IV-Urban**	**Panel IV-Rural**	**Panel IV-Urban**
Total Public Spending	-0.039	0.166	-0.029	0.166	0.171	0.02
	(0.072)	(0.098)*	(0.079)	(0.098)*	(0.098)*	(0.094)
Household Wealth score	0.009	0.002	0.007	0.002	0.013	0.005
	(0.011)	(0.003)	(0.011)	(0.003)	(0.012)	(0.003)
Number of people living in the locality	-0.011	0.001	-0.01	0.001	-0.014	0.005
	(0.012)	(0.002)	(0.012)	(0.002)	(0.006)**	(0.003)
Average educational level in the region	0.709	-1.121	0.887	-1.121	1.644	-1.521
	(0.800)	(0.723)	(0.908)	(0.723)	(0.777)**	(0.835)*
Highlands	-0.116	0.013	-0.123	0.013	-0.03	0.066
	(0.055)**	(0.014)	(0.057)**	(0.014)	(0.056)	(0.034)*
Poverty Index	0.558	0.272	0.55	0.272	-0.597	0.898
	(0.477)	(0.203)	(0.486)	(0.203)	(0.703)	(0.352)**
Debt	0.222	-0.302	0.192	-0.302	-0.254	-0.044
	(0.303)	(0.180)*	(0.307)	(0.180)*	(0.347)	(0.170)
Year=2002	0.106	0.216	0.171	0.216	-0.155	-0.164
	(0.314)	(0.288)	(0.359)	(0.288)	(0.423)	(0.326)
Number of observations	1285	2636	1285	2636	1285	2636
R-squared	0.233	0.600	0.239	0.600	0.644	0.663

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. It includes regional fixed effects and time fixed effects. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year. Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance (2000 – 2006).

Table 9C
IV Estimation
Impact of public expenditure on a child health outcomes and inputs by area

Dependent Variable:	Prenatal care intensity		Tuberculosis vaccine		Low birth weight		Serious illness	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Total Public Spending	0.118	-0.020	0.014	0.001	-0.025	0.092	-0.112	0.051
	(0.053)**	(0.064)	(0.007)*	(0.002)	(0.016)	(0.017)***	(0.049)**	(0.029)*
Other Controls	YES	YES	YES	YES	YES	YES	YES	YES
Number of Observations	1289	642	1304	670	1317	669	1216	688
R-squared	0.117	0.065	0.078	0.048	0.045	0.141		

Robust standard errors. * Significant at 10%; ** significant at 5%; *** significant at 1%. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 9D
IV Panel Estimation
Impact of public and private health centers on child nutrition in rural areas

Dependent Variable: Z-score (height for age)	
Predicted probability of accessing a public health center	-0.550
	(0.103)***
Probability of accessing a private hospital	0.481
	(0.171)***
Interaction of public health center and private hospital	-0.687
	(0.159)***
Other Controls	YES
Number of Observations	676
R-squared	0.45

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. It includes regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 10
IV Panel Data Estimation
Impact of public expenditure on a child's nutritional level by gender and area

Dependent Variable: Z-score (height for age)	**Rural**		**Urban**	
	Female	**Male**	**Female**	**Male**
Total Public Spending	-0.093	-0.025	0.334	0.262
	(0.065)	(0.080)	(0.112)***	(0.095)***
Other Controls	YES	YES	YES	YES
Number of Observations	343	333	585	616

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. It includes regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table11
IV Panel Data Estimation
Impact of public expenditure on a child's nutritional level by birth weight quartiles and area

Dependent Variable: Z-score (height for age)	Rural		Urban	
	Lowest quartile	**Higher quartiles**	**Lowest quartile**	**Higher quartiles**
Total Public Spending	0.053	-0.118	0.094	0.348
	(0.112)	(0.059)*	(0.075)	(0.100)***
Other Controls	YES	YES	YES	YES
Number of Observations	154	497	254	931

Robust standard errors clustered by region-year in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%. It includes regional fixed effects, individual fixed effects and time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 12
IV Panel Data Estimation
Impact of public expenditure on a child's nutritional level by maternal mother tongue and area

Dependent Variable: Z-score (height for age)	Rural		Urban	
	Indigenous	**Not indigenous**	**Indigenous**	**Not indigenous**
Total Public Spending	-0.058	0.675	-0.341	0.314
	(0.041)	(1.271)	(0.441)	(0.095)***
Other Controls	YES	YES	YES	YES
Number of Observations	370	306	206	996

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%
It includes regional fixed effects, individual fixed effects, time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Table 13
IV Panel Data Estimation
Impact of public expenditure on a child's nutritional level by wealth quartiles and area

Dependent Variable: Z-score (height for age)	Rural		Urban	
	Poor	**Not Poor**	**Poor**	**Not Poor**
Total Public Spending	-0.025	-0.010	0.301	0.267
	(0.092)	(0.074)	(0.744)	(0.089)***
Other Controls	YES	YES	YES	YES
Number of Observations	353	323	326	875

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%
It includes regional fixed effects, individual fixed effects, time fixed effects and all the previous controls. Spending measured in 100 million soles. The instrument for all the IV estimations is the amount of natural resources royalties assigned to the regions in each fiscal year.
Source: Young Lives Study Round 1 and 2, ENAHO 2002, 2006 and Ministry of Economic and Finance Budgetary Expenditure for 2000 - 2006.

Appendix

Appendix 1: Variation in the amount of royalties assigned to each region in each year


Peru Natural Resource Royalties, 2006
Colombia
Ecuador
Brazil
Bolivia
Chile
Amazonas
San Martin
La Libertad
Huanuco
Pasco
Junin
Cusco
Madre de Dios
Apurimac
Ayacucho
Huancavelica
Arequipa
Puno
Regions of Peru
Natural Resource Royalties (Millions of Soles)
None
Less than 1
1 - 10
10 - 50
More Than 50
N
W
E
S
0
100
200
400
Kilometers